STATE OF MINNESOTA

BEFORE THE PUBLIC UTILITIES COMMISSION

In the Matter of Minnesota Power's	)	
Petition for Approval of the Energy*Forward*	)	*PUC Docket No. E-015/AI-17-568*
Resource Package	)	*OAH Docket No. 68-2500-34672*

PETITION FOR RECONSIDERATION

OF THE

CLEAN ENERGY ORGANIZATIONS (CLEAN GRID ALLIANCE, FRESH ENERGY, MINNESOTA CENTER FOR ENVIRONMENTAL ADVOCACY, SIERRA CLUB AND THE UNION OF CONCERNED SCIENTISTS)

February 13, 2019

INTRODUCTION

Clean Grid Alliance, Fresh Energy, Minnesota Center for Environmental Advocacy, Sierra Club, and the Union of Concerned Scientists[1] (collectively, "Clean Energy Organizations" or "CEOs") request that the Minnesota Public Utilities Commission reconsider its January 24, 2019 decision to approve the Affiliated Interest Agreements with Conditions between Minnesota Power ("MP" or, "the Company") and its affiliate South Shore Energy, LLC related to the construction and operation of the Nemadji Trail Energy Center, (NTEC), a proposed 525 MW natural gas combined-cycle power plant in Superior, WI.

I. Facts and Procedural History

This case is about Minnesota Power's request to develop, construct, operate, and maintain a combined cycle gas plant in Superior, Wisconsin. Although the plant will be jointly owned by Dairyland and MP's subsidiary, South Shore Energy, LLC, MP will be the Construction Agent, the Operating Agent, and will pass on to its customers the costs and revenue, if any, from operating the plant.[2]

CEOs provided a complete procedural history up through the March 26, 2018 contested case hearing in their post-hearing briefs filed on May 1, 2018 and May 22, 2018. On July 2, 2018, the Administrative Law Judge found against Minnesota Power and recommended that the Commission not approve the affiliated interest agreements. In the ALJ's Findings of Fact,

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[1] The Union of Concerned Scientists ("UCS") employs scientists, analysts, and engineers to develop and implement innovative, practical solutions to some of society's most pressing problems. Its mission is to put rigorous, independent science to work by combining technical analysis and effective advocacy to create policy solutions for a healthy, safe, and sustainable future. With respect to climate change and energy, UCS conducts research and analysis to advance understanding of renewable and other energy technologies, policies, and markets, and to evaluate energy resource and climate change mitigation options in the electricity sector. UCS senior energy analyst Michael B. Jacobs provided testimony in this docket on behalf of the CEOs. UCS joins this petition as a person aggrieved by the decision and directly affected by it, under Minn. Stat. § 216B.27, subd. 1.

[2] Findings of Fact, Conclusions of Law, and Recommendation, *In the Matter of Minnesota Power's Petition for Approval of the Energy*Forward *Resource Package*, Docket Nos. OAH 68-2500-34672/PUC E-015/AI-17-568, July 2, 2018, at 6 [hereinafter "ALJ Report"].

Conclusions of Law and Recommendation (the "ALJ Report"), the ALJ concluded that Minnesota Power failed to carry its burden that the NTEC was needed and reasonable.

Subsequently, the CEOs and the other parties filed Exceptions to the ALJ Report. The CEOs encouraged the Commission to adopt the ALJ's Recommendation with only minimal changes. Specifically, the CEOs described how approval of Minnesota Power's request would violate state law, is not in the public interest, and is not necessary to ensure that Minnesota Power customers have reliable and cost-effective electricity. Also, the CEOs took exception to the ALJ's acceptance of MP's load growth forecast and instead urged the Commission to adopt the CEO's more realistic, and slower, load growth forecast.

The Commission met on October 18th to consider Minnesota Power's petition for approval and to receive oral arguments from the parties. On October 29th, the Commission met again to review the Petition for review under the Minnesota Environmental Policy Act ("MEPA") filed by Honor the Earth. On January 24, 2019, the Commission issued its order approving the affiliated interest agreements with certain conditions. As detailed in the Order, the Commission rejected the recommendation of the ALJ. In addition, the Commission denied the request for review under MEPA, finding that the approval of the affiliated interest agreements was not an action that required environmental review under MEPA.

ARGUMENT

II. The Minnesota Environmental Policy Act Requires Environmental Review for the Approval of Affiliate Interest Agreements Authorizing a Regulated Utility to Construct and Operate a Large Energy Facility

MEPA is our state's "look before you leap" law. By requiring government agencies to study the environmental consequences of their actions before those decisions are made, the law is designed to "promote efforts that will prevent or eliminate damage to the environment"[3] and "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."[4] The Act is primarily procedural in nature, but its procedural directive to study less damaging alternatives to a proposal serves a substantive function as well. The Legislature's clear intention is that by evaluating other means of achieving the same purpose, government agencies will ultimately choose alternatives or mitigations that are less harmful to natural systems and the

[3] Minn. Stat. § 116D.01.
[4] Minn. Stat. § 116D.02, subd. 2 (1).

people that depend on them. Indeed, one of the statute's action forcing provisions is directed at this purpose: "[n]o state action significantly affecting the environment shall be allowed . . . so long as there is a feasible and prudent alternative consistent with the reasonable requirements of the public health, safety, and welfare and the state's paramount concern for the protection of its air, water, land and other natural resources from pollution, impairment, or destruction."[5]

The principal means by which more preferable and feasible alternatives are identified is through environmental impact statements and environmental assessment worksheets. To that end, the law states that "[w]here there is potential for significant environmental effects resulting from any major governmental action, the action shall be preceded by a detailed environmental impact statement prepared by the responsible governmental unit."[6] If these conditions exist – a major governmental action with the potential for significant impacts – then a final governmental decision on a permit or project approval is prohibited prior to the completion of the environmental study.[7]

A. Approval of the Affiliate Agreements is a Governmental Action Having Significant Effects on the Environment

The construction of a 525-MW gas-fired electricity generation facility is, by definition, an action that has the potential for significant environmental effects.[8] It is therefore no surprise that the agency charged with implementing MEPA's regulations, the Environmental Quality Board ("EQB"), informed the Commission that "[MEPA] appl[ies] to the proposed governmental action being considered by the PUC."[9] The only questions at issue presently are two aspects of the current proposal that the Commission believes render the Act inapplicable: whether the approval of the affiliate interest agreements for NTEC constitute a "governmental action" and whether

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[5] Minn. Stat. § 116D.04, subd. 6.

[6] Minn. Stat. § 116D.04, subd. 2a (a).

[7] Minn. Stat. § 116D.04, subd. 2b.

[8] Minn. R. 4410.4400, subp. 3 (listing "large electric power generating plant" in the category of projects mandating an EIS); Minn. R. 4410.0200, subp. 41 and Minn. R. 7849.1100, subp. 6 (defining "large electric power generating plant" as "any electric power generating plant or combination of plants at a single site with a combined capacity of 50,000 kilowatts or more and transmission lines directly associated with the plant that are necessary to interconnect the plant to the transmission system.").

[9] Order Approving Affiliated Interest Agreements with Conditions, *In the Matter of Minnesota Power's Petition for Approval of the Energy*Forward *Resource Package*, Docket No. E-015/AI-17-568, January 24, 2019, at 5 [hereinafter "Order"].

MEPA applies to governmental actions having significant effects out of state. Under state law, both questions must be answered in the affirmative.

MEPA regulations define "governmental actions" as "activities including projects wholly or partially conducted, permitted, assisted, financed, regulated, or approved by governmental units."[10] The term "project" is defined as "a governmental action, the results of which would cause physical manipulation of the environment, directly or indirectly."[11] This determination, furthermore, "shall be made by reference to the physical activity to be undertaken and not to the governmental process of approving the project."[12]

The approval of the affiliate agreements in this case is a project partially permitted or approved by a governmental unit, the results of which will cause physical manipulation of the environment. The Company's petition requests approval for MP to "take the lead in developing, constructing, operating, and maintaining NTEC."[13] The affiliate agreements approved by the Commission's order in this docket assign to the Company the right and the obligation to develop, construct, operate and maintain the plant.[14] The Commission's approval of the affiliate agreements results in Minnesota Power having the "primary responsibility for the management of the planning, permitting, design, construction, acquisition and procurement, completion, startup and commissioning of NTEC; the planning, permitting, design, construction, acquisition and procurement and completion of any capital improvements, renewals, additions, replacements, modifications, or repairs to NTEC; and the scheduling, dispatch, sale, or other disposition of energy and ancillary services."[15] Given the magnitude and the scope of the affiliate agreements, it strains credulity to argue that the approval of these documents does not constitute a "permit" or "approval" of an activity causing physical manipulation of the environment. The result of the Commission's approval is the assignment to the Company of the obligation to construct and

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[10] Minn. R. 4410.0200, subp. 33.

[11] Minn. R. 4410.0200, subp. 65.

[12] *Id.*

[13] ALJ Order at 10.

[14] Ex. MP-4, App. D (Assignment of Rights Agreement (Construction Agent) between South Shore and Minnesota Power); Ex. MP-4, App. E (Assignment of Rights Agreement (Operating Agent) between South Shore and Minnesota Power).

[15] Ex. MP-25 (Supinski Direct) at 29.

operate a gas plant, resulting in very real construction and plant operation that would not occur if the agreements are not approved.[16]

Not only will MP construct and operate the plant, it will pass through its fuel purchase costs and energy sales revenue to its customers, just as if it wholly owned a 250 MW plant in Minnesota. The Commission has not merely approved a power purchase contract between MP and a merchant generator, the Commission has approved MP's construction and operation of a brand new gas plant. Once the Capacity Dedication Agreement is approved by the Commission, the approval "gives MP rights to the plant as if the asset would be held in rate base," generating a return for the Company on its $700 million investment.[17] On this point the Company's position is unequivocal: "The CDA provides that Minnesota Power is giving the Commission authority over the contract and relationship on the same basis as if Minnesota power owned the NTEC plant in its own name as a rate-based asset."[18]

B. The Commission Misconstrued the Nature of its Actions With Respect to its Obligations Under MEPA

The Commission seemed to ultimately give great weight to the Company's representations that the approval of the affiliate agreements is more akin to a power purchase agreement than approval of a power plant's certificate of need or siting permits. This argument does not accord with the record in this case. To begin with, the Commission has acknowledged that this proceeding is very much like a certificate of need proceeding, and directed the Office of Administrative Hearings ("OAH") to evaluate the proposal by looking at the certificate of need criteria.[19] The Commission's comparison to a PPA approval seems to indicate a belief that the affiliate agreements are a merely ministerial action, a bureaucratic action that "will not grant

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[16] *Id.* at 28 (noting that the Company's acceptance of the Construction Agent and Operating Agent responsibilities is contingent on receiving approval from the Commission for the affiliate agreements); Transcript of PUC Meeting, Oct. 18, 2018 at 92-93 (Testimony of S. Rakow); Ex. MP-5, App. H (Unit Contingent Capacity Dedication Agreement). The Commission's order raises the capacity dedication to 50%, meaning that if the affiliate interest agreements are not approved by the Commission, NTEC will have half of its capacity stranded, making it a certainty that the project would not move forward without the participation of Minnesota Power.

[17] Ex. MP-5, App. H (Unit Contingent Capacity Dedication Agreement between South Shore and Minnesota Power).

[18] Ex. MP-27 (Supinski Rebuttal) at 24.

[19] Notice and Order for Hearing at 5, 9.

permission to construct or operate the plant."[20] But unlike a purely ministerial action, in this case construction of the NTEC plant will not occur unless the affiliate agreements are approved. There is nothing in the record to suggest that construction of NTEC would proceed in the absence of the Company's involvement and investment. Unlike the present docket, the approval of a power purchase agreement does not result in the construction, operation, and maintenance of a large gas plant. Rather than a mere purchase of electricity from an already constructed generator selling electricity into the MISO market, NTEC itself has been a creation of the Company for years. The Company retained a consulting firm in 2013 to evaluate development of a combined cycle power plant.[21] It issued an RFP in October 2015 seeking bids for up to 400 MW of natural gas capacity.[22] After selecting the Superior, WI site, it then petitioned the Commission for approval of the affiliate agreements giving it the obligation to develop, construct, operate and maintain the plant and acquiring the rights to the plant on the same basis as if Minnesota power owned the NTEC plant in its own name as a rate-based asset."[23] There is in fact very little of these circumstances that resembles a power purchase agreement.

The Commission also seemed to place great weight on the fact that the plant will be built in Wisconsin, a fact that, for the Commission, denied it jurisdiction over the plant: "the CEOs ask that the Commission undertake environmental review of a Wisconsin power plant over which the Commission has no jurisdiction."[24] It is no doubt true that NTEC will require many other permits and approvals before it may begin construction; the same is true for nearly every large industrial proposal in the country. Overlapping and concurrent jurisdiction over projects is common, as is overlapping and concurrent environmental review.[25] This does not mean, however, that the Commission "has no jurisdiction." The immediate effect of the Commission's action is to "giv[e] the Commission authority over the contract and relationship on the same basis as if Minnesota power owned the NTEC plant in its own name as a rate-based asset."[26] The fact that

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[20] Order at 6.

[21] Petition, Appendix T, Page T-47, T-48.

[22] Ex. MP-8 at App. R, R-3.

[23] Ex. MP-27 (Supinski Rebuttal) at 24.

[24] Order at 7.

[25] *See, e.g.*, *Lakes and Parks Alliance of Minneapolis v. FTA*, 91 F. Supp. 3d 1105 (D. Minn. 2015) (involving environmental review for a light rail project undertaken by both state and federal agencies simultaneously).

[26] Ex. MP-27 (Supinski Rebuttal) at 24; *see also* Transcript of PUC Meeting, Oct. 18, 2018 at 11 ("[W]e structured this project, NTEC, as if it is owned – an owned asset by Minnesota Power, with

the Commission's approval of the agreements is but one approval among many needed for the proposal to proceed does not deprive the Commission of "jurisdiction."

More importantly, the overlapping jurisdiction between Minnesota and Wisconsin does not absolve the Commission of its obligations under MEPA. The fact that a project may need a federal approval does not mean that a state agency can avoid its environmental review obligations by assuming the federal government will fulfill its obligations, and the same is true when a neighboring state has overlapping permitting authority. A Minnesota agency cannot delegate its obligations under MEPA to another state.

Nor can it be said that MEPA does not apply to governmental actions having significant environmental impacts outside state borders. There is nothing in state law that prohibits a governmental agency from evaluating the out of state effects of an agency decision made in Minnesota, nor is there any provision that allows an agency to avoid its MEPA obligations simply because those impacts will occur across state lines. If a decision by a MN state agency results in substantial effect on the environment, MEPA applies, whether the physical location of the thing "permitted, assisted, financed, regulated, or approved" is within MN boundaries or not.[27] The primary intent of the law is to ensure agency decisionmaking is informed by the consequences of its actions;[28] it matters not where those consequences occur.

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significant oversight by the Commission. Because of the Wisconsin law requiring a separate entity in Wisconsin, we had to set up as a subsidiary through the affiliate South Shore, but this Commission will provide additional oversight and review of this, including a soft cap on the capital costs and a review of the charges from a fuel mix on an ongoing basis.") (testimony of D. Moeller, Minnesota Power).

[27] *Richland/Wilkin Joint Powers Auth. v. U.S. Army Corps of Engineers,* No. 13-2262, 2015 WL 2251481 *1, *12 (D. Minn. May 13, 2015), aff'd, 826 F.3d 1030 (8th Cir. 2016) (MEPA's "mandates on Minnesota governmental units do not evaporate when those units take action on portions of cross-border project built outside of *Minnesota*."); *see also Envtl. Def. Fund, Inc. v. Massey,* 986 F.2d 528, 536–37 (D.C. Cir. 1993) (holding that NEPA's environmental impact statement requirements applied to the National Science Foundation's plans to incinerate food wastes in Antarctica because NEPA applies to the decisionmaking process itself, which was occurring in the U.S., even though the incineration occurred on another continent); see also *Minn. Ctr. for Envtl Advocacy v. Minn. Pollution Control Agency*, 644 N.W. 2d 457, 468 (Minn. 2002) (noting that Minnesota courts look to NEPA case law for guidance).

[28] *Iron Rangers for Responsible Ridge Action v. Iron Range Resources*, 531 N.W.2d 874, 880 (Minn. Ct. App. 1995).

III. The Commission Should Not Approve the Construction and Operation of a Fossil-Fuel Fired Electricity Generating Facility by a Regulated Entity Prior to Identifying a Specific Need in an IRP

Minnesota's resource planning laws and regulations were crafted to require a holistic assessment of a utility's future electricity load and supply, viewed in the context of the regional system as a whole. The wisdom of this holistic approach is evident in this proceeding; the record abounds with references to the fact that Minnesota Power "is not an island."[29] To ensure that no utility decision is made in isolation, our resource planning law contains a number of procedural protections that place every resource acquisition decision within the context of a larger whole. Resource plans must provide long-range greenhouse emissions reduction plans and opportunities for installation of distributed generation, plans to meet 50 and 75% of energy needs through a combination of renewable energy and conservation, and plans to procure energy efficiency savings "systematically and aggressively."[30] Perhaps most importantly, as discussed in detail below, our laws direct the Commission to implement a preference for renewable energy in its decisionmaking.[31]

Many of these important considerations were reflected in the Commission's Order on the Company's 2015 IRP filing, resulting in an order that balanced the Company's desire to acquire a large gas-fired plant against the Commission's obligations to ensure that fossil-fuel resources are approved only after renewable alternatives have been shown to be harmful to the public interest. These considerations, however, were unfortunately abandoned one year later by the Commission's decision to allow a request to build a new fossil fuel resource to proceed outside of an IRP process. This decision stacked the deck against meaningful consideration of renewable alternatives, contrary to clear statutory direction.

A. The Commission's order does not reflect the statutory preference for renewable energy and conservation in §§ 216B.2422, 216B.243 and 216B.2401

Not only do our resource planning laws provide a clear structure to ensure a resource acquisition decision is not made in isolation, they also provide a clear direction. In the resource planning law, the certificate of need law and the energy savings law, the legislature has directed the

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[29] *See, e.g.,* Transcript of PUC Meeting, Oct. 18, 2018, at 10, 34.

[30] Minn. Stat. § 216B.2422, subd. 2, subd. 2c; Minn. Stat. § 216B.2426; Minn. Stat. § 216B.2401.

[31] Minn. Stat. § 216B.2422, subd. 4; Minn. Stat. § 216B.243; Minn. Stat. § 216B.2401.

Commission to choose clean energy first. The resource planning law is unequivocal: the Commission "shall not approve a new or refurbished nonrenewable energy facility in an integrated resource plan or a certificate of need . . . unless the utility has demonstrated that a renewable energy facility is not in the public interest."[32] This language is mirrored in the certificate of need statute: "[t]he commission may not issue a certificate of need under this section for a large energy facility that generates electric power by means of a nonrenewable energy source . . . unless the applicant for the certificate . . . has demonstrated that the alternative selected is less expensive (including environmental costs) than power generated by a renewable energy source."[33] An applicant must also demonstrate that "demand for electricity cannot be met more cost effectively through energy conservation and load-management measures."[34] Those conservation measures are to be "procured systematically and aggressively."[35]

The Commission's Order relies on the Department's modeling to counter this statutory presumption in favor of renewable energy: "by comparing NTEC's impact on overall system costs to that of wind and solar resources, the Department's analysis met the renewable-resource requirements of Minn. Stat. § 216B.2422 and 216B.243, subd. 3a."[36] This reliance is misplaced; the Department's modeling does not meet the statutory requirement of "demonstrating that a renewable facility is not in the public interest." As described further below in Section IV.A, the Department's analysis contains fundamental flaws that limited the ability of the model to consider renewables as an alternative to the proposed project.

Perhaps most foundationally, the Department programmed the model to restrict the amount of wind and solar the model could select, particularly in the early years of the planning period. As described in the Department's comments on MP's 2015 IRP, "The Department allowed Strategist to choose generic wind units in even numbered years for 2018 to 2030; the size of the units was 300 MW for 2018 and 100 MW in the subsequent years.... The Department made 100 MW generic solar units available in odd numbered years for 2019 and 2021. The Department made 50 MW generic solar units available in odd numbered years for 2023 to 2029."[37] In other words, the Department capped the model's ability to select wind a maximum of

[32] Minn. Stat. § 216B.2422, subd. 4.
[33] Minn. Stat. § 216B.243, subd. 3a.
[34] Minn. Stat. § 216B.243, subd. 3.
[35] Minn. Stat. § 216B.2401.
[36] Order at 21.
[37] Department Comments in Docket No. E015/RP-15-690 at page 17, attached as Attachment A.

300 MW in 2018 and only 100 MW in subsequent (even numbered) years – in odd numbered years, the model was not allowed to consider any wind. The only change to these assumptions made in this proceeding was to divide the 100 MW of solar available in 2019 into two 50 MW blocks.[38] The Department's modeling results in this proceeding showed that "300 or 400 MW of wind capacity (three or four units) was selected by 2020 in all but three of the model runs. [And] 100 MW of solar capacity (2 units) was selected by 2020 in 60 percent of the model runs."[39] In other words, the model selected the maximum amount of renewable energy it was allowed to select in the vast majority of the Department's runs. This is clear evidence that the model would have selected more wind and perhaps more solar if the Department had allowed it to do so, even under all of the Department's base case assumptions, which included inflated renewable energy prices and used no capacity credit for wind. However, in no run did the Department allow Strategist to pick more wind in 2018 or 2020 or more solar in 2019. Given this artificial cap on renewable energy that the Department placed in its modeling runs, the Department's model cannot be used to justify compliance with the renewable preference requirements of Minn. Stat. §§ 216B.2422 and 216B.243, subd. 3a.

Even if the modeling were not so fundamentally flawed, the Department was clear that its analysis was not intended as a review of alternatives, but as a way to "ensure that the proposed resource acquisition is reasonably tied to IRP outcomes."[40] The resource planning statutes require much more than a utility showing that their proposal to construct and operate a new gas-fired power plant are "reasonably tied" to IRP outcomes. They require a much more specific showing that clean energy alternatives are harmful to the public interest. The Department's modeling did not address this question, and cannot be relied on to satisfy the statutory presumption in favor of clean energy first. Indeed, CEOs provided modeling indicating that a clean energy portfolio is in fact a more reasonable, lower cost alternative to the NTEC proposal.

Moreover, even if the Department's modeling were not so flawed, section 216B.2422 requires the Commission to consider other factors beyond cost-optimizing modeling. The statute requires the Commission to consider whether the resource acquisition will help the utility achieve the greenhouse gas reduction goals under section 216H.02, as well as the ratepayer impacts from

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[38] SRR-3 at page 16.

[39] SRR-3 at page 16.

[40] Ex. DER-8 at 19 (Rakow Direct).

reduced exposure to fuel price volatility.[41] As described in the sections below, the weight of the evidence does not support approval of NTEC based on either of these factors.

i. The Order departed from prior IRP orders for the Company that were designed to protect the process from bias toward fossil fuel fired generation

The timeline of this case makes it clear just how unusual this process has been, and how that process served to calcify a preference for a gas plant, contrary to the statutory directive. The Company had explored the possibility of building a new gas plant as early as 2013, when the Company hired an engineering consultant to evaluate development of a combined cycle power plant.[42] On September 1, 2015, the Company filed its 2015 IRP, in which it proposed to begin a competitive procurement process for 200-300 MW of combined-cycle generation.[43] Rather than allowing the Commission to deliberate and make a decision on that IRP, only a few weeks after the IRP filing the Company issued an RFP for up to 400 MW of natural gas-fired capacity and energy.[44] Many parties criticized the RFP as premature, including the CEOs and the coalition of large industrial customers.[45] The Commission allowed the RFP to proceed, but cautioned the Company that there would be "no presumption that any or all of the generation identified in that bidding process will be approved," and required the Company to include a "wide variety of replacement options" in its next resource plan, including a "full analysis of all alternatives to natural gas, including renewables, energy efficiency, distributed generation, and demand response."[46] The Commission's direction to the Company was not ambiguous: "the Commission agrees with the Clean Energy Organizations and the Large Power Intervenors that Minnesota Power's evaluation of replacement generation should not be limited to one resource."[47] The next

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[41] Minn. Stat. § 216B.2422, subd. 4.

[42] Petition, Appendix T, p. T-47, T-48.

[43] Order Approving Resource Plan with Modifications, July 18, 2016, *In the Matter of Minnesota Power's 2016-2030 Integrated Resource Plan*, Docket No. E-015/RP-15-690 (hereinafter "2016 IRP Order").

[44] Petition, Appendix R.

[45] ALJ Order at 9.

[46] 2016 PUC Order 9, 15.

[47] *Id.* at 8.

resource plan, which was to include the Commission-ordered robust analysis of clean energy alternatives, was set for February 1, 2018.[48] That resource plan was never filed.

Ignoring the IRP procedures a second time, the Company declined to comply with the Commission's order to provide a full analysis of clean energy alternatives in its next IRP, and instead it filed its request for approval of the Energy*Forward* resource package on July 28, 2017.[49] That resource package included two projects that *were* approved in an IRP Order (the Nobles wind project and the Blanchard solar project) and one that was not – the NTEC proposal. In other words, the Company had developed its NTEC proposal over four years; during that time it had ample opportunities to have that proposal reviewed in an IRP docket, as directed by Minn. Stat. § 216B.2422, subd. 6. It was in part due to these concerns that the ALJ concluded in this docket that the Company's "alternatives analysis was biased in favor of NTEC."[50] To this day there has never been a size, type, and timing determination approving the construction of a new gas-fired plant.

Instead of going through the IRP process, the Company requested an extension of time to file its next IRP, which the Commission had ordered to contain an analysis of alternatives to the gas plant. This extension of time was to accommodate the proposal for the gas plant that it was directed to analyze in its next resource plan.[51] By departing from its prior orders and bypassing the resource planning process, the Commission's grant of that extension and referral of the petition to OAH subverted the intent of our resource planning laws.

The Commission can correct this error by following its practice and procedure in past resource planning dockets. For Xcel's 2016 IRP, for instance, the Commission declined to "determine with specificity the fuel type and location to address the identified 750 MW capacity need."[52] Similarly, in this matter the Commission should deny the approval of the affiliate interest

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[48] *Id.* at 16.

[49] ALJ Order at 10.

[50] ALJ Order at 104.

[51] Order Referring Gas Plant for Contested Case Proceedings, and Notice and Order for Hearings, *In the Matter of Minnesota Power's Petition for Approval of the Energy*Forward *Resource Package*, Docket Nos. E-015/RP-15-690, E-015/AI-17-568, Sept. 19, 2017 [hereinafter "Notice and Order for Hearings"].

[52] Order Approving Plan with Modifications and Establishing Requirements for Future Resource Plan Filings, *In the Matter of Xcel Energy's 2016-2030 Integrated Resource Plan*, Docket No. E-002/RP-15-21, Jan. 11, 2017, at 9.

agreements and evaluate the forecasted capacity and energy needs in the next IRP. At a minimum the Commission should deny the approval of the affiliate interest agreements and order the Company to initiate an all-source RFP.

ii. The Commission should not approve an affiliate agreement for the construction and operation of a large energy facility in the absence of a size, type, and timing determination

As described in the timeline above, the Company has been developing its plans for a gas-fired generation facility for many years, outside of the IRP process. During that time, the Commission has directed the Company not to assume that any capacity or energy need should be met with fossil fuels, but the Commission ultimately relented and abandoned that direction by referring the petition to OAH for a contested case, rather than directing the Company once again to submit an IRP filing. That decision was in error. The resource planning statute directs a utility to "indicate in its resource plan whether it intends to site or construct a large energy facility."[53] If the Commission approves the proposed facility in the resource plan, then a separate certificate of need proceeding is not necessary.[54] In this case the Commission followed that law with respect to the wind and solar proposals included in the Enery*Forward* Resource Package. For those two aspects of the proposal, the Commission found that it had "already approved the acquisition of additional wind and solar generation by Minnesota Power" in its prior IRP order.[55] It had *not* approved the gas plant in any IRP order, but referred the matter to OAH anyway. In such instances where a facility is proposed outside of the IRP process, the law instructs that "the commission shall conduct the resource plan proceeding consistent with the requirements of § 216B.243 with respect to the proposed facility."[56]

Should the plant proceed to construction, it will have been built without the Commission ever having fulfilled its obligation to ensure that the size, type, and timing of a utility's resource acquisitions are determined in the context of the system as a whole, and within the framework that clean energy is the preferred, default option. Such a result is contrary to the intent of state law

[53] Minn. Stat. § 216B.2422, subd. 6.
[54] *Id.*
[55] Notice and Order for Hearings at 5.
[56] Minn. Stat. § 216B.2422, subd. 6.

and the Commission's practice.[57] This is directly contrary to an almost identical situation in Xcel's most recent IRP docket. In that docket the utility's preferred plan included the construction in the 2020s of two new gas fired generators, a combined cycle generator on the site of its retiring coal plant and a combustion turbine generator in North Dakota.[58] For both of those resources, the Commission declined to approve a specific fuel type and location of generation capacity to address the identified need.[59] Rather, the Commission concluded that a plan that "does not specify location or generation type in that time frame will be more consistent with the public and ratepayer interests."[60]

It is not clear what circumstances would distinguish the Xcel IRP case from the present case, except that no need was even identified in the last Minnesota Power IRP. The Commission's order in Minnesota Power's last IRP docket directed the Company to include a full analysis of clean energy alternatives to the gas plant in its next IRP, which was to be filed February 1, 2018.[61] But rather than follow through with that plan, the Commission allowed the Company to defer resource planning in favor of simply moving forward with the gas plant proposal. The Commission should remedy this error by denying approval of the affiliate agreements and directing the Company to submit a full analysis of clean energy alternatives to the gas plant, as it ordered in the last IRP.

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[57] Minn. Stat. § 216B.2422; Order Closing Docket, Establishing New Docket, and Schedule for Competitive Resource Acquisition Process, *In the Matter of the Application of Northern States Power Company d/b/a Xcel Energy for a Certificate of Need for Approximately 450 MW of Incremental Capacity for the Black Dog Generating Plant Repowering Project*, Docket Nos. E-002/CN-11-184, E-002/CN-12-1240, Nov. 21, 2012 (noting that "once the size, type, and timing of Xcel's resource need is determined, the need should be addressed through a competitive resource acquisition process" and concluding that the notice plan for a competitive resource acquisition process should not specify the size, type, and timing of the required resources because those decision had not yet been made); Order Approving Plan with Modifications and Establishing Requirements for Future Resource Plan Filings, *In the Matter of Xcel Energy's 2016-2030 Integrated Resource Plan*, Docket No. E-002/RP-15-21, Jan. 11, 2017, at 8 ("Historically, the Commission has used resource planning as a tool to assess and determine the appropriate size, type, and timing of generation resources.") [hereinafter "Xcel 2016 IRP Order"].

[58] Xcel 2016 IRP Order at 1.

[59] *Id.* at 9-10.

[60] *Id.*

[61] Order Approving Resource Plan with Modifications, *In the Matter of Minnesota Power's 2016-2030 Integrated Resource Plan*, Docket No. E-015/RP-15-690, July 18, 2016, at 9.

iii. Limited and restricted modeling cannot be used to support a resource acquisition in the absence of a size, type, and timing determination

One the clearest examples of the problems arising from the abandonment of the IRP process is the predetermined nature of the modeling used to support the NTEC proposal in this matter. As explained in the CEOs Initial Brief, the Company and the Department's resource modeling constrained the model's ability to select certain resources. It was only allowed to select NTEC in the year 2025, rather than exploring whether it could be added later, and, in the case of Minnesota Power's modeling, it was not allowed to select any renewable resources prior to 2025.[62] The Commission responded to these criticisms by concluding that "correcting th[ose] assumptions would likely not have changed the outcome."[63] This conclusion is at odds with the record in this case. When those assumptions were corrected in the model by using a combination of Commission-ordered energy efficiency and more reasonable assumptions about achievable demand response, the results demonstrated that the Company has almost no capacity need at all, and that a clean energy portfolio offers a lower cost portfolio.[64]

These erroneous assumptions would almost certainly have been addressed had this proposal gone through a typical IRP process. As CEO's expert Anna Sommer described,

> In a typical IRP, it would be important to model resources as available at the earliest possible date as well as model the possible retirements of existing units. This is particularly pertinent here because the size, type and specific timeframe for an addition of a resource such as NTEC was not identified by the Commission in Minnesota Power's last IRP. Ideally, such a decision would be made in the context of Minnesota Power's entire system, rather than focusing on a single resource. For instance, Minnesota Power did not examine whether its remaining coal units, Boswell 3 and 4, might need to retire prior to their current end of life. It also did not allow Strategist to choose generic wind and solar resources until 2025. With the sunsetting of the PTC and the Investment Tax Credit ("ITC") moving from 30% to 10%, constraining wind and solar to the period between

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[62] CEOs Initial Br. At 20. As discussed above, the Department's modeling placed artificial limits on the amount of renewable energy it could select in early years of the model.

[63] Order at 21.

[64] Ex. CEO-16 at 27 (Sommer Direct).

2025 and 2034 eliminates the possibility of taking advantage of the current level tax incentives.[65]

The ALJ agreed with this analysis, concluding that "the Company has not provided a reasonable explanation for constraints it placed on resource selection in the Strategist model."[66] The Commission's Order ignored these fundamental deficiencies. The Commission allowed the Company to proceed outside the confines of the IRP laws, and the Company took advantage of that allowance by offering a stunted and circular form of resource modeling that assumed what it wanted to prove. The Commission can relieve these undue constraints by denying the approval of the affiliate interest agreements and ordering the Company to file its next IRP, which will provide a venue for analyzing the entirety of the Company's system and all available alternatives over the course of its entire planning period.

B. In bypassing the resource planning process, the Commission's order undercuts the purposes of resource planning and threatens the public interest

Although the issue raised here is a matter of procedure, it would be a mistake to construe the impacts of abandoning the IRP process as purely ministerial. Because this matter was referred to the OAH before any determination from the Commission on size, type, or timing, the resulting proceeding is a jumble. The Company proposed a facility that it contends is necessary to meet a need for dispatchable capacity in 2025-2031.[67] The amount of this perceived need has changed significantly, from 400 MW in the initial 2015 RFP, to 150 MW in a revised RFP, and then finally to 250 MW in the final negotiations.[68] But the investment required for this proposal is significant, and well over market rates (see Section VI.B, *infra*). Putting such an investment into the utility's rate base must be a decision tied to specific needs that are first determined by the Commission. By sending the proposal to OAH with the instruction to determine if the investment is needed and reasonable, considering all factors, the Commission has placed the Company's ratepayers at the mercy of their vendor. Without the IRP oversight from the Commission, the Company's incentive to overbuild is unchecked.

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[65] Ex. CEO-16 at 19-20 (Sommer Direct).
[66] ALJ Order at 47.
[67] Ex. MP-13 at 14-16 (Pierce Direct).
[68] Ex. DER-8 at 34-35 (Rakow Direct).

One of the primary purposes of resource planning is to "ensure that utilities give adequate consideration to factors whose public policy importance has grown in recent years, such as the environmental and socioeconomic impact of different resource mixes."[69] This docket amply demonstrates why it is critical that the Commission perform this function. Without it, the Company simply disregarded the Commission's order to include an analysis of gas plant alternatives in its next IRP and supported its gas plant proposal with modeling that severely and unreasonably restricted the ability of clean energy resources to function as substitutes for fossil fuel resources. The Commission should provide assurance that the Company will give adequate consideration to environmental and socioeconomic impact by ordering the Company to conduct an analysis of gas plant alternatives in its next IRP.

IV. The Commission's Order Is Not Supported by the Evidence in the Record

A. The Commission's finding that the Department's modeling was robust or reliable is unsupported by the record

After hearing the evidence in this case and developing this voluminous record, the ALJ concluded that "the Company's Strategist analysis of NTEC and other resource options is insufficient to demonstrate that NTEC is needed and reasonable as compared to other alternatives to meet the future electric needs of Minnesota Power's customers."[70] She continued: "Similarly, the Department's Strategist results are not sufficiently robust or reliable for purposes of determining whether the 250 MW NTEC purchase is needed and reasonable because its analysis also used a number of unreasonable assumptions."[71] She concluded that "[t]he CEO's Strategist modeling, which reached different results with more reasonable assumptions, confirms that a more robust alternatives analysis is necessary."[72]

While the Commission did not reach the issue of the sufficiency of Company's modeling, it did not agree with the ALJ's determination that the Department's modeling was insufficient.[73] It based this conclusion on two major premises: first, that the CEOs' preferred assumptions are

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[69] Order Approving Plan Subject to Conditions, Requiring Further Filings, and Setting Requirements for Next Resource Plan, *In the Matter of Otter Tail Power Company's 2011-2025 Resource Plan*, Docket No. E-017/RP-10-623, Feb. 9, 2012.

[70] ALJ Report at 70.

[71] *Id.* at 71, para. 342.

[72] *Id.* at 71, para. 343.

[73] Order at 21.

within the range of forecast contingencies evaluated by the Department, and so correcting the issues the CEOs identified with the Department's modeling would not change the outcome; and second, that the Department appropriately limited the model's selection of NTEC to 2025 because there is no evidence in the record to suggest that NTEC is available in any other year. As explained below, both of these premises are incorrect.

i. The Commission's conclusion that the Department's modeling contingencies address CEO's concerns is not based in the record

The Order asserts that, to the extent that the CEOs' criticisms of DOC's modeling assumptions "have merit, correcting the assumptions would likely not have changed the outcome."[74] In particular, the Order contends that "even assuming the CEOs are correct that greater levels of demand response and energy efficiency should have been evaluated, their preferred assumptions are still within the range of forecast contingencies evaluated by the Department."[75] From these premises, the Order draws the conclusion that, "[i]n sum, the Department evaluated reasonable ranges for key variables," and so "its Strategist results are sufficiently robust and reliable for purposes of determining whether the NTEC energy purchase is needed and reasonable."[76] In essence, the Order takes the position that the Department's modeling sensitivities (or "contingencies," as the Department calls them) were broad enough to account for the issues raised by the CEOs, and so the Department's modeling is sufficiently robust to justify the NTEC purchase.

CEOs respectfully advise that these assertions in the Order are incorrect. First, it is important to make clear that the Department's modeling process and sensitivities were not in fact broad enough to encompass the concerns raised by CEOs. Department witness Dr. Stephen Rakow's modeling process is explained in his Direct Testimony, SRR-3, "Review of Minnesota Power's Resource Planning Analysis."[77] Dr. Rakow took his base case from Minnesota Power's 2015 Integrated Resource Plan and updated it in the following ways: he updated the energy forecast; he updated the price forecasts for generic wind and solar; and he added the project-specific inputs for the NTEC proposal in 2025.[78] Based on this updated "base case," he looked at

[74] Order at 21.
[75] *Id.*
[76] *Id.*
[77] Ex. DER-8, Att. SRR-3.
[78] *Id.* at 12-14.

three levels of energy savings and four different modeling approaches that varied CO_2 costs, utility discount rate, and spot markets. To these twelve overall sets of runs he applied "contingencies" (more commonly called "sensitivities") based on variations in environmental externalities; solar, wind, coal and natural gas prices; capital costs; energy and demand forecast; and spot market prices.[79]

CEOs raised several critical problems that Dr. Rakow's modeling does not address or remedy. For example, CEO Witness Anna Sommer pointed out in her Direct Testimony that in its modeling, Minnesota Power assigned zero capacity value to wind.[80] Ms. Sommer observed that MISO guidance indicates that wind should be assigned a 12.5% capacity credit.[81] There is no evidence in the record that Dr. Rakow's modeling remedied this issue. Given that Dr. Rakow developed his modeling base case from his modeling of Minnesota Power's 2015 IRP (which commits the same mistake), and that he did not list capacity values as one of the criterion that he analyzed in his contingencies,[82] the weight of the evidence suggests that he did not look at how assigning a different capacity credit to wind might impact the modeling results. Because some capacity need was identified in Strategist absent reasonable levels of demand response and energy efficiency, it is likely that the lack of a wind capacity credit would impact the results. Ms. Sommer was not able to replicate Dr. Rakow's Strategist runs because he used a different version of Strategist than did Minnesota Power.[83] However, when she used more reasonable capacity credit assumptions using Minnesota Power's version of Strategist, NTEC was not selected as the least-cost option.[84] In other words, correcting this error did in fact contribute to a different outcome.

Dr. Rakow's modeling contingencies also do not remedy Ms. Sommer's critique that he did not examine a reasonable amount of demand response and energy efficiency. The Commission's Order required an analysis of demand response and efficiency as alternatives to some or all of the proposed 250 MW NTEC purchase.[85] The Commission relied on the Department's Strategist modeling to conclude that an adequate analysis of demand response and energy efficiency was completed. Specifically, the Commission noted that there was sufficient

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[79] *Id*. at 14-15.
[80] Ex. CEO-16 at 12.
[81] *Id*. at 13.
[82] *See* DER-8, Att. SRR-3 at 12-14,
[83] Ex. CEO-17 (Sommer Rebuttal) at 6, 8.
[84] Ex. CEO-16 (Sommer Direct) at 21, 28 (Table 3).
[85] Order at 9.

variation in the Department's forecast contingencies to cover the range of energy efficiency and demand response suggested by the CEOs.[86] This conclusion is in error.

In his modeling, Dr. Rakow looked at load forecast contingency bands of +/- 5 percent.[87] Dr. Rakow contends that this variation in load forecast is a reasonable substitute for additional demand response or energy storage. Ms. Sommer points out in her Rebuttal Testimony, however, that even Dr. Rakow's lowest load forecast yields a peak demand that is only 77 MW less than Minnesota Power's base case load forecast.[88] In other words, none of Dr. Rakow's contingencies looked at whether demand response, additional storage, and the loss of UPM Blandin's load of 20 MW could together reduce the load forecast by more than 77 MW.[89] Ms. Sommer pointed out in her testimony that this is not a reasonably varied low-end contingency.[90] Her own low end sensitivity, looking at a combination of energy efficiency, demand response, and a lower load forecast, was below the "low end band" that Dr. Rakow modeled. Dr. Rakow also argues that because he included in his modeling a 200 MW combustion turbine, this "peaking resource" option could substitute for his failure to allow the model to select more than 14 MWs of additional demand response.[91] However, as Ms. Sommer notes in her Rebuttal Testimony, not only is it unreasonable to constrain demand response to a 200 MW block, but also Dr. Rakow presents no evidence that his combustion turbine cost assumption is a reasonable assumption for the cost of demand response.[92]

In his Surrebuttal, Dr. Rakow argues that his demand and energy forecast contingencies can substitute for modeling additional energy storage or demand response because they have the same effect on dispatchable resources like NTEC. He argues:

> "The point is that, to Strategist's operation of dispatchable resources such as NTEC, the following changes all have the same effect:
>
> - a decrease in the demand and energy forecast;
> - an increase in energy conservation;
> - an increase in the supply of non-dispatchable resources (such as wind); and

[86] *Id*.
[87] Ex. CEO-17 (Sommer Rebuttal) at 7.
[88] Ex. CEO-17 (Sommer Rebuttal) at 9.
[89] *Id*.
[90] *Id*.
[91] Ex. DER-11 (Rakow Surrebutal) at 41-42.
[92] Ex. CEO-17 (Sommer Rebuttal) at 9-10.

- an increase in the must-run segment of dispatchable resources;

That is, the changes listed above all result in a lower remaining energy requirement to be filled by the dispatchable resources."[93]

However, Dr. Rakow's argument is a flawed oversimplification of how Strategist works. First, while it is true that all of these factors might serve to reduce NTEC dispatch, Dr. Rakow provides no evidence that the magnitude of change caused by each of these criteria would be the same and that therefore they are all substitutable for each other. For example, he has provided no evidence that energy storage would have the same shape and magnitude of energy "production" as did his "low load forecast." Nor did he provide any evidence that his low load forecast reduced demand by the same magnitude as the 30 GWh energy efficiency assumption recommended by Ms. Sommer (and which is consistent with Minnesota Power's historical efficiency achievements). Dr. Rakow is also seemingly asking the Commission to believe increasing the supply of wind would necessarily result in the same shape and magnitude of energy as increasing the must-run segment of a dispatchable resource. If all of these different variables were in fact perfectly substitutable for each other, then it would be far simpler and yet just as accurate to perform an IRP in a spreadsheet holding the energy contribution from multiple resources constant and merely comparing their costs to identify the "least cost" resource. As the Commission knows, nothing could be further from the truth.

Most importantly of all, however, Dr. Rakow's modeling process is fundamentally flawed because it failed to examine key variables in combination with each other.[94] While the Department's range of contingencies give the appearance of thoroughness, they do not address the most significant of CEOs' critiques: that while one or even two of these key contingencies varied together may not, by themselves, be sufficient to eliminate the choice of NTEC, the combination of reasonable changes in inputs results in a lower-cost plan that does not include NTEC.

As noted above, Dr. Rakow would have this Commission find that a low load forecast can substitute for modeling additional energy storage and demand response. While the reasons why this argument is without merit are provided above, it is also worth noting that even if it were

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[93] Ex. DER-11 (Rakow Surrebuttal) at 47.

[94] *See* Ex. CEO-17 (Sommer Rebuttal) at 8-9; CEOs' Reply to the Exceptions to the ALJ's Findings of Fact, Conclusions of Law, and Recommendation of Minnesota Power and the Department of Commerce, August 1, 2018, at 9-11.

true, the Department did not conduct a single model run in which the combination of additional energy storage and additional demand response could be chosen.[95] Yet there is no practical reason that Minnesota Power could not do both. Similarly, the Department did not conduct a single run in which the model was allowed to choose wind at a price less than the base case assumption and solar at a lower cost than the base case assumption without also presuming that gas CCs and CTs experienced the same percentage reduction in capital cost.[96] Nor did the Department allow Strategist, in any run, to pick between energy storage and demand response and energy efficiency while also considering renewables at a cost lower than the Department's base case assumptions.[97] In no run does the Department give any capacity credit to wind. Perhaps most critically, the Department never allows Strategist to pick additional wind before 2020, despite the fact that in every model run the Department's modeling selected 400 MW of wind, the maximum the Department allowed it to select by that year – indicating that wind is the lowest cost resource, and that the model would likely select more of it if so allowed.[98] Any one of these variables, modeled in isolation, may not eliminate the choice of NTEC by Strategist. Even modeling two of these variables together might not eliminate NTEC as the lowest cost option. Instead, it is the combination of multiple, reasonable changes in modeling assumptions that leads to a lower-cost plan without NTEC.

This is precisely why the CEOs' critiques of both the Department's and Minnesota Power's base case assumptions are so important. The Department's "contingencies" examine only a subset of these important variations simultaneously. When the Department claims that the choice of NTEC is reasonable given the preponderance of runs in which NTEC is included, it is the Department's flawed decision to simultaneously vary just a few of the assumptions from the base case that leads to this result. This error is compounded by the fact that the Department has clearly overstated the costs of wind and solar in its modeling[99], and the fact that neither the

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[95] *See* DER-8, Att. SRR-3, Attachment 1 (Department's detailed modeling results).

[96] *Id.*

[97] *Id.*

[98] *Id*. In its comments on MP's 2015 IRP at page 17 (attached as Exhibit 1), the Department stated, "The Department allowed Strategist to choose generic wind units in even numbered years for 2018 to 2030; the size of the units was 300 MW for 2018 and 100 MW in the subsequent years." This means that the maximum amount of wind that the Department allowed the model to select by 2020 was 400 MW. In his exhibit SRR-3, Dr. Rakow states that he relied upon his IRP modeling and does not give any indication that this assumption was modified for the purposes of this proceeding.

[99] *See infra* regarding recent new information regarding renewable energy prices.

Department nor Minnesota Power modeled solar energy coupled with battery storage nor other combinations of renewables and storage. Simply put, the Department's modeling is not robust enough to capture a reasonable set of costs and variations in renewables, battery storage, energy efficiency, and demand response.

The results of CEOs' modeling demonstrate the significance of this issue with the Department's modeling. When Ms. Sommer used a more reasonable set of assumptions for energy efficiency, demand response, wind and solar capacity credit, and load, and allowed Strategist to consider all of these criteria in combination, NTEC was not selected. The Commission's conclusion that "to the extent [CEOs'] criticisms have merit, correcting the assumptions would likely not have changed the outcome,"[100] is clearly at odds with the results of CEOs' modeling and thus inaccurate and merits reconsideration.

ii. The Commission's determination that the Department's decision to constrain the availability of NTEC to one year was reasonable is in error

The Department's model constrained the availability of NTEC to one year: 2025. By limiting the model in this way, the Department's analysis only considers whether renewables could substitute for the oversized, too-early NTEC, not whether renewables could meet Minnesota Power's energy needs as part of a reasonable expansion plan.

The Commission's order states:

> However, the Department made a generic 200 MW combined-cycle resource available for selection in each year of the planning period. What was limited to 2025 was the selection of a combined-cycle resource with NTEC's specific characteristics. This was reasonable: there is nothing in the record to suggest that NTEC is available in any other year.[101]

The problem with this reasoning is that a need for the type, sizing, and timing of a gas CC has not been established prior to this proceeding. So, if modeling NTEC is intended to establish a need for the plant, as required under Minnesota law, then the size, type, and timing of the resource's availability in the modeling ought to vary. The presence of a generic CC does not substitute for this. The Department's Exhibit DER-8, Attachment SRR-3 does not suggest that the generic CC

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[100] Order at 21.
[101] *Id.*

capital costs were updated from the 2015 IRP, making it likely that they are different from NTEC's cost. Further, as the Commission acknowledges in its order, "NTEC was the first combined-cycle gas generator to be selected by Strategist in the Department's modeling. When two intermediate units were selected, NTEC was selected first, followed by the 200 MW option."[102] This could be interpreted in one or both of two ways: first, that the Department specified that Strategist must take NTEC before it took a generic CC unit, in which case the Department is effectively committing the same error as MP and restricting it to the choice of NTEC in 2025. The second possible interpretation is: if Strategist always chose NTEC first regardless of capital cost, load levels, etc., then the generic CC assumptions must have been so different from NTEC that the generic CC cannot reasonably be considered a proxy for building NTEC in some year other than 2025. Put another way, if the only difference of significance between NTEC and the generic CC was size (250 versus 200 MW) and timing, there should be multiple Department runs in which the generic CC is selected in place of NTEC.

B. NTEC is not needed to protect ratepayers from spot market risks

The Commission determined that the NTEC purchase is needed to supply MP's customers' energy requirements.[103] This determination is based on the Department's resource planning analysis. The Department concluded that "MP's energy needs are the driving factor" for the Department's position that a need exists for additional power in the 2025 timeframe, not capacity needs.[104] The Commission states that regardless, Minnesota Power will be purchasing power from the MISO market, and that NTEC "provides a hedge against spikes in market prices," implying that this hedging effect supports the Commission's conclusion that the NTEC purchase is needed and reasonable.[105] This conclusion is not supported by the record.

The ALJ concluded specifically that the "Company has failed to demonstrate that the 250 MW NTEC purchase is needed and reasonable as a dispatchable, flexible resource to balance its system and mitigate exposure to energy markets."[106] The Department did not challenge the market risk finding in its Exceptions brief. The ALJ's conclusion is based on the Department's

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[102] *Id.* at 19.
[103] *Id.* at 12.
[104] *See* DOC's Response to Exceptions, August 2, 2018 at 2.
[105] Order at 21.
[106] ALJ Report at 88.

testimony that the Company's market risk in 2025 appears to be manageable, given its existing resource mix.[107]

The record therefore supports a conclusion that the NTEC purchase is not needed to protect MP's ratepayers from price spikes due to spot market exposure. Dr. Rakow concluded his analysis by finding that "the level of risk appears to be manageable without NTEC."[108] He states that "[f]urther mitigation risk measures . . . would have to be relatively low cost."[109] Dr. Rakow reiterates this conclusion in his Surrebuttal, stating that his

> analysis demonstrates that any insurance [Minnesota Power] might purchase against price spikes, such as purchasing energy storage, would have to be very low cost in order to make economic sense. Simply put, given the facts in this proceeding, there is no demonstration that it would be reasonable to require ratepayers to pay for additional insurance against price spikes unless the cost of any such insurance is very low.[110]

There is no evidence in the record that NTEC constitutes such "very low" cost insurance. The Commission's conclusion that NTEC provides a "hedge against spikes in market prices" is thus not supported even by the Department's testimony.

The extent to which the record is devoid of any support for NTEC as a hedge against market risk is notable. Dr. Rakow presents an analysis entitled "Review of Minnesota Power's Dispatchable Capacity Need," which he frames as an analysis of whether Minnesota Power needs additional resources to mitigate its "spot market exposure."[111] Dr. Rakow concludes that "until volatility in spot market prices increases, further dispatchable capacity is removed from [Minnesota Power]'s system, or load increases significantly, the level of risk appears to be manageable with the current resource mix."[112] Nevertheless, in his Surrebuttal, Dr. Rakow appeared to support the purchase of NTEC at least in part from a price mitigation standpoint, stating, "NTEC will reduce ratepayer exposure to spot market price risk to a small degree[.]"[113]

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[107] *Id.*; Ex. DER-8 (Rakow Direct) at 20.
[108] Ex. DER-8 at 20.
[109] Ex. DER-8, Att. SSR-4 at 20.
[110] Ex. DER-11 at 59-60.
[111] Ex. DER-8, Att. SRR-4.
[112] *Id.* at 20.
[113] Ex. DER-11 at 67.

As CEOs explained in detail in their Initial Post-Hearing Brief, pages 37-41, Dr. Rakow's analysis was extremely conservative, and essentially ignored the price risk mitigation value of all of Minnesota Power's wind resources. Dr. Rakow calculated Minnesota Power's "exposure to spot market prices" by undertaking the following steps.[114] First, Dr. Rakow took the 2025 forecast for peak demand and energy from Minnesota Power's annual forecast report filing.[115] He then estimated the Company's hourly supply in 2025, by "determin[ing] the firm resources available to meet the demand on an hourly basis."[116] Dr. Rakow defined "firm resources" as those that "were dispatchable, would not be retired in 2025 and had firm fuel supply."[117] In other words, his definition excluded from Minnesota Power's supply all of Minnesota Power's wind and solar resources, as well as non-dispatchable hydro.[118] This includes 873 MW of wind, 33 MW of solar, and 35 MW of small hydro.[119]

He then compared Minnesota Power's hourly supply (from only the "dispatchable capacity" as defined above) to the 2025 demand forecast.[120] He then tabulated the number and size of the "capacity deficits" identified in on-peak and off-peak hours.[121] From this comparison, he concluded that "[Minnesota Power] would have about 400 on-peak hours with a capacity deficit over 400 MW."[122]

Given this level of identified exposure, Dr. Rakow then looked at what he calls "risk mitigation measures," which include Minnesota Power's intermittent generation facilities (solar and wind), non-dispatchable hydro generation facilities, load management resources and Energy Exchange Agreements with Manitoba Hydro.[123] He contended that solar resources "do not appear to be a significant mitigation measure for spot market price spikes" given the size of Minnesota Power's solar capacity (33 MW by 2025) and the fact that the Company's solar production is greater than 20 percent of installed capacity in "only 178 of the 400 hours" where

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[114] Ex. DER-8, SRR-4 at 5.
[115] *Id*.
[116] *Id.* at 6.
[117] *Id.*
[118] Ex. CEO-6 at 3; Ex. DER-8, SRR-4 at 3, 6.
[119] Ex. DER-11 at 55: 13-14.
[120] Ex. DER-8, SRR-4 at 7-8.
[121] *Id*. at 14, Table 4.
[122] *Id.* at 15.
[123] *Id*. at 18.

the Company has a deficit above 400 MW.[124] For wind, Dr. Rakow "did not compare wind production patterns to [Minnesota Power]'s capacity deficits," but noted that Minnesota Power's wind resources potentially would mitigate price spikes.[125] He examined the potential for demand response to mitigate price spikes. He found that 192.5 MW of demand response reduces the number of hours with capacity deficits above 400 MW from 400 hours to 59 hours, or around an 85 percent reduction.[126]

The failure to quantify the extent to which Minnesota Power's wind, solar, and hydro resources -- over 900 MW -- could mitigate any price spike risks is a serious limitation in Dr. Rakow's analysis, as CEO Witness Jacobs explained in his testimony.[127] In essence, as summarized by Mr. Jacobs, Dr. Rakow decided to handle wind's "lack of predictability" in production by "mak[ing] a qualitative judgment to assign no value" to wind.[128] Mr. Jacobs concluded that

> Dr. Rakow's attempt to define and quantify the magnitude of Minnesota Power's risk to spot market price spikes . . . is flawed to the point that even his assertion based on this analysis—that the NTEC unit could provide value as a hedge against Minnesota Power's exposure to spot market price spikes—is dubious.[129]

As pointed out by Mr. Jacobs, accrediting wind with even a small amount of price mitigation value could have drastically impacted Dr. Rakow's results. Notably, when Dr. Rakow added 192.5 MW of large power interruptible services as a "mitigation measure" in the last step of his analysis, the impact is to reduce the number of hours with a capacity deficit of 400 MW or more by 85 percent.[130] In other words, adding only a fraction of Minnesota Power's "non-dispatchable" resources results in resolving the majority of the price exposure risk. A serious question thus remains as to whether the entirety of that risk would have been addressed if Dr. Rakow had included Minnesota Power's wind, an adjusted amount of solar, and the non-dispatchable hydro.

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[124] *Id.*
[125] *Id.*
[126] *Id.* at 19-20.
[127] Ex. CEO-6.
[128] *Id.* at 5.
[129] *Id.* at 2.
[130] *Id.* at 4.

In this case the record shows that the extremely conservative analysis of market risk concluded that NTEC was not necessary to manage that risk. CEOs respectfully request that the Commission thus reconsider this justification for approving the NTEC proposal.

V. The Results of RFPs for Wind and Solar After the Commission's Decision Undermine the Validity of the Department's Modeling

On December 28, 2017, during the development of intervenor Direct Testimony, Public Service Company of Colorado (PSCo), an Xcel subsidiary, released a 30-day update on its all-source solicitation. That update contained the median bid price of responses to an all-source solicitation issued by PSCo. The prices contained in that update for wind, solar, and battery storage were considered remarkably low. However, because the solicitation was unique to PSCo and the results of other, similar solicitations were not yet public, there was some speculation that some of the bid prices, particularly, for wind and solar were due to the preferential resource in the PSCo service territory.

This notion was upended by the results of Northern Indiana Public Service Company's (NIPSCO) all-source RFP. The results of that RFP, shown in aggregate form in NIPSCO's November 1, 2018 IRP filing, demonstrated that the price declines for wind, solar, and battery storage were not unique to PSCo's service territory. Indeed, the RFP results demonstrate price declines in wind, solar, and battery storage have continued since Indiana tends to have lower wind and solar capacity factors than does Colorado. Table 1 shows selected, key results from the two RFPs. In-service dates for the NIPSCO bids range from 2021 to 2024; dates for the PSCo bids are not available.

Table 1. Comparison of NIPSCO and PSCo All-Source RFP Results[131]

	Resource Size[A] (Nameplate MW)		Bid Price		Pricing Units
Technology	**PSCo**	**NIPSCO**	**PSCo**	**NIPSCO**	
Battery Storage	77	510	11.3	4.31	$/kw-mo
Wind	414	945 and 479	18.1	25.52 and 38.11	$/MWh
Solar	179	500, 975, 1352, and 308	29.5	28.45, 33.93, 37.62, and 62.87	$/MWh
Solar + Storage[B]	183	175, 295, and 1525	36	24.80, 28.24, and 34.54	$/MWh

[131] Public Service Company of Colorado 2017 All Source Solicitation 30-Day Report in Colorado Public Utility Commission Proceeding No. 16A-0396E and NIPSCO 2018 IRP available at: https://www.in.gov/iurc/files/2018%20NIPSCO%20IRP.pdf

Wind + Solar + Storage	578	300	30.6	28.68	$/MWh

[A] PSCo resource size is the average of the project MWs bid in, while NIPSCO resource size is the tranche size. NIPSCO RFP responses were divided into tranches for IRP modeling based on cost.

[B] A fourth tranche is not shown here due to its relatively small size, 25 MW.

In comparison, the Department's modeling assumed wind costs of:

- $30 per MWh each year for a PPA available in 2018 and 2020;
- $34 per MWh each year for a PPA available in 2022;
- $44 per MWh each year for a PPA available in 2024;
- $53 per MWh each year for a PPA available in 2026;
- $56.25 per MWh each year for a PPA available in 2028; and
- $59.50 per MWh each year for a PPA available in 2030.[132]

The Department's modeling also assumed a flat solar cost of $50 per MWh.[133] Figures 1 and 2 show graphically how the Department's assumptions compare to these RFP results.

Figure 1. Department early wind costs are generally significantly more than RFP wind costs

[132] Ex. DER-8, Attachment SRR-3, p. 13. Note also that wind could not be chosen every year in the Department's modeling and only 300 MW was available in 2018 and then just 100MW in every even-numbered year thereafter.

[133] *Id.*

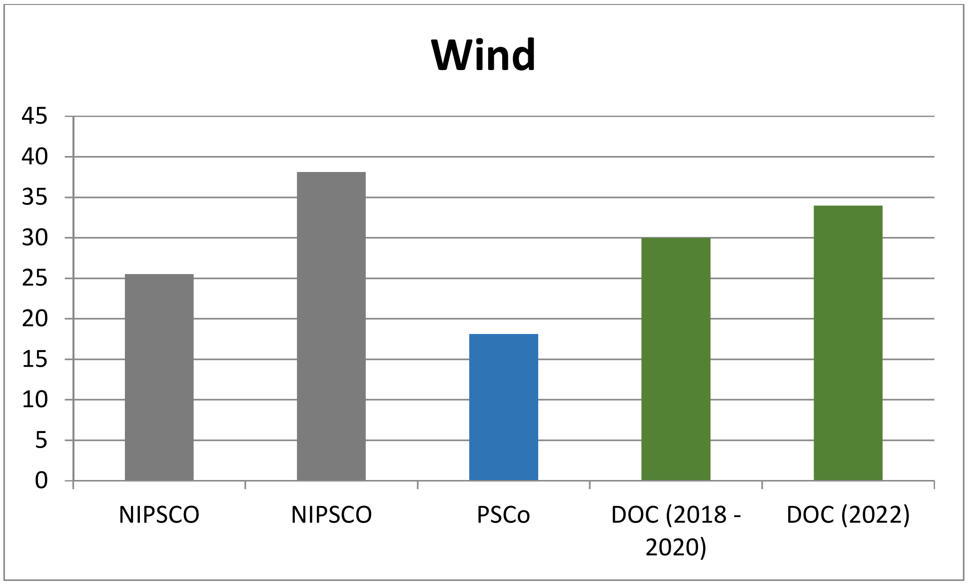
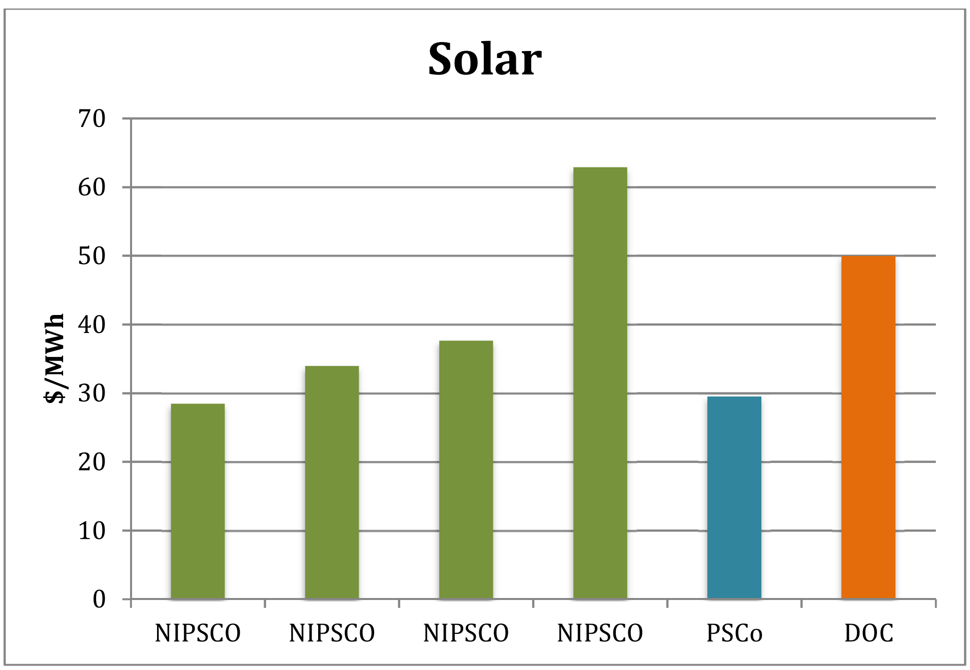


Figure 2. Department solar costs are generally significantly more than RFP solar costs



Because these RFP results are so much lower than the Department's assumptions, they are persuasive evidence that lower renewables and battery storage prices coupled with the ability to select more of those resources along with more energy efficiency and demand response and assigning a non-zero capacity credit to these resources would result in the same conclusion that

CEOs' modeling arrived at – NTEC is not the least cost choice to meet any capacity and energy need the Company might have.

VI. New Information Provides Further Evidence That NTEC Is Not Compatible With Minnesota's Statutory Carbon Reduction Goals

Since the evidentiary hearing was held on NTEC, several new studies have come out that further caution against the trend of replacing coal plant retirements with new gas resources. Moreover, recent filings by other utilities provide new evidence that casts doubt on whether the NTEC proposal is a "good deal" for Minnesota Power customers, indicating that the Commission should instruct Minnesota Power to conduct a new Request For Proposals -- this time without constraints on the size or type of resource -- prior to deciding whether to authorize the NTEC proposal. CEOs respectfully request that the Commission reconsider its Order on the basis of this new evidence.

A. New information further bolsters the record that approval of NTEC is not consistent with Minnesota's statutory greenhouse gas reduction targets.

In this docket, the CEOs presented testimony from J. Drake Hamilton that pointed out that approval of the NTEC proposal would be inconsistent with Minnesota's statutory greenhouse gas goals.[134] In her Direct Testimony, Ms. Hamilton pointed out that Minnesota's utilities cannot continue to replace baseload coal plant retirements with large new gas plants and still meet Minnesota's statutory greenhouse gas targets of reducing emissions by 80% by 2050.[135] She noted that the State currently is not even on track to meet the goal of reducing economy-wide greenhouse gas emissions 30% by 2025.[136] She estimated that in order for Minnesota's electricity sector emissions to achieve their pro rata share of reducing economy-wide emissions by 80% by 2050, the sector must reduce its emissions to 9.6 million tons CO2e by 2050.[137] She noted, however, that the electricity sector will likely have to reduce its emissions by more than its pro rata share in order to achieve the economy-wide goal.[138] While Minnesota Power has stated that its total Energy*Forward* package, including NTEC, will reduce the Company's emissions by 42% by 2025, the Company acknowledges that it projects its CO2 emissions after 2030 will remain flat,

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[134] Ex. CEO-5 (Hamilton Direct).
[135] *Id.* at 8-9.
[136] *Id.* at 4.
[137] *Id.* at 10.
[138] *Id.* at 7-8.

and then will actually *increase* between 2025 and 2034, resulting in only a 29% reduction by 2030.[139] She thus concluded that Minnesota Power has not demonstrated that the NTEC proposal is consistent with achieving the statutory goals. Ms. Hamilton further observed that Minnesota is experiencing an unfortunate trend in which coal plant retirement announcements have been followed with significant new gas build proposals.[140] She noted that, if this trend continues, Minnesota is unlikely to achieve its 2050 goals.[141]

In the months subsequent to the evidentiary hearing in this matter, two studies have been published that further call into question the prudence of approving yet another large new gas plant in Minnesota. First, Vibrant Clean Energy published a study entitled "Minnesota's Smarter Grid: Pathways Toward a Clean, Reliable and Affordable Transportation and Energy System," attached as Attachment B to this Petition. That study conducted in-depth optimization modeling of scenarios that could achieve Minnesota's 80% by 2050 goal. The study found that Minnesota's greenhouse gas emissions from the electricity sector will need to be reduced by 91%, or 4.5 million metric tons, by 2050.[142] This 4.5 million metric ton cap is less than half the total emissions that Ms. Hamilton assumed the electricity sector could emit in 2050 for purposes of her analysis. With this more stringent cap, emissions from NTEC alone could account for more than 10% of Minnesota's electricity sector greenhouse gas emissions budget for 2050.[143]

A report issued in January 2019 by Rhodium Group further underscores the concrete carbon implications of the trend of replacing coal plants with large new gas plants. This report, attached as Attachment C to this Petition, noted that U.S. CO2 emissions rose by 3.4% in 2018, reversing three prior years of decline.[144] The Report notes that while a record number of coal-fired coal plants were retired in 2018, natural gas "not only beat out renewables to replace most of this lost generation but also fed most of the growth in electricity demand."[145] The chart below, reproduced from the Rhodium Group report, demonstrates the scale of this nationwide shift to gas generation.

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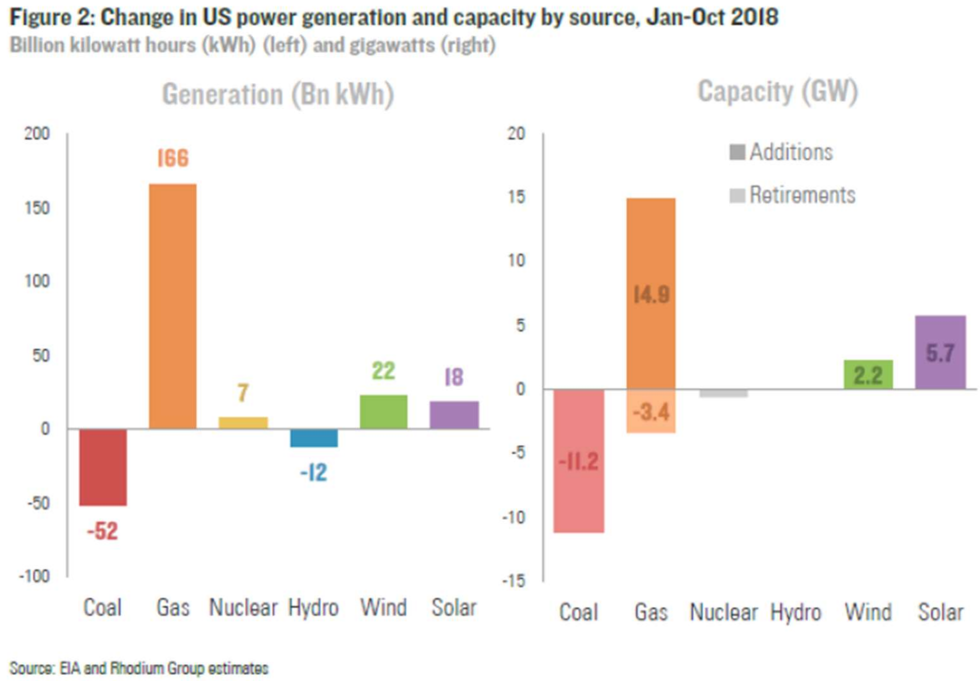
[139] *Id.* at 8.
[140] *Id.* at 11.
[141] *Id.* at 12.
[142] Attachment B at 11.
[143] Ex. CEO-5 (Hamilton Direct) at 13.
[144] Attachment C at 1.
[145] *Id.*



The Report found that between January and October of 2018, natural gas-fired generation increased by 166 billion kWh, three times the decline in coal generation and four times the combined growth of wind and solar.[146] The Report determined that in order to meet global greenhouse gas emissions reductions targets like the Paris Agreement, the U.S. will need to reduce CO2 emissions by 2.6% on average in every year for the next seven years, more than twice the pace the U.S. achieved between 2005 and 2017.[147]

These reports highlight the critical nature the resource determination before the Commission. This new evidence indicates Minnesota utilities must prioritize replacement of its coal plants with renewable energy, efficiency, and demand response, not with large new fossil emitting facilities.

CEOs strongly support the Commission's determination that Minnesota Power's next resource plan must include a plan for the early retirement of Minnesota Power's two remaining coal plants, Boswell 3 and 4, as well as a securitization plan that could be used to mitigate potential ratepayer impacts from their early retirement. CEOs agree that early retirement of those

[146] *Id.* at 3.
[147] *Id.* at 7.

units is essential to achieving further necessary reductions in greenhouse gas emissions. However, it is CEOs' position that the weight of the evidence shows that the NTEC proposal is not consistent with Minnesota's greenhouse gas reduction targets, and should be rejected. CEOs respectfully request that the Commission reconsider its approval of the NTEC proposal, and instead order the Company to examine the need for any new capacity or energy resources in the context of its next IRP, in conjunction with the early retirement of Boswell 3 and 4.

B. New information suggests that the Commission should instruct Minnesota Power to conduct a new Request For Proposals prior to approving the NTEC proposal

In the time since the evidentiary hearing, new information has become available that casts further doubt on whether NTEC represents a good deal for Minnesota Power ratepayers. First, as discussed above in section V, recent all-source RFPs by Public Service Company of Colorado and Northern Indiana Public Service Company have demonstrated significant declines in the prices of wind, solar, and battery storage. These declines are well below those modeled by Ms. Sommer in her testimony. In many instances they also fall beyond the low end contingency modeled by the Department of Commerce. In addition, they demonstrate the cost competitiveness of combinations of wind and storage or solar and storage that the Department did not even consider as an option in its modeling.

A recent application filed by XcelEnergy in Minnesota, docket IP6949, E002/PA-18-702, also provides new information indicating that Minnesota Power should conduct a new Request for Proposals before moving forward with the NTEC self-build option. In November 2018, XcelEnergy filed a petition for approval of its acquisition of the 375 MW Mankato Energy Center (MEC I) and the 345 MW expansion project (MEC II). In its application, XcelEnergy asserts that the purchase price for MEC "is comparable to other combined cycle purchases we have seen in this region," at $855/kW.[148] XcelEnergy notes that other "recent CC sale transactions or proposal in the region" include:

- The Riverside Energy Center, costing an average of $827/kW;
- The Fox Energy Center, at an average price of $875/kW; and

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[148] XcelEnergy Petition For Approval of the Acquisition of the Mankato Energy Center, Docket. No. IP6949, E002/PA-18-702, Nov. 27, 2018, at 16.

- The Nemadji Trail Energy Center, at a proposed price of $1,333/kW.[149]

This information suggests that the proposed NTEC facility may cost approximately one and a half times more than other recent combined cycle purchases in the region. CEOs respectfully submit that this information further calls into question the reasonableness and prudence of the NTEC proposal. CEOs request that the Commission reconsider its Order based on this information, and instead instruct Minnesota Power to conduct an all-source RFP as part of its next integrated resource plan.

CEOs are not asking the Commission to direct the Company to engage in an unending series of RFPs. Rather, CEOs ask the Commission to take advantage of the significant amount of time remaining until the presumed 2025 need for new capacity by instructing Minnesota Power to update its RFP results, which are now multiple years out of date (the CC RFP was issued in 2015 and the DR, wind, and solar RFPs were issued in 2016).

CONCLUSION

For the foregoing reasons the CEOs respectfully request that the Commission reconsider its Order of January 24, 2019 and deny the requested approval of the affiliate interest agreements for Minnesota Power's Petition for Approval of the Energy*Forward* Resource Package.

Dated: February 13, 2019

Respectfully submitted,

/s/ Kevin P. Lee

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[149] *Id.* at 16-17.

Center for Environmental Advocacy, Sierra Club & the Union of Concerned Scientists)

MINNESOTA DEPARTMENT OF COMMERCE

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January 4, 2016 **PUBLIC DOCUMENT**

Daniel P. Wolf
Executive Secretary
Minnesota Public Utilities Commission
121 Seventh Place East, Suite 350
St. Paul, MN 55101-2147

RE: **PUBLIC Comments of the Minnesota Department of Commerce, Division of Energy Resources**
Docket No. E015/RP-15-690

Dear Mr. Wolf:

Attached are the **PUBLIC** Comments of the Minnesota Department of Commerce, Division of Energy Resources (the Department) in the following matter:

> Minnesota Power's Application for Approval of its 2015-2029 Integrated Resource Plan.

The Petitioner is:

> Lori Hoyum
> Policy Manager
> Minnesota Power
> 30 West Superior Street
> Duluth, MN 55802-2191

The Department recommends that the Commission approve Minnesota Power's 2015-2029 Integrated Resource Plan with modifications. The Department's team of Samir Ouanes, Susan Peirce, Stephen Rakow, Zac Ruzycki, Sachin Shah and I are available to answer any questions the Commission may have.

Sincerely,

/s/ CHRISTOPHER T. DAVIS
Rates Analyst

CTD/lt
Attachment

TABLE OF CONTENTS

Section

PUBLIC DOCUMENT

BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

PUBLIC COMMENTS OF THE
MINNESOTA DEPARTMENT OF COMMERCE
DIVISION OF ENERGY RESOURCES

MINNESOTA POWER'S 2016 RESOURCE PLAN

DOCKET NO. E015/RP-15-690

I. INTRODUCTION

A. *COMMISSION ORDER*

Minnesota Power (MP or the Company) submitted its last resource plan on March 1, 2013 in Docket No. E015/RP-13-53. On November 12, 2013, the Commission submitted its *Order Approving Resource Plan, Requiring Filings, and Setting Date for Next Resource Plan* with the following Order Points:

1. The Commission approves Minnesota Power's 2013 – 2027 resource plan. This approval does not extend to particular projects that are currently under review in other proceedings or will be subject to review in future proceedings, but is a general finding that the plans filed by Minnesota Power appear to be reasonable in light of the entire record.
2. The Commission finds that Minnesota Power's proposal to refuel Laskin units 1 and 2 to operate on natural gas by 2015 is reasonable.
3. The Commission finds that Minnesota Power's proposal to remove Taconite Harbor unit 3 from Minnesota Power's system by the end of 2015 is reasonable.
4. If Minnesota Power pursues refueling Laskin units 1 and 2 to operate on natural gas, or removing Taconite Harbor unit 3 from Minnesota Power's system, then, within nine months of the date of this Order, Minnesota Power shall file updated project costs and associated schedules.
5. Minnesota Power shall obtain approximately 200 MW, subject to need, of intermediate capacity (and associated energy) in the 2015 – 2017 timeframe by constructing the resource itself, by sharing in the ownership of the resource, or by procuring the resource through bilateral contracts, whichever option is most cost-effective.
6. The Commission finds that with Minnesota Power's proposed retirement of

Taconite Harbor unit 3, the current resource plan demonstrates Minnesota Power's need for an additional 50 MW of capacity in 2015, increasing up to 100 MW by 2019. Based on the modeling in the record, adding intermediate resources most appropriately reflects the nature of Minnesota Power's system needs.

7. When Minnesota Power commits to a specific bilateral contract, the Company shall file pertinent details of the contract, such as the duration, price, and amount of capacity and associated energy to be procured.
8. Minnesota Power shall file with the Commission all relevant MISO Attachment Y requests and the results of each, including whether Minnesota Power has requested MISO to evaluate any Minnesota Power unit as a System Support Resource.
9. On or before September 1, 2015, Minnesota Power shall make its next resource plan filing.
10. Thirty days prior to its next resource plan filing date, Minnesota Power shall file its energy and demand forecast and Strategist commands.
11. The Commission approves an energy savings goal of 1.87 percent of Minnesota Power's retail sales by its next resource plan filing.
12. For its next resource plan, Minnesota Power shall:
    a. Identify the amount of energy savings embedded in each year of its load forecast, in terms of total savings (kWh) and as a percentage of non-CIP-exempt retail sales;
    b. Identify the amount of system-wide energy savings, including aggregate data for CIP-exempt customers, embedded in each year of its load forecast;
    c. Evaluate additional conservation scenarios for its CIP-exempt and non-CIP-exempt customers, that would achieve greater energy savings beyond those in the base case; and
    d. Provide cost assumptions for achieving every 0.1 percent of savings above 1.5 percent of non-CIP-exempt retail sales.
13. In its next resource plan filing, Minnesota Power shall include the midpoint of the Commission's approved CO_2 range in its base case assumptions.
14. In its next resource plan filing, Minnesota Power shall include a full analysis of the effects of retiring or repowering the Taconite 1 and 2 plants, including transmission and distribution effects.
15. In its next resource plan filing, Minnesota Power shall provide a summary of its compliance with new statutory measures and how the legislative changes impact its resource plan.

In compliance with Order Point 10, MP filed its energy and demand forecasts and Strategist commands on July 31, 2015. Further, in compliance with Order Point 9, MP submitted the instant resource plan on September 1, 2015. On November 4, 2015 MP supplemented its initial filing with additional information in response to Order Point 12 above. On November 9, 2015, the Department submitted a letter concluding that, with the supplemental information, MP's 2015 resource plan should be considered complete.

II. MP'S 2015 IRP

A. MP'S RESOURCE NEEDS DURING PLANNING PERIOD

Table 1 below shows MP's resource needs over its 2015 IRP planning period. Negative numbers indicate that MP needs to add resources. For example, in 2017, MP is expected to have a capacity deficit of 48.6 MW, growing to 54.2 MW in 2018.

Table 1: MP's Capacity Resource Needs[1]

Year	Surplus/ (Deficit) in MW
2015	40.6
2016	97.6
2017	(48.6)
2018	(54.2)
2019	(12.8)
2020	125.3
2021	119.2
2022	93.7
2023	67.6
2024	41.1
2025	(113.5)
2026	(140.2)
2027	(285.8)
2028	(293.5)
2029	(302.1)
2030	(310.0)

[1] The Department's calculation is based on the following assumptions:
- Future resources under contract come on-line as scheduled (Power Purchase Agreement from the Manitoba Hydro Electric Board, MHEB);
- MP achieves demand savings embedded in econometric forecast;
- Taconite Harbor 1 & 2 shut down in 2026;
- Boswell 1 & 2 shut down in 2024; and
- No resources for the Solar Standard are acquired.

B. MP'S ANALYSIS APPROACH

MP stated that it used a four step planning approach for evaluating how to proceed given concerns with environmental regulations and the need to add capacity to its system. MP used the first two steps to define the Company's Preferred Coal Plan. The four steps are as follows:

1. Screen Remission Options for Small Coal & Alternatives. MP evaluated whether a remission alternative is most cost-effective for each remaining small coal-fired generation facility and screens which new resource alternatives and DSM programs are most cost-effective at augmenting the power supply. By "remission alternative" MP means repowering the generation facility with a different fuel.

2. Detailed Coal Analysis. MP determined if a small coal-fired generation facility should be closed/shutdown prior to the accounting end of life rather than move forward with the cost effective option from Step 1. This step included a series of over 35 sensitivities that stress generation cost drivers such as delivered fuel, CO_2 penalties, capital and additional customer load outlooks.

3. Detailed Coal Analysis. MP identified a resource expansion plan that will augment the preferred Small Coal Strategy identified in Steps 1 and 2 that it believes will best meet its customer requirements.

4. Comparative Analysis. MP compared its Preferred Plan to the following three alternative resource expansion plans[2]:

    a. Continue small coal operations through the mid-2020s.

    b. Refuel Boswell 1&2 with natural gas.

    c. Early shutdown of remaining small coal-fired generation.

C. MP'S PROPOSED RESOURCE PLAN

Based on its analysis, MP proposes the following plan:

1. Idle Taconite Harbor 1&2 (150 MW) in 2016, use for reliability when market conditions are favorable[3].

---

[2] The comparison included over 50 sensitivities such as delivered fuel cost, CO_2 regulation costs, capital costs and additional customer load forecasts.

[3] Minnesota Power's definition of "idling" Taconite Harbor 1&2 was clarified in the Company's response to Information Request 12 from the Clean Energy Organizations (CEO):

> Minnesota Power will offer Taconite Harbor Energy Center ("THEC") into the annual Midcontinent Independent System Operator ("MISO") Capacity Auction for the 2016/2017 planning year in March 2016. Minnesota Power will then continue to offer THEC into each subsequent Annual Capacity Auction for planning years 2017/2018, 2018/2019 and 2019/2020. If

2. Upgrade environmental performance of Boswell 1&2 (130 MW) by 2018.

3. Procure 200 MW bilateral market purchases to bridge needs between 2016 and 2019.

4. Procure 33 MW of solar energy by 2025, beginning with the 10 MW Camp Ridley project in 2016.

5. Submit a request for proposals (RFP) for 200 MW-300 MW of combined cycle resources for implementation by 2024[4].

6. Procure average annual energy savings of 57.3 GWh (1.87 percent) during the planning period.

7. Begin procurement of 250 MW of energy and 133 MW of capacity from Manitoba Hydro beginning in 2020.

8. Reduce MP's offtake from the Young 2 coal generating station from 100 MW to 0 MW by 2026.

9. Propose an 8-10 MW customer backup generation pilot program in 2016.

MP's Preferred Plan is presented graphically in Table 2 below.

THEC is selected as economical in the capacity auction, Minnesota Power will offer THEC into the energy and ancillary services market if the units clear MISO's Annual Capacity Auction for that planning year.

[4] MP actually submitted an RFP for 200-400 MW. See http://www.duluthnewstribune.com/news/3897552-minnesota-power-seeks-bids-first-big-gas-plant

Table 2: MP's Preferred Plan

Year	THEC 1&2	BEC 1&2	DSM	Backup Generation Pilot Program	Natural Gas CC	Solar Resources	Manitoba Hydro PPA	Young 2
2015								95 MW
2016	Idle			8 MW Proxy		10 MW Camp Ripley		95 MW
2017			Consider additional investment (+11 GWh as proxy)					95 MW
2018		SO_2 Reduction						95 MW
2019								95 MW
2020	Cease Coal					12 MW Proxy	383 MW	95 MW
2021								95 MW
2022								75 MW
2023								57 MW
2024		closely assess for retirement			200-300 MW			38 MW
2025						10 MW Proxy		19 MW
2026								0 MW
2027								0 MW
2028								0 MW
2029								0 MW
2030								0 MW

III. DEPARTMENT ANALYSIS

A. REVIEW OF MP's ENERGY AND DEMAND FORECASTS

1. Overview of MP's Forecasts

The Department evaluated MP's energy and peak demand forecasts by:

- reviewing the Company's output data to examine the reasonableness of Minnesota Power's forecast period growth rates and adjustments to forecast outputs, and
- comparing the Company's current forecast, based on its Advance Forecast Report (AFR) 2014, with the Company's previous forecasts to see whether there were any unusual changes in forecast outcomes compared to MP's AFR 2012.

Changes in forecast methodology or other factors outside of the forecasting model--such as unusual weather, economic changes, or changes in consumption by large customers--may lead to significant, but reasonable, differences between a current forecast and previous forecasts. However, generally speaking, a review of how well a forecast predicts usage over a prior period is a good indicator of the quality of the overall forecasting process.

For example, in Appendix A of the Petition, MP provided detailed information on its forecast used in the IRP. In figures 12 through 14, MP provided information on its past forecast accuracy.[5] For example, for 2013 MP states that the difference between the forecast produced in 2013 (AFR 2013) and the 2013 year-end actual was 0.2 percent. In other words, the forecast was lower than the year-end actual by 0.2 percent.

For this IRP, the Company used a modeling approach for each of its rate class models and its peak demand model that was similar to the model the Company used in its previous IRP filing. The Company used various economic variables, monthly determinants, weather conditions, and trend variables to estimate monthly sales. Minnesota Power developed separate energy sales forecasts for each customer class. The Company developed its total system sales forecast by summing all of its class-specific forecasts. Minnesota Power arrived at its total retail energy requirement (including generation necessary to offset losses) by applying a monthly loss factor to its energy sales forecasts.

On page 1 of its Appendix A, MP stated the following:

> Per Order Point 10 of the 2013 Integrated Resource Plan's November 12, 2013 Order,[1] Minnesota Power is required to file its energy and demand forecast and Strategist commands thirty days prior to its next resource plan filing date, which is September 1, 2015. Therefore, the Company used the AFR2014 as the basis for the 2015 Integrated Resource Plan ("2015 Plan") due to the inability to conduct the extensive analysis required for the 2015 Plan between the July 1 submittal of Minnesota Power's 2015 Annual Electric Utility Forecast Report ("AFR2015") and August 1 when the forecasts and commands were required to be submitted. A sensitivity case using data from the AFR2015 was performed in July and the results are discussed in Appendix K beginning on page 30.
>
> 1 Docket No. E015/RP-13-53.

On page 39 of its Petition, MP stated the following:

[5] See Pages 41-43, Appendix A of MP's Petition.

> 8. Minnesota Power's energy demand outlook was updated with AFR2014, its July 1, 2014 submittal to the Department of Commerce – Division of Energy Resources ("Department").[28]
>
> 28 As Minnesota Power needed to begin its resource planning analysis in early 2015, the AFR2014 was the latest load outlook available for use. The AFR2015 filing was made to the Department on July 1, 2015, and was incorporated into the analysis as a sensitivity to ensure the short and long-term action plans were not impacted by the update in projection (See Appendix K).

Thus, MP forecasts its energy requirements and peak demands from 2014 through 2028.

2. Energy and Demand Forecasts

a. Forecast of Energy Requirements

Table 3 below presents MP's forecasted energy requirements at the 50th percentile of probability.

Table 3: MP Total Delivered Energy (MWh)

	Median 50% Probability
2014	11,705,702
2015	11,953,998
2016	12,330,905
2017	12,909,749
2018	13,002,284
2019	13,062,008
2020	13,158,395
2021	13,169,713
2022	13,217,452
2023	13,275,706
2024	13,363,068
2025	13,386,634
2026	13,448,376
2027	13,512,349
2028	13,614,472
Average Annual Growth 2014 - 2028	**1.1%**

Table 3 above shows that at the 50th percentile forecast MP projects that its delivered energy requirement will grow by 1.1% annually.

b. Forecast of Peak Demand

Table 4 below presents MP's forecasted delivered summer and winter peak demand at the 50th percentile of probability. On page 25 of its Petition, MP stated the following:

> Minnesota Power is historically a winter peaking utility, and based on monthly trends in load behavior is expected to remain winter peaking for the AFR2014 period of 2014 to 2028.

MP's summer and winter delivered peak demand is projected to grow by 1.2 and 1.1%, respectively, during the forecast periods. The delivered peak demand is forecasted monthly using weather variables.

Table 4: MP's Peak Demand Forecast

	MP Delivered Peak Demand Median (50%)	
	Summer Peak (MW)	Winter Peak (MW)
2014	1,555	1,599
2015	1,606	1,629
2016	1,641	1,755
2017	1,740	1,770
2018	1,752	1,777
2019	1,760	1,786
2020	1,769	1,794
2021	1,775	1,801
2022	1,781	1,807
2023	1,788	1,817
2024	1,795	1,825
2025	1,802	1,833
2026	1,810	1,842
2027	1,818	1,851
2028	1,825	1,860
Average Annual Growth 2014 - 2028	**1.2%**	**1.1%**

The Department's modeling section and comments below discuss MP's reserve margin. In its Petition, MP stated the following:[6]

> In the 2015 Plan analysis, Minnesota Power used the summer peak demand forecast coincident with MISO's peak ("MISO coincident peak") for determining the capacity requirements. The MISO coincident peak is where Minnesota Power demand is projected to be at the time MISO's entire system peaks in the summer period. Traditionally, Minnesota Power has planned its capacity requirements for its own system peak, which occurs in the winter.

[6] See Page 42 of Appendix K: Detailed Analysis Section.

The coincidence factor (CF) referenced above is first calculated by dividing MP's demand at the time of MISO peak (coincident demand) to the overall peak on MP's system, regardless of whether it coincides with MISO's peak (non-coincident demand peak). If the coincidence factor is 100 percent, then MP's peak fully coincides with MISO's peak and there is no diversity between MP's system and MISO's system. If the coincidence factor is less than one, then MP's peak occurs at a different time than MISO's peak and MP can use some of that diversity in the system to serve its customers' needs.[7] MISO provides its monthly peak data by month and year (for the particular month; only June, July, August and September data are currently published by MISO).[8]

The diversity factor (DF) is then calculated by subtracting the coincidence factor from 1 (1 – CF = DF). For illustrative purposes, a difference of 1 percent DF on MP's system (assuming a 2,000 MW peak) translates into a change of approximately 20 MW. Thus, another reason the Department modeled forecast bands around the peak demand is to address potential changes in the diversity factor and reserve margin as explained in the modeling section of these comments.

3. Input Data

Minnesota Power's forecast models used historical monthly energy sales, historical monthly peak demand data, economic variables, demographic variables, trend variables, and weather variables. The Company's economic and demographic variables are derived from various sources, including Regional Economic Models, Inc.; IHS Global Insight; and the Federal Reserve Board. Minnesota Power's weather data is taken from the National Oceanic and Atmospheric Administration's Duluth monitoring station and from Weather Underground.[9]

In its Appendix A, MP provided detailed information on its forecast methodology, assumptions and inputs for the 2014 AFR. For example, on page 11 of its Appendix A, MP provided a discussion on methodological adjustments to its 2014 AFR. On page 19 of its Appendix A, MP stated the following:

[7] A coincidence factor closer to zero (which is not the case with MP) would indicate a great deal of diversity between MISO's peak and a utility's peak.
[8] Please see MP's electronic file titled, "2005-2013 Historical Peak Dates and Times.pdf"
[9] See Page 15 of Appendix A.

> Minnesota Power made a number of adjustments to internally developed data for the 2014 AFR, which fall into four general categories:
>
> 1. Revisions of count, sales, and peak demand data
>
> 2. Adjustments to raw customer count data for billing anomalies
>
> 3. Adjustments to raw sales and peak demand data for large load additions and losses
>
> 4. Revision of customer appliance saturation rate estimates

In its *June 3, 2013 Comments* in MP's last IRP in Docket No. E015/RP-13-53 (Docket 13-53), the Department pointed out inconsistencies in MP's data at the time:[10]

> The Department appreciates MP's reconciliation and explanation of the data discrepancies as mentioned above and described in detail in its response to Department IR no. 23. However, rather than requiring discovery by the Department to flesh out basic information about the Company's forecast data, MP should provide detailed explanation(s) and documentation upfront, similar to its response to Department IR no. 23, in any filing relying on forecasts, including resource plans, certificates of need and rate cases. This upfront transparency and reconciliation in any data would not only enable MP to keep track of all changes in its data and forecasts from period to period but also enable third party reviewers to readily know what changes may have transpired in MP's data and forecasts. Thus, the Department recommends that the Commission require MP to provide detailed explanation(s) and documentation upfront, in a manner similar to its response to Department IR no. 23, whenever MP submits data and forecasts or uses data and forecasts in any regulatory filing requiring forecasts.

The Department appreciates MP's inclusion of the explanation and reconciliation of the data in its *Petition*. The Department also appreciates all the detailed information provided by MP in its Appendix A regarding its energy and peak demand forecasts.

[10] See page 11 of the Department's *June 3, 2013 Comments* in Docket 13-53.

4. Output Data

Minnesota Power is unique among Minnesota utilities given the size of large industrial load on its system relative to the rest of its retail load. The electric load associated with these large industrial customers accounts, on average, for approximately 54 percent[11] of Minnesota Power's total system load; in addition, some of these large customers have their own on-site generation. These unique operational characteristics require Minnesota Power to adjust its energy and peak demand forecasts accordingly.

The Company's official peak forecast is based on the sum of its econometric forecast, Coincident Customer's Net Load (CCNL), Customer Generation, and Dual Fuel load. Minnesota Power's official energy forecast is the sum of its econometric forecasts, as described earlier in this section, the CCNL, and Customer Generation.

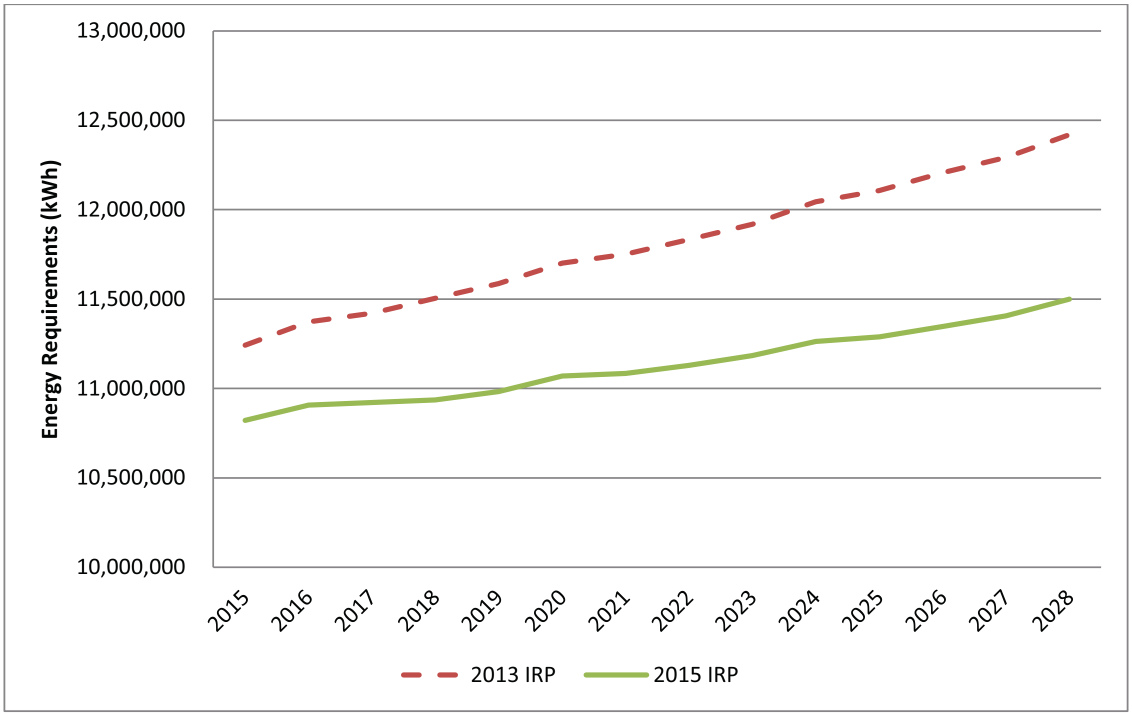
5. Consistency with Previous IRP Forecasts

As noted earlier, the forecasts used in the current IRP are constructed using Minnesota Power's 2014 AFR and the forecasts in its previous IRP filing were constructed using its 2012 AFR. Minnesota Power's AFR represents its long-run forecasting and planning approach that is updated on an annual basis. MP also uses the AFR and other information when estimating test year sales in its rate case filings.

The total energy forecasts and peak demand forecasts, on an annual basis, are similar between the current IRP filing (based on the 2014 AFR) and its previous IRP (based on the 2012 AFR). Minnesota Power projects lower energy (kWh) consumption in the current IRP compared to the previous IRP filing. In Figure 1 below, the Department compares the two forecasts graphically.

[11] See Page 1 of *Section 1: About Minnesota Power* of the Company's Petition.

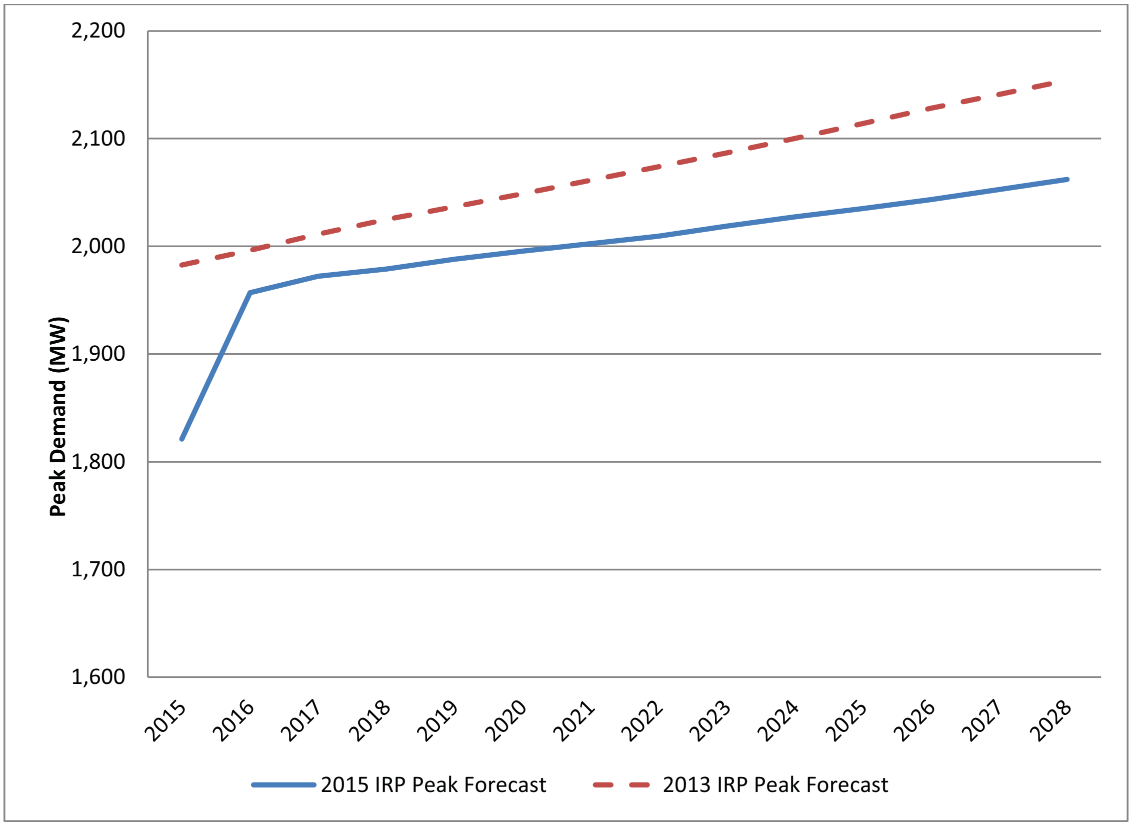
Figure 1: Comparison of Energy Forecasts



Based on its graphical review, other than the lower forecast (approximately four percent lower in 2016, estimated to grow to approximately six percent lower in 2028), the Department does not observe material differences in the forecasting patterns between the forecasts. However, as explained before, factors outside of the forecasting model, such as unusual weather, economic changes, or changes in consumption by large customers, may lead to significant, but rational, differences between a current forecast and previous forecasts.

The Company projects lower peak demand (MW) in the current IRP filing compared to the previous IRP. In the same manner as the energy forecasts, the Department also compared the peak demand forecasts graphically, as shown in Figure 2 below.

Figure 2: Comparison of Peak Demand Forecasts



Overall, the Department did not observe any differences in the forecasting pattern between the two forecasts except in the period from 2015 to 2016.

On page 3 of its Appendix A, MP stated the following:

> **Moderate Growth Scenario with Deferred Resale:** includes additional loads served by Minnesota Power and its wholesale customers that are likely but not yet certain. This scenario's assumptions are identical to those in the Moderate Growth scenario except the start of a new mining customer's facility in Nashwauk is delayed by one year. This scenario demonstrates the sensitivity of Minnesota Power's demand and energy outlook to the timing of this prospective customer's start-up.

In its 2013 IRP, MP assumed incremental load additions and demand growth of approximately 125 MW beginning in winter 2013 compared to the current IRP, which assumes incremental load additions and demand growth of 183 MW in 2016. The Department concludes that, with the reconciliation of the new customer load, the peak demand forecast results are sufficiently similar for IRP purposes.

6. DOC's Recommendations

Minnesota Power has continued to work on improving its sales and peak demand forecasts since its previous IRP filing. In the resource plan, the Department's analytical approach is typically geared more towards range estimates and risk analysis as opposed to point estimates, which is the primary tool in a proceeding such as a general rate case. As a result, the Department concludes that MP's forecasts are satisfactory for IRP planning purposes and recommends their approval.

B. MODELING REVIEW

1. Introduction

The Department used Strategist to review MP's modeling efforts. The general process followed by the Department when reviewing Strategist modeling is as follows:

1. obtain from the applicant a base case file, and the commands necessary to re-create the various scenarios explored by the Company;
2. re-run the applicant's base case file to make sure that the outputs match and the Department is working with the correct file;
3. review the base case's inputs and outputs for reasonableness;
4. create a new base case, which includes any changes deemed necessary to the Company's base case;
5. run scenarios of interest on the new base case to explore various risks and alternative futures;
6. assess the results of the scenarios and establish a new preferred case; and
7. run scenarios of interest on the new preferred case to test the robustness of the preferred case.

The Department's overall goal in reviewing utility modeling efforts is to determine if the Company's proposed plan results in a reliable, low cost, low environmental impact system that manages risk, and to recommend modifications if needed.

2. Verifying MP's Strategist Results

The first step in the Department's modeling was to obtain from MP the Company's reference case and the commands necessary to re-create certain contingencies and scenarios explored by the Company in the Petition.[12] The Department re-ran the reference case provided by MP through Strategist. The Department's outputs matched the results included in the file provided by MP, confirming that the Department was working with the inputs that created MP's outputs and that modeling could proceed.
For the second step, the Department attempted to match the results from the reference case file provided by MP to the reference case results reported in the Petition. However, the cost results for the full study period did not match the costs reported by MP. The Department ultimately determined that MP appeared to be providing results from 2032 even though MP actually ran Strategist through 2034 with a subsequent end effects period.

[12] This Strategist data was provided by MP on July 31, 2015—one month prior to filing the Petition.

Having verified how MP reported its results in the Petition, the Department concluded that it would be preferable for the cost results reported in our comments to be for the full study period. The Department also determined that it would be preferable to use a 15-year planning period (2016-2030) since that is the duration specified in the resource planning rules.[13]

3. *Changes to MP's Reference Case*

The Department made several changes to MP's reference case file with the spot market turned on. There were no significant issues with MP's wind expansion unit and solar expansion unit. However, the Department concluded that a different wind modeling approach would enable greater flexibility in sizing of the wind units. MP has an up-front energy need; larger wind and solar units could potentially supply that need in the early years of the plan. However, once that initial need is filled smaller units provide a better match for MP's forecasted energy growth rate.

The Department allowed Strategist to choose generic wind units in even numbered years for 2018 to 2030; the size of the units was 300 MW for 2018 and 100 MW in the subsequent years. The units were labeled superfluous (which means Strategist can choose them if they provide cost-effective energy even when there is no capacity need) in years 2018 to 2022. The Department included estimates of integration and cycling costs in the generic wind costs.[14] The 2018 wind unit was modeled with a flat cost of $50 per MWh for 20 years. The cost of subsequent wind units was escalated at two percent per year to determine the flat cost.[15] For energy production the Department assumed a 42.5 percent capacity factor. As with MP's modeling of generic wind units, the Department also assumed that the generic wind units would not provide any accredited capacity.[16]

The Department made 100 MW generic solar units available in odd numbered years for 2019 and 2021. The Department made 50 MW generic solar units available in odd numbered years for 2023 to 2029. The generic solar units were labeled superfluous (to address energy needs when there is no capacity need) in years 2019 to 2025. The Department assumed the units had a price of $100 per MWh for 20 years in 2019. The price was assumed to not change for units available in subsequent years, thus making solar expansion units progressively cheaper relative to the other alternatives available to Strategist in subsequent years of the planning period. For energy production the

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[13] A 15-year end effects period was also included in each Strategist run.
[14] The Department used the cost rates estimated by Xcel Energy; see Xcel Energy's petition at page 18 of Appendix J in Docket No. E002/RP-15-21. The Department acknowledges the Petition's statement that MP "has not identified any direct impacts to its ancillary services requirements that are due to renewable implementation as part of the RES requirements." However, the Department added these costs because they are relatively small, enable more consistent modeling across utilities, and recognize that MP may run into small integration costs in the future.
[15] For example, the 2024 unit costs a flat $56.31 per MWh, and the 2028 unit costs $60.95 per MWh.
[16] The Department concluded that MP's assumption of no accredited wind capacity was reasonable given MP's difficulty in obtaining accredited capacity prior to major transmission lines coming in-service connecting Minnesota with load centers further east (expected around 2020) and also considering that significant transmission costs may not be justified to obtain the small quantity of accredited capacity wind offers. Lastly, note that lack of transmission for accreditation may also lead to wind energy being curtailed—another factor that led the Department to reduce the overall wind capacity factor.

Department used a 20 percent capacity factor.[17] The Department's generic solar units have a capacity accreditation factor of about 52 percent.

MP adjusted the demand forecast inputs to its Strategist database to account for the fact that the reserve ratio is applied to the Company's demand at the time of MISO's peak rather than MP's own (non-coincident) peak. This adjustment means that Strategist uses a lower peak demand than the forecast predicts, with the reduction designed to mimic the coincident peak rather than the non-coincident peak. The Department was concerned that, while perhaps unlikely, MP's approach might impact the model results negatively, either now or in the future if it were continued to be used.[18] Therefore, the Department adjusted these inputs to use the approach used by Xcel and the Department in Xcel's most recent resource plan.[19] The Department entered MP's non-coincident peak demand forecast and then adjusted the required reserve ratio to account for MISO's coincidence factor. The reserve margin at the time of MISO's peak is 7.1 percent. Using MP's 2014 Advanced Forecast Report the coincidence factor between MP's system and MISO system peak is [TRADE SECRET DATA HAS BEEN EXCISED].[20] Therefore, the effective reserve margin is:

[TRADE SECRET DATA HAS BEEN EXCISED]

Another change was to reduce the size of the spot market that MP could access by 50 percent. The Department made this modification to reduce the Company's reliance on the spot market to about five percent of total energy needs after MP's purchase from Manitoba Hydro comes on-line in 2021. Unlike Xcel, MP has an overall energy short position (i.e. needs energy) early in the planning period. Therefore, MP's Strategist model requires availability of spot market purchases. However, the Department concluded that MP's reliance on the spot market was rather high after the first few years and a reduction was advisable. The Department ran each contingency through a version of the Strategist database with the wholesale market available and with the wholesale market turned off. The results are available in the Attachments to these comments.

Lastly, to improve the efficiency of the Strategist modeling, the Department made two adjustments to eliminate redundant expansion alternatives by limiting the number of potential plans or "states" considered by Strategist. The first change was to eliminate the availability of distributed generation (DG) units because MP already had peaking units available. The second change was to defer the availability of the combustion turbine (CT) and combined cycle (CC) expansion units by one year (to 2021 and 2022 respectively) and make the one-year bridge purchase available for an additional year.[21]

4. Scenarios Analyzed by the Department

The Department focused its Strategist analysis on the potential shutdown dates for the Company's Taconite Harbor 1 and 2 and Boswell 1 and 2 units. In order to limit the number

[17] This solar capacity factor is consistent with the assumption of both MP and Xcel in their recent resource plans.
[18] Changing the capacity in this manner will impact, for example, the load factor.
[19] Reflected in Department's July 2, 2015 comments in Docket No. E002/RP-15-21.
[20] Taken from the file CP-AFR_2014_(Mod_Deferred)_Strategist.xlsx
[21] This change also ensured that MP had sufficient time to plan, permit, and construct a new power plant.

of scenarios, MP performed a screening analysis to limit the options run through Strategist to a reasonable number. Overall, because natural gas is not a viable option, the Department agrees with MP's screening analysis that determined continued coal use is more economic than gas conversion at Taconite Harbor at any capacity factor.[22] Therefore, the Department did not further analyze a Taconite Harbor gas conversion option.

In addition to the four scenarios analyzed by MP in detail, the Department created two additional scenarios to provide a more complete picture of potential options (and not because it was thought the two additional scenarios might be economic). The six scenarios studied in detail are:

1. Taconite Harbor early shut down, Boswell early shut down (TEBE);
2. Taconite Harbor early shut down, Boswell gas conversion (TEBG);
3. Taconite Harbor early shut down, Boswell late shut down (TEBL);
4. Taconite Harbor late shut down, Boswell early shut down (TLBE);
5. Taconite Harbor late shut down, Boswell gas conversion (TLBG); and
6. Taconite Harbor late shut down, Boswell late shut down (TLBL).

Note that each shut down scenario was modeled under three different levels of energy savings:

- 57.3 GWh average annual energy savings (46.5 GWh approved in MP's last CIP[23]+11 GWh annual energy savings);[24]
- 61.2 GWh average annual energy savings (46.5 GWh approved in MP's last CIP+15 GWh);and
- 76.5 GWh average annual energy savings (46.5 GWh approved in MP's last CIP +30 GWh).

See the DSM section of the comments for further details and analysis of MP's DSM scenarios.
Lastly, note that each shut down scenario was run under four different modeling approaches:

- CO_2 and externality costs applied, utility discount rate (8.2%), spot market on;
- No CO_2 and externality costs, utility discount rate (8.2%), spot market on;
- CO_2 and externality costs applied, social discount rate (2.5%), spot market on; and
- CO_2 and externality costs applied, utility discount rate (8.2%), spot market off.

5. Contingencies Analyzed

[22] See Figures 15 and 16 of the Petition and discussion on pages 49-50.
[23] Docket No. E015/CIP-13-409.
[24] The 57.3 GWh energy savings level approximates the 1.85 percent of energy savings required by the Commission's Order in MP's previous IRP, Docket No. E015/RP-13-53. Note that, in the low to middle levels of DSM, the total amount of DSM is less than the sum of the two figures because the existing level of DSM is assumed to decrease slightly over time.

For each scenario, the Department ran the following contingencies:

a. externalities: two contingencies, high externalities/CO_2 internal cost and low externalities/CO_2 internal cost;
b. solar prices: four contingencies, higher and lower in $10 per MWh increments (+$20, +$10, -$10, -$20).
c. wind prices: four contingencies, higher and lower in $10 per MWh increments (+$20, +$10, -$10, -$20).
d. coal prices: two contingencies, 30 percent higher and lower costs;
e. natural gas prices: four contingencies, higher and lower in 25 percent increments (+50%, +25%, -25%, -50%);
f. capital costs: two contingencies, higher and lower by 30 percent;
g. energy and demand forecast: four contingencies, higher and lower in 2.5% increments applied to both (+5%, +2.5%, -2.5%, and -5%); and
h. spot market prices: two contingencies, higher and lower by 25 percent.

As with the Xcel resource plan, the Department considered running contingencies regarding the diversity factor and required reserve ratio assumptions since these are likely to change in the future. However, the demand forecast band simulates such changes. For example, assuming a higher diversity factor is similar to assuming a lower demand forecast. Assuming a higher reserve ratio is similar to assuming a higher demand forecast. In this case:

- The mid-high forecast with a 7.17 percent diversity factor results in the same capacity requirement as the base forecast and a 4.70 percent reserve ratio;
- The mid-low forecast with a 2.40 percent diversity factor results in the same capacity requirement as the base forecast and a 4.70 percent reserve ratio;
  - The range of diversity factors implicit in the mid-high to mid-low forecast band is 2.40 to 7.17 percent;
- The mid-high forecast with a 4.64 percent reserve ratio results in the same capacity requirement as the base forecast and a 7.10 percent reserve ratio;
- The mid-low forecast with a 10.04 percent reserve ratio results in the same capacity requirement as the base forecast and a 7.10 percent reserve ratio;
- The range of reserve ratios implicit in the mid-high to mid-low forecast band is 4.64 to 10.04 percent.

Note that the forecast contingencies impact both energy and demand. However, the Department determined that the added time and complexity of the analysis would outweigh the benefit of additional information from more contingencies to address the diversity factor and the reserve ratio. Consequently, the Department did not run contingencies on the diversity factor and the reserve ratio.

Thus, the Department ran each of the six scenarios regarding the Taconite Harbor and Boswell facilities a total of 25 times, the base case plus 24 contingencies. The following charts illustrate some of the contingency bands analyzed.

Figures 3 and 4 below show the base demand and energy forecasts and contingencies used by the Department. The Department used two high and two low forecast bands. The mid-high and mid-low forecast bands represent the normal band in between which MP's requirements will fluctuate. The highest/lowest forecast bands represent significant additions or subtractions of energy and demand requirements.

Figure 3: Energy Forecast Contingencies

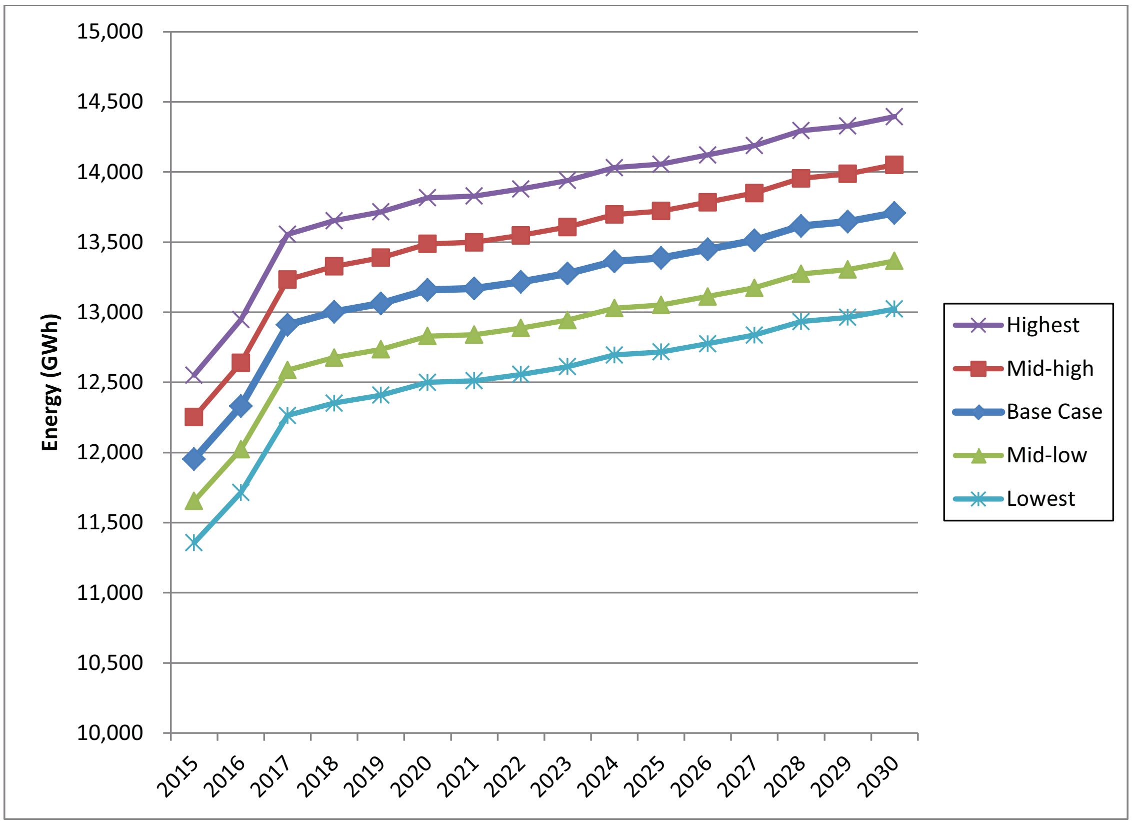


Figure 4: Demand Forecast Contingencies

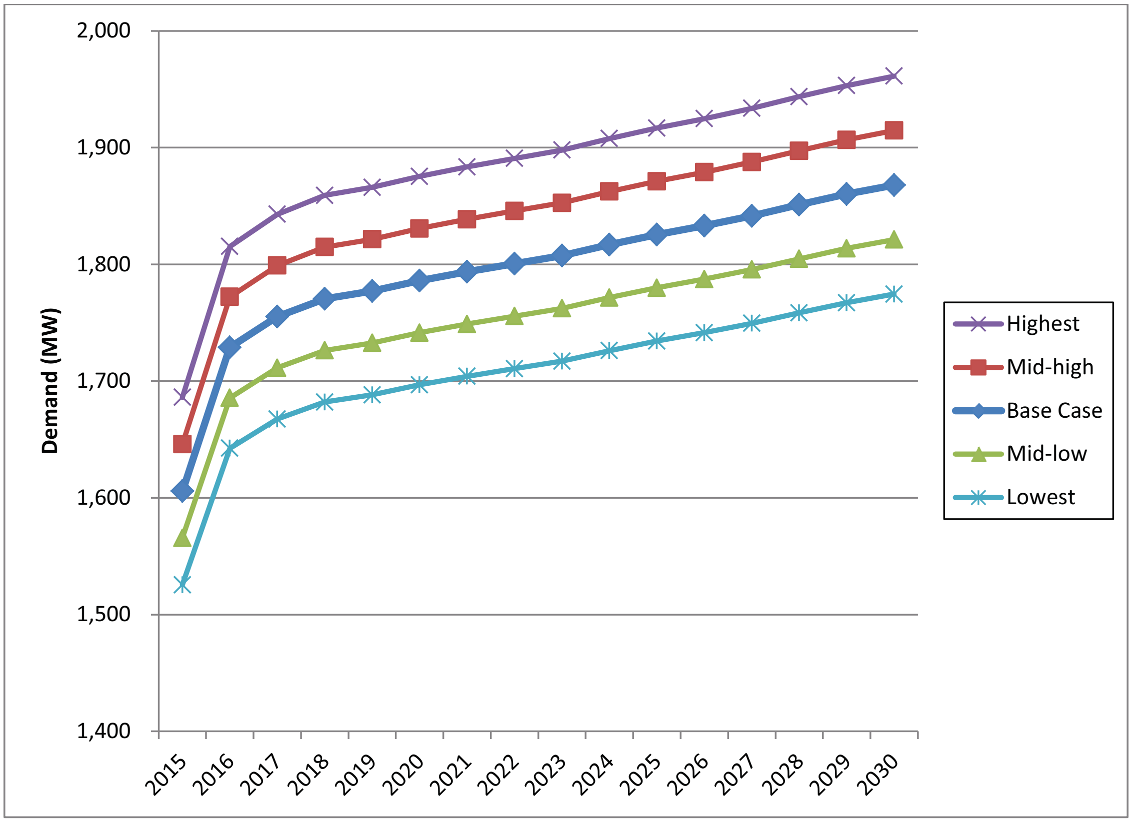


Figure 5 below shows the base natural gas price forecast and the contingencies modeled by the Department.[25] The Department used two high and two low natural gas bands in an attempt to determine how much natural gas prices have to change before they significantly impact the overall expansion plan.

[25] MP modeled natural gas prices varying by month. The prices shown are for December and/or January.

[TRADE SECRET DATA HAS BEEN EXCISED]

Figures 6 and 7 below show the base coal price forecast and the contingencies used by the Department in its analysis of Boswell 1 and 2 and Taconite Harbor 1 and 2.

[TRADE SECRET DATA HAS BEEN EXCISED]

5. *Modeling Approaches*

The Department analyzed each scenario under four different overall modeling approaches. Again the goal was to determine if the expansion plan would be significantly impacted by a different approach. The Department's first modeling approach, as described above, employed MP's cost of capital as the discount rate, the Commission's median externality and CO_2 cost values, and the spot market turned on.

The Department's second modeling approach continued to use the utility's cost of capital as the discount rate and left the spot market turned on but excluded externality and CO_2 cost values. In essence, this approach has no planning for future environmental regulation—that is it assumes that the Company can continue to impose the cost of pollution on others and does not attempt to plan for meeting future environmental regulations.

The third approach used a societal discount rate based on 20-year U.S. Treasury yields,[26] the Commission's median externality and CO_2 cost values, and the spot market turned on. This was an attempt to use a societal discount rate to create a better societal cost approach than has been used in past dockets. Note that for simplicity the discount rate was applied to all costs.

In the Department's fourth approach we used the utility's cost of capital as the discount rate, the Commission's median externality and CO_2 cost values, but turned the spot market off.

6. *Model Outputs*

a. *Base Case Modeling Results*

The Department ran MP's preferred case—Taconite Harbor 1 and 2 close early, Boswell 1 and 2 close late—with all of the Department's changes under the first modeling approach discussed above. The resulting expansion plan, assuming 11 GWh of added annual energy savings, is shown in Table 5 below.

[26] The values are available at http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield At the time of the Department's analysis the rate was 2.51 percent. Note that the 20-year treasury rate is used by the Department's Conservation Improvement Program unit for the societal benefit/cost test.

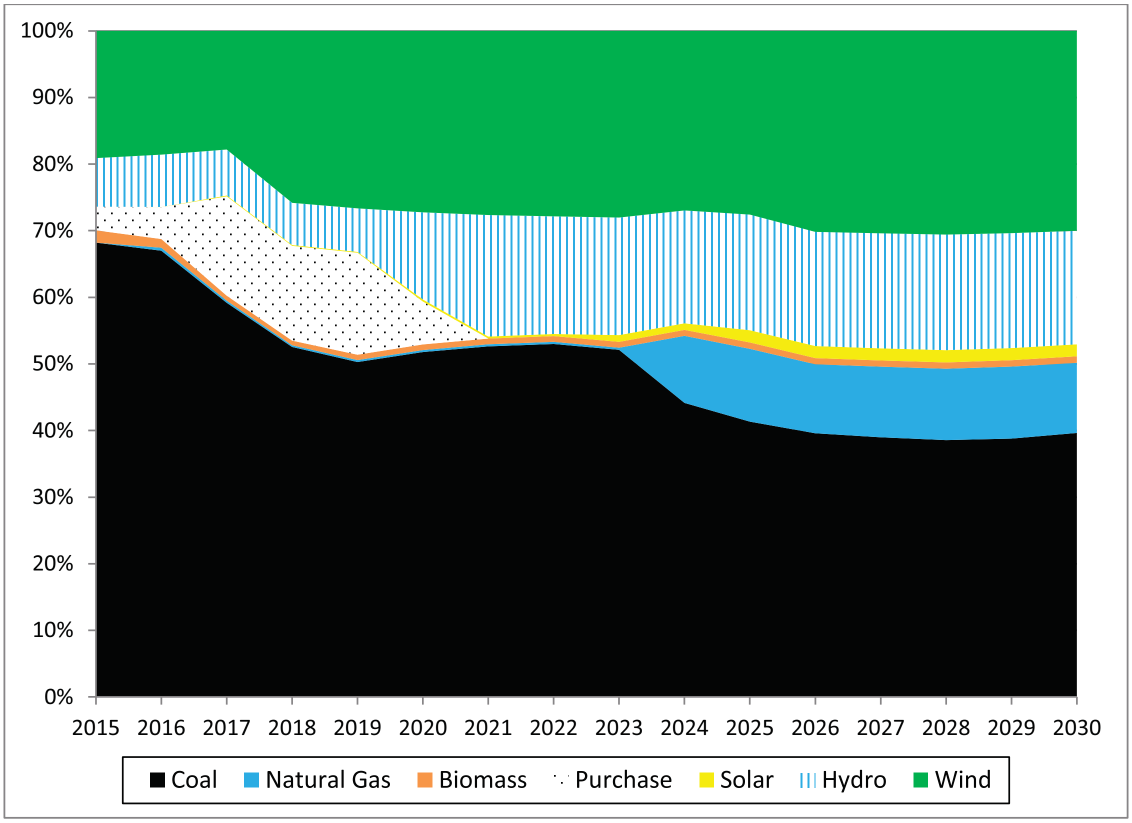
Table 5: Base Case Expansion Plan (units)[27]

Year	Wind (100 MW)	Solar (50 MW)	CC units (192 MW)	CT units (202 MW)
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	3	0	0	0
2019	0	0	0	0
2020	1	0	0	0
2021	0	0	0	0
2022	0	0	0	0
2023	0	1	0	0
2024	0	0	1	0
2025	0	1	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0

Additional information for the base case is shown in Figures 8 to 10 below.

[27] Capacity is nameplate for the wind and solar and accredited for the CC and CT units.

Figure 8: Energy Mix (2015-2030)



As shown in Figure 8 above, MP's fuel mix is projected to become much more diversified. The largest energy sources are projected to be coal, natural gas, hydro, and wind; each of which provides more than 10 percent of the Company's energy by the end of the planning period (2030). The portion of the Company's energy mix that is from low emission resources (wind, solar and hydro) grows from about 25 percent in 2015 to about 50 percent by 2030.

Figure 9: Internal Cost per MWh[28]

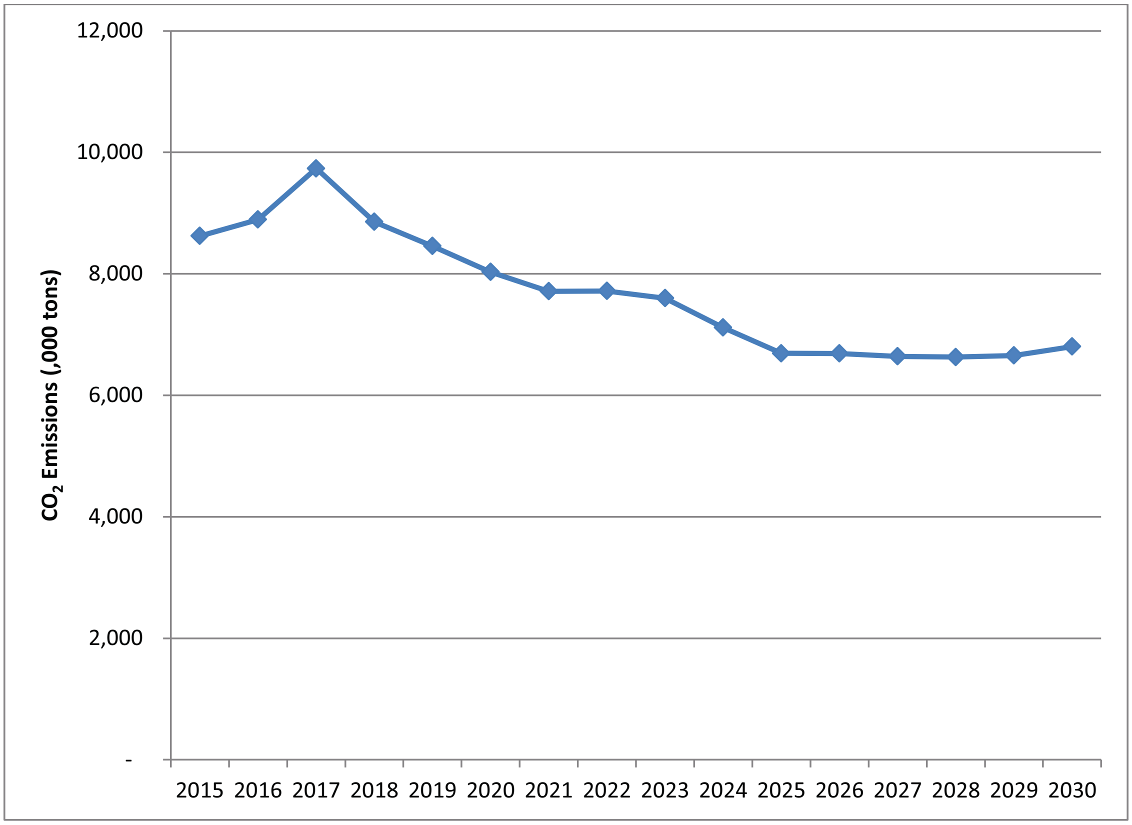
[TRADE SECRET DATA HAS BEEN EXCISED]

In Figure 9 above the dashed lines (Total Cost – Effluent Expense) show the cost per MWh without the Commission's estimate of the cost of future CO_2 regulation ($21/MWh). The solid lines show the cost per MWh with the Commission's estimate of the cost of future CO_2 regulation. As shown in Figure 9, in the base case the cost per MWh (in nominal dollars) will **[TRADE SECRET DATA HAS BEEN EXCISED]** during the planning period (2015-2030). When converted to real dollars using a two percent inflation rate **[TRADE SECRET DATA HAS BEEN EXCISED].** When emissions costs are removed, MP's cost per MWh (in nominal dollars) will **[TRADE SECRET DATA HAS BEEN EXCISED]** When converted to real dollars using a two percent inflation rate **[TRADE SECRET DATA HAS BEEN EXCISED]**

This analysis demonstates that the majority of the cost increase shown in Figure 9 is due to the assumed cost of future CO_2 regulation and general inflation, not due to the internal costs of future resources.

[28] Externality costs are excluded.

Figure 10: MP System CO_2 Emissions[29]



As shown in Figure 10 above, MP's CO_2 emissions under the base case are projected to slowly decrease starting in 2017 and continuing for the duration of the planning period. The decrease between 2017 and 2030 is approximately 21 percent under base case conditions.

b. Base Case Contingency Analysis

The cost of the base case and the contingencies under the first modeling approach discussed above are shown in Table 6 below.

[29] Note that CO_2 emissions are based upon MP's CO2-E information. See page 6 of Appendix J of the Petition for a description of MP's CO_2 inputs.

Table 6: Base Case Cost (PVSC[30] $ Million)

Contingency	PVSC	Difference from Base	% Change from Base
Base	$ 11,764		
CO_2/externalities High	$ 12,665	$ 902	7.7%
CO_2/externalities Low	$ 10,821	$ (942)	-8.0%
Solar -$20	$ 11,744	$ (20)	-0.2%
Solar - $10	$ 11,754	$ (10)	-0.1%
Solar + $10	$ 11,774	$ 10	0.1%
Solar +$20	$ 11,784	$ 20	0.2%
Wind -$20	$ 11,441	$ (322)	-2.7%
Wind - $10	$ 11,607	$ (157)	-1.3%
Wind + $10	$ 11,875	$ 111	0.9%
Wind +$20	$ 11,885	$ 121	1.0%
Coal Low	$ 11,170	$ (594)	-5.0%
Coal High	$ 12,339	$ 576	4.9%
Capital Cost Low	$ 11,667	$ (97)	-0.8%
Capital Cost High	$ 11,830	$ 66	0.6%
Natural Gas - 50%	$ 11,430	$ (334)	-2.8%
Natural Gas - 25%	$ 11,605	$ (159)	-1.3%
Natural Gas + 25%	$ 11,890	$ 126	1.1%
Natural Gas + 50%	$ 11,994	$ 230	2.0%
Forecast Low	$ 11,227	$ (536)	-4.6%
Forecast Mid-low	$ 11,484	$ (280)	-2.4%
Forecast Mid-high	$ 12,050	$ 286	2.4%
Forecast High	$ 12,363	$ 600	5.1%
Market Low	$ 11,614	$ (149)	-1.3%
Market High	$ 11,944	$ 181	1.5%

Table 6 shows the top contingencies, in terms of the absolute value of the percent change in costs, including CO_2 costs, coal costs, natural gas costs, and forecasting. However, only the CO_2, coal, and high/low forecast contingencies created an impact of more than three percent. When assembling a preferred case the Department considered ways to mitigate MP's exposure to these three more significant risks.

Total carbon emissions for the planning period are shown below in Table 7.

[30] Present Value of Societal Costs.

Table 7: Base Case CO_2 (tons, 2015-'30)

Contingency	CO_2 Emissions (,000 tons)	Difference from Base	% Change from Base
Base	122,839		
CO_2/externalities High	118,924	(3,916)	-3.2%
CO_2/externalities Low	127,992	5,153	4.2%
Solar -$20	122,839	-	0.0%
Solar - $10	122,839	-	0.0%
Solar + $10	122,839	-	0.0%
Solar +$20	124,369	1,530	1.2%
Wind -$20	120,728	(2,112)	-1.7%
Wind - $10	120,728	(2,112)	-1.7%
Wind + $10	131,734	8,895	7.2%
Wind +$20	134,655	11,815	9.6%
Coal Low	128,044	5,205	4.2%
Coal High	120,618	(2,221)	-1.8%
Capital Cost Low	124,369	1,530	1.2%
Capital Cost High	122,839	-	0.0%
Gas - 50%	123,263	424	0.3%
Gas - 25%	123,327	488	0.4%
Gas + 25%	123,484	645	0.5%
Gas + 50%	125,253	2,413	2.0%
Forecast Low	119,580	(3,260)	-2.7%
Forecast Mid-low	120,955	(1,884)	-1.5%
Forecast Mid-high	126,902	4,062	3.3%
Forecast High	126,520	3,680	3.0%
Market Low	123,183	343	0.3%
Market High	122,462	(378)	-0.3%

1. Small Coal Scenarios

Attachments 1 to 13 provide selected summary data from the outputs for the scenarios and contingencies assuming various shut down dates and conversion for Taconite Harbor units 1 and 2 and Boswell units 1 and 2. The Department's integrated resource plan (IRP) team reviewed information similar to that provided in Attachments 1 to 13 when analyzing the Department's modeling results.

Regarding the small coal shut down scenarios, generally shutting down Taconite Harbor units 1 and 2 early is more cost effective than a later shut down date. Based upon review of the modeling results, the Department concluded that the overall best plan clearly involves shutting down Taconite Harbor units 1 and 2 early. As discussed elsewhere in these comments, the Department also concluded that the overall best plan involves an additional annual 30 GWh of energy efficiency, or annual energy savings of 76.5 GWh. The final question for the Department was the action plan to recommend regarding Boswell units 1 and 2. In most circumstances the gas conversion option was the highest cost of the three alternatives for Boswell units 1 and 2.[31] The cost of the remaining two alternatives (early and late shut down) were typically very close in cost. In addition, the number of wind, solar, CT, and CC units in the expansion plan did not vary significantly with the shutdown date. The main difference was that an early shut down required MP to rely upon substantial short term base load capacity for an additional three years.[32] The short term capacity is necessary to meet the Company's load and capability requirements. From this information the Department concluded that MP should coincide its shut down of Boswell units 1 and 2 with the addition of natural gas capacity. This approach will allow the Boswell units 1 and 2 to be shut down without the necessity of relying upon the availability of capacity and energy in the short term market. An earlier shut down might only result in shutting down MP-owned coal units and forcing the Company to purchase energy from other coal units.[33]

At this point in the Department's analysis, our preferred action plan included:

- shutting down Taconite Harbor units 1 and 2 early;
- shutting down Boswell units 1 and 2 as soon as replacement capacity is available; and
- 76.5 GWh of energy savings.

The remaining question was what supply-side units should be included in the small coal replacement package? Tables 8a and 8b below summarize the number of times that various amounts of least cost fossil fuel unit additions (CT and CC) were selected by Strategist under different modeling contingencies.

Table 8a: Fossil Fuel Additions under TEBE Contingencies[34]

	0 CT	1 CT	2 CT
0 CC	-	20	-
1 CC	47	4	-
2 CC	29	-	-

[31] The three alternatives are an early shut down, a conversion to a natural gas boiler, and a late shut down.
[32] Here the unit added is a one year purchase of 150 MW of capacity with energy produced 24 hours a day, seven days a week. The unit is typically added three years in a row.
[33] In the MISO real-time market coal is a marginal fuel over 80 percent of the hours in most months.
[34] There are 100 contingencies since each scenario contains 25 contingencies and these tables address one scenario (TEBE or TEBL each with 76.5 GWh of energy efficiency) under four different conditions.

Table 8b: Fossil Fuel Additions under TEBL Contingencies

	0 CT	1 CT	2 CT
0 CC	-	7	-
1 CC	61	4	-
2 CC	28	-	-

Regarding fossil fuel units, in both the TEBE and TEBL scenarios approximately two-thirds of all contingencies resulted in adding either one CT unit or one CC unit; the most common addition being a single CC unit, especially in the TEBL scenario. Two CC units are often added when the wholesale market is turned off.[35] One CC unit and one CT unit also was chosen when the wholesale market is turned off. Since the risks related to exposure to the spot market would be mitigated by deferring the shutdown of Boswell 1 and 2 until replacement capacity is available, it is less likely that a second CC unit would be needed. Thus, the Department concludes that the addition of a single CC unit is preferable.

With a single CC unit and 30 GWh of added energy efficiency in the small coal replacement package, the remaining question is the least cost additions of renewable energy. Regarding solar units, under TEBL conditions over 80 percent of contingencies that add 1 CC unit also add 1 solar unit; under TEBE conditions the ratio is still high, but falls to 61 percent. Therefore, the Department concludes that Strategist shows a strong preference for a single, 50 MW solar unit in the least cost, small coal replacement package.

Regarding wind units, the data demonstrate a preference for no wind or a single wind unit (100 MW).[36] Under TEBL conditions about 66 percent of contingencies that add 1 CC unit also add 0 or 1 wind units; under TEBE conditions the ratio is 64 percent. Therefore, the Department concludes that Strategist shows a strong preference for up to 100 MW of wind in the least cost, small coal replacement package.

With the small coal shut down and small coal replacement packages determined, the final step in the Department's analysis was to determine what actions should be taken in the five-year action plan (2016 to 2020) to support the overall small coal recommendation. First, all of the Strategist runs had forced solar additions in order to meet the Company's obligation under Minnesota's solar energy standard (SES). The forced solar units during the five-year action plan are 11 MW in 2016, and 12 MW in 2020.[37] Second, under the Department's overall small coal recommendation, Strategist typically selected 300 MW of wind in 2018. Therefore, the Department recommends that the five-year action plan include:

- 11 MW of solar in 2016 and 12 MW of solar in 2020; and
- 300 MW of wind in 2018.

[35] Under TEBE, 20 of 29 contingencies selecting two CC units assumed the wholesale market was off. Under TEBL, 19 of 28 contingencies selecting two CC units assumed the wholesale market was off.
[36] This wind is in addition to the approximately 300 MW of wind acquired as part of MP-s five-year action plan, discussed elsewhere in this section.
[37] Note that an additional 10 MW of solar is forced later in the planning period (2025) for SES compliance purposes.

Table 9 below shows the Department's preferred expansion plan. For purposes of preparing this table, the Department assumed that MP could procure the small coal replacement package in 2022.

Table 9: Department's Preferred Expansion Plan (2016-2030, nameplate capacity)

Year	CC	CT	Solar Options	Solar Standard Compliance	Wind Options
2016	-	-	-	11	-
2017	-	-	-	-	-
2018	-	-	-	-	300
2019	-	-	-	-	-
2020	-	-	-	12	-
2021	-	-	-	-	-
2022	200 to 400	-	Up to 50	-	Up to 200
2023	-	-	-	-	-
2024	-	-	-	-	-
2025	-	-	-	10	-
2026	-	-	-	-	-
2027	-	-	-	-	-
2028	-	-	-	-	-
2029	-	-	-	-	-
2030	-	-	-	-	-

1. *Department Recommended Plan and Potential Compliance with the Clean Power Plan*

After selecting a recommended plan for MP, the Department determined that it might be helpful to see how the Department's recommendation regarding MP's resource plan might fit into a potential, overall Clean Power Plan (CPP) compliance strategy for Minnesota as a whole. Necessarily, this analysis is preliminary, but the Department provides it here as one of many analyses being done to assess what may be necessary in Minnesota to comply with the CPP.

To start, the Department briefly reviewed the U.S. Environmental Protection Agency's (EPA) rate and mass goals for Minnesota. It has not yet been decided whether Minnesota will pursue a rate-based or mass-based goal. However, given that the mass goal is easier to calculate at this time, the Department used the mass-based approach for this overview.[38] To determine the affected generating units located in Minnesota, the Department consulted EPA's website and found a list of potentially affected units as of August 2015.[39] The

[38] Minnesota's goals are available on EPA's website at: http://www3.epa.gov/airquality/cpptoolbox/minnesota.pdf.
[39] See http://www2.epa.gov/sites/production/files/2015-11/documents/tsd-fp-affected-egu.pdf.

Department then reviewed the status of the units and the availability of modeling outputs for the utility owning the units.

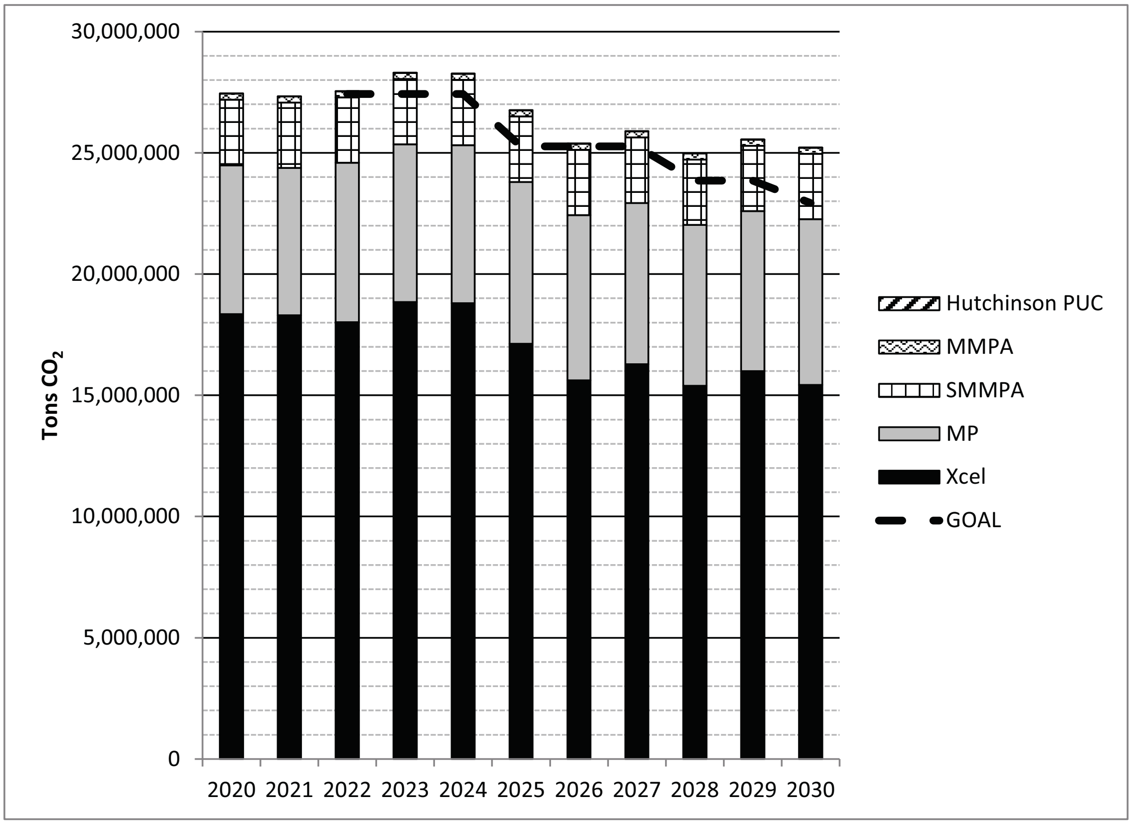
The following affected units are not included in a Strategist database:

- Fox Lake 3—owned by Interstate Power and Light, to be retired prior to 2022;
- Austin Northeast—owned by Austin Municipal Utility, to be retired prior to 2022;
- Silver Lake—owned by Rochester Public Utilities, to be retired prior to 2022;
- Faribault Energy Park (MMPA)—owned by Minnesota Municipal Power Agency;
- Hutchinson Plant #2 (HUC)—owned by Hutchinson Municipal Utility; and
- Sherburne County #3 (SMMPA)—partially owned by Southern Minnesota Municipal Power Agency.

The Department calculated the expected CO_2 annual emissions for SMMPA by multiplying the emissions factor from Xcel's Strategist database by the median generation for 2007-2010 and 2014 as reported in SMMPA's annual filing under Minnesota Rules 7610.[40] Emissions for HUC and MMPA were the 2012 levels reported by EPA. The remaining affected units were in the Strategist databases of Xcel, MP, and Otter Tail Power Company. However, OTP's affected units (Hoot Lake 2 and 3) are scheduled to be retired in 2020. Therefore, OTP was excluded from further consideration. Data for Xcel's affected units[41] was taken from the Department's recommended plan under base case conditions in Docket No. E002/RP-15-21. Data for MP's affected units[42] was taken from the scenario that assumes Boswell 1 and 2 retire early, as being reasonably representative of the impact of the Department's recommendation in this resource plan. (As discussed above, the Department recommends that Minnesota Power retire Boswell 1 and 2 once replacement power from a CC unit is acquired.) The results of this analysis, shown below in Figure 11,indicates that, other than potentially in the last years (2029-2030), significant actions beyond those already ordered by the Commission or recommended by the Department may not be required.[43]

[40] The years 2011-2013 were excluded due to the impact of an extended forced outage.
[41] Xcel's affected units are assumed to include: King; Black Dog 2/5, 3, and 4; Sherco 1, 2, and 3 (including the gas boiler conversion); High Bridge, Riverside, LS Power Cottage Grove; Calpine Mankato (including the recently approved expansion). Some of these units (at Black Dog) retire prior to 2020.
[42] MP's affected units are assumed to include: Boswell 1, 2, 3, and 4; Hibbard 3 and 4; Laskin 1 and 2; and Taconite Harbor 1, 2, and 3. Some of these units (at Taconite Harbor) retire prior to 2020.
[43] The Department notes that, given a particular scenario, CO_2 emissions can vary significantly depending upon the contingency under consideration. For example, MP's emissions in any one year might decrease by 300,000 to 400,000 tons and might increase by 1,100,000 tons or more.

Figure 11: Preliminary Estimate of Minnesota's Clean Power Plan Compliance Status



8. Department Recommended Action Plan

First, the Department recommends that the Commission approve a five-year action plan that includes MP:

- acquiring up to 300 MW of wind capacity in about 2018;
- acquiring solar units of 11 MW in 2016 and 12 MW in 2020;
- shutting down the Taconite Harbor 1 and 2 units in 2017,
- procuring annual average energy savings of 76.5 GWh.

Second, the Department recommends that the Commission require MP to pursue a small coal replacement package of approximately 100 MW of wind, 50 MW of solar, and 200 MW of CC capacity with the Boswell 1 and 2 units being shut down when the CC replacement capacity is on-line.

Third, given that MP intends to further explore distributed generation through its backup generation pilot project, the Department recommends that the Commission require MP to conduct a distribution study to identify interconnection points on its distribution system for small-scale distributed generation resources.

C. REVIEW OF MP's DEMAND-SIDE MANAGEMENT

1. Background

One purpose of resource planning is to estimate the optimal amount of demand-side resources for meeting the Company's customers' future needs.

Minn. Stat. §216B.2401 clearly identifies energy savings as the State's preferred energy resource:

> The legislature finds that energy savings are an energy resource, and that cost-effective energy savings are preferred over all other energy resources. The legislature further finds that cost-effective energy savings should be procured systematically and aggressively in order to reduce utility costs for businesses and residents, improve the competitiveness and profitability of businesses, create more energy-related jobs, reduce the economic burden of fuel imports, and reduce pollution and emissions that cause climate change. Therefore, it is the energy policy of the state of Minnesota to achieve annual energy savings equal to at least 1.5 percent of annual retail energy sales of electricity and natural gas through cost-effective energy conservation improvement programs and rate design, energy efficiency achieved by energy consumers without direct utility involvement, energy codes and appliance standards, programs designed to transform the market or change consumer behavior, energy savings resulting from efficiency improvements to the utility infrastructure and system, and other efforts to promote energy efficiency and energy conservation.

When analyzing the appropriateness of a utility's energy savings plan within an IRP, the Department considers, along with other factors:

- Minnesota's clear preference for energy savings as a resource;
- The Company's historical energy savings achievements;
- The Company's costs of different energy savings levels; and
- The impact of different amounts of energy savings on the Company's total system costs.

Order Point 11 of MP's last IRP stated: [44]

[44] November 12, 2013 Commission Order Approving Resource Plan, Requiring Filings, and Setting Date for Next Resource Plan, Docket E015/RP-13-53

> The Commission approves an energy savings goal of 1.87 percent of Minnesota Power's retail sales by its next resource plan filing.

In Order Point 12 of the same Order, the Commission instructed that for its next resource plan, Minnesota Power shall:

> a. Identify the amount of energy savings embedded in each year of its load forecast, in terms of total savings (kWh) and as a percentage of non-CIP-exempt retail sales;
> b. Identify the amount of system-wide energy savings, including aggregate data for CIP-exempt customers, embedded in each year of its load forecast;
> c. Evaluate additional conservation scenarios for its CIP-exempt and non-CIP-exempt customers, that would achieve greater energy savings beyond those in the base case; and
> d. Provide cost assumptions for achieving every 0.1 percent of savings above 1.5 percent of non-CIP-exempt retail sales.

In its analysis, the Department visits each of these Order points and evaluates the compliance by the Company point by point.

2. MP's Proposed Energy Savings

Appendix B of MP's filing details the DSM scenarios and sensitivities that MP analyzed in this resource plan. Additionally, Section IV of MP's filing, 2015 Plan Development, provides a narrative that describes the Company's preferred DSM scenarios. MP analyzed three scenarios proposing incremental additions on top of its base scenario, which is based on the energy savings goals approved in the Company's most recent triennial CIP. [45] A summary of the Company's current approved CIP savings levels is shown in Table 10 below.

Table 10: Current Approved CIP Triennial Energy Savings

Year	Proposed Goal (kWh)	Adjusted Average Retail Sales (kWh)	Proposed Savings %	Statutory Savings Goal
2014	46,553,951	3,071,179,967	1.52%	1.50%
2015	46,539,000	3,071,179,967	1.52%	1.50%
2016	46,545,084	3,071,179,967	1.52%	1.50%

[45] Docket No. E015/CIP-15-409

Table 11 below shows the four DSM scenarios modeled by MP, including costs, incremental energy savings (as compared to approved CIP levels) and total energy savings.

Table 11: MP's Incremental Energy Savings Scenarios[46]

Scenarios			Annual Program Costs			
Annual Savings at the Generator (GWh)	*% of Sales (rounded)*	*Plan*	*Incentives*	*Admin*	*Nonimpact*	*Total Costs*
46.5	1.50%	Existing	$3,418,012	$1,243,589	$2,417,854	$7,079,455
57.3	1.87 %	+ 11 GWh	$4,809,780	$1,723,687	$3,211,156	$9,744,623
61.2	2.00%	+ 15 GWh	$5,570,768	$1,946,120	$3,626,781	$11,143,669
76.5	2.50%	+ 30 GWh	$9,432,408	$2,853,205	$5,319,279	$17,604,891

3. *MP's Historical Energy Savings Costs*

Historically, Minnesota Power has achieved energy savings at costs significantly below the national electric utility industry average. The Company stated that:

> Minnesota Power has met or exceeded the 1.5 percent savings goal since the Next Generation Energy Act of 2007 was implemented in 2010. Between 2010 and 2014, achieved first-year savings ranged from roughly 60,000 to roughly 78,000 MWh, with costs ranging between $5.6 million and $7.2 million. First-year savings averaged about $0.09 per kWh—about $0.15/kWh less than the 2013 industry average.[47]

MP provided its recent historical costs and achievements in Appendix B of the filing. The historical achievements indicate that MP's residential programs have provided approximately 20 percent of the Company's CIP energy savings. In 2014, MP's residential projects delivered energy savings at an average first-year energy savings cost of $0.13 per kWh ($130/MWh) while MP's commercial/industrial (C/I) programs delivered energy savings at an average annual first year energy savings cost of $0.0045 per kWh ($45 per MWh), down from $0.06/kWh in 2010. Between 2010 and 2014, MP's first year energy savings from MP's C/I customers increased by 20 million kWh. Figure 12 below illustrates MP's CIP savings and costs since 2005.

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[46] The 57.3GWh energy savings is equivalent to the 1.87 percent of retail sales energy savings required by the Commission in Order Point 11 of Docket No. E015/RP-13-53.
[47] Page 2, Appendix B

Figure 12: Minnesota Power Historical CIP Achievements

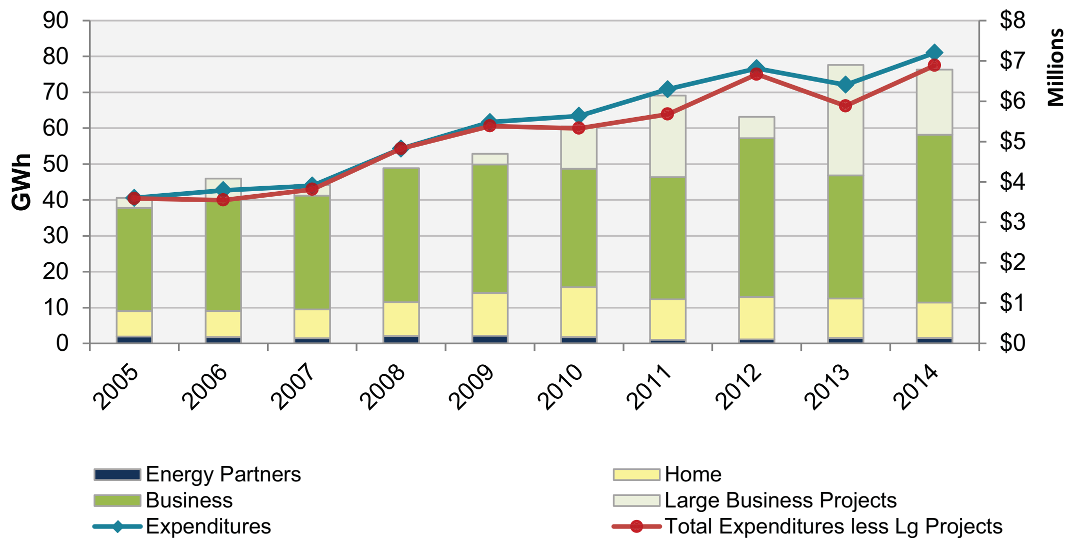
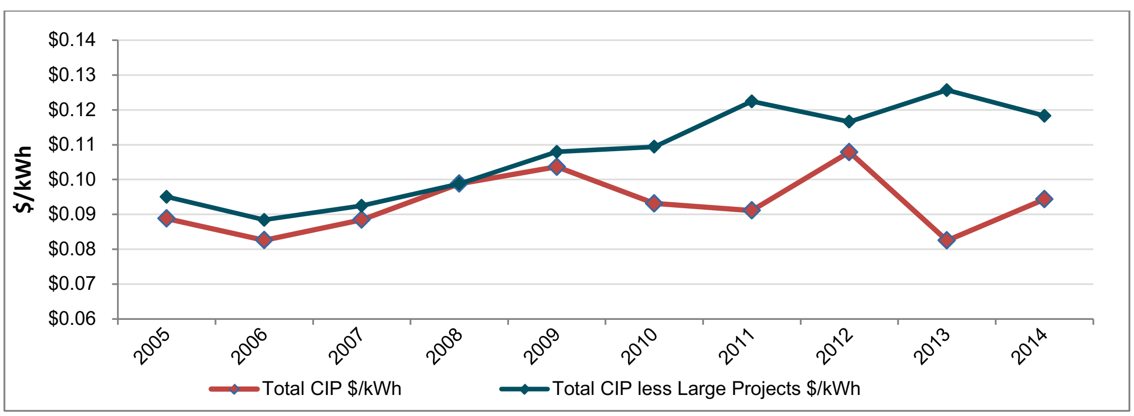


Figure 13 below illustrates the Company's total portfolio cost per first-year kWh savings, including residential and C/I programs. The figure plots two series of costs, one that includes MP's large, one-time C/I projects and one that excludes these projects. MP's large C/I projects have resulted in large amounts of energy savings at a low cost.

Figure 13: Total Portfolio Cost per First-Year kWh



MP reasons that, since these projects are difficult to predict and have large savings impacts, they should not be considered indicative of future levels and costs of MP's CIP energy savings. From 2010-2014, the Company achieved its energy savings at a total program cost of approximately $0.12/kWh or $120/MWh (MP excluded large one-time projects in its calculation).

4. Department Analysis

To analyze the appropriate level of energy savings in MP's IRP, the Department considered the following factors:

- MP's compliance with Commission Order Point 11 from Docket No. E015/MP-RP-13-53 requiring the Company to procure energy savings equivalent to 1.87 percent of retail sales;
- MP's compliance with other Commission Order Points 12 a through d; and
- Department modeling of cost-effective levels of energy savings.

The Department discusses each of these issues below.

a. Order Point 11 – 1.87 percent energy savings goal

Order Point 11 of MP's previous IRP filing stated:

> The Commission approves an energy savings goal of 1.87 percent of Minnesota Power's retail sales by its next resource plan filing.

The Department estimates that 1.87 percent translates into energy savings of approximately 57.3 GWh. MP's +11 GWh scenario would comply with this requirement. The Department's review of MP's Strategist inputs indicates that MP included the +11GWh incremental savings in its preferred plan. However, statements from MP regarding the amount of energy savings in its preferred plan are ambiguous, and are not clear from reading the Company's narrative.[48] The Department requests that the Company provide a more clear and discrete energy savings proposal in future resource plan filings. Based on the Department's review of MP's Strategist inputs, the Department concludes that the Company complied with Commission Order Point 11.

b. Order Points 12a and 12b—embedded energy savings

When MP creates its econometric forecast, the Company inputs historical customer energy and demand use that have been impacted by the historical energy and demand savings of both its CIP and CIP-exempt customers. Thus an econometric forecast already has a certain amount of energy and demand savings embedded into it. The forecast assumes that the future is a function of the past achievements. This concept is important because embedded energy savings must be accounted for when evaluating what level of future energy savings is appropriate. For example, if a forecast already has 100 MWh of energy savings embedded

[48] For example, in Appendix B, MP states:

> Minnesota Power has included additional investment in CIP as part of its short-term action plan in order to augment its already high performing energy efficiency portfolio. (See Section IV for details on energy efficiency included in the resource plan.) The Company believes that **some additional savings compared to the existing CIP may be achievable and will continue its efforts to determine that level of savings along with delivery strategies.** [Emphasis added.]

in it, and the Company wants to evaluate the impact and cost-effectiveness of a DSM scenario with average annual energy savings of 125 MWh, the utility's analysis should:

- Include the costs of the entire 125 MWh of future annual energy savings, but
- Include the impact of only the incremental 25 MWh because the 100 MWh is already assumed in the forecast.

In response to Commission Order Point 12b, MP estimated the amount of energy savings embedded in each year of its forecast. Table 12 below shows the initial data MP used for its calculations.

Table 12: Embedded Energy Savings in IRP Forecast

Year	Annual Impacts (GWh)			Total (GWh)
	CIP Customers	Adjusted CIP Customers[49]	CIP Exempt	
2006	[TRADE SECRET DATA HAS BEEN EXCISED]			
2007				
2008				
2009				
2010				
2011				
2012				
2013				
2014				
2015				
2016				
2017				
2018				
2019				
2020				
2021				
2022				
2023				
2024				
2025				
2026				
2027				
2028				

For its CIP customers, MP first subtracted the energy savings of projects larger than 1 million kWh, reasoning that these types of projects are too difficult to predict, from its reported CIP energy savings. The result is shown above in the column labeled Adjusted CIP Customers. MP's adjusted 2010-2014 CIP energy savings total 258 GWh.

For its CIP-exempt customers, MP averaged the 2007-2010 energy savings, which is **[TRADE SECRET DATA HAS BEEN EXCISED]** annually. MP then assumed that the forecast would include five years of MP's CIP-Exempt customers' **[TRADE SECRET DATA HAS BEEN EXCISED]**

[49] These figures exclude non-CIP exempt projects larger than 1 million kWh, which MP considers as unlikely to be replicable in the near future without new large customers, and savings associated with previously non-CIP exempt customers who have since opted out of Minnesota Power's CIP program.

of energy savings, or **[TRADE SECRET DATA HAS BEEN EXCISED]**. MP calculated total embedded energy savings by adding the 258 GWh savings from CIP customers and the **[TRADE SECRET DATA HAS BEEN EXCISED]** from CIP-Exempt customers, or **[TRADE SECRET DATA HAS BEEN EXCISED]**. For future years, MP assumed that the forecast would include energy savings based on MP's approved 2015 CIP energy savings goal, or 47 GWh. For CIP-exempt customers, MP assumed that **[TRADE SECRET DATA HAS BEEN EXCISED]** of energy savings would continue to be embedded annually. The results of MP's calculations are shown in Table 13 below.

Table 13: MP's Estimate of Embedded Energy Savings Over Planning Period

	Five Year Summation			Embedded Savings	Difference
Year	Non-CIP Exempt[50]	CIP Exempt	Total		
2014	[TRADE SECRET DATA HAS BEEN EXCISED]				
2015					
2016					
2017					
2018					
2019					
2020					
2021					
2022					
2023					
2024					
2025					
2026					
2027					
2028					

When reviewing MP's estimate and use of embedded energy savings, we considered whether MP's estimate of embedded energy savings reasonable and whether MP used the embedded energy savings correctly in its IRP analysis.

[50] These figures exclude non-CIP exempt projects larger than 1 million kWh which are unlikely to be replicable in the near future without new large customers, and savings associated with previously non-CIP exempt customers who have since opted out of Minnesota Power's CIP program

i. MP Estimate of Embedded Energy Savings

The Department is not aware of any industry best practices for estimating the amount of energy savings embedded in a forecast. However, the Department concludes that one way MP could improve its estimate by not excluding the savings from the large (one million kWh and greater) energy savings projects. Regardless of how unlikely that MP thinks it is that such savings will occur in the future, the savings occurred in the recent past and thus are reflected in the data points that MP used to estimate its embedded energy savings.

In addition, for years 2015-2029, MP estimated each year that its CIP Customers' contribution to embedded energy savings was equal to its approved CIP energy savings goal for 2015, approximately 47 GWh. This approach is unduly conservative since MP averaged CIP energy savings of 69 GWh from 2010-2014 (51 GWh if the large projects are excluded.) Thus, the Department concludes that MP underestimated its embedded energy savings.

The Department typically estimates that embedded energy savings are based on the last five year's energy savings. Using MP's actual CIP results for CIP Customers and MP's estimate of a contribution of **[TRADE SECRET DATA HAS BEEN EXCISED]** from CIP-Exempt customers, the Department estimates that MP's embedded energy savings are **[TRADE SECRET DATA HAS BEEN EXCISED]** (2010-2014 CIP energy savings of 347 GWh + **[TRADE SECRET DATA HAS BEEN EXCISED]** from CIP Exempt customers).

ii. Using the Embedded Energy Savings to Evaluate DSM Scenarios

Currently, Minnesota electric utilities use different methods for evaluating the impact and cost-effectiveness of future DSM investments in their IRP portfolios. When time permits, the Department proposes to convene interested parties to see whether best practices can be established.

c. Order Points 12c and 12d—additional conservation scenarios, including cost assumptions

Table 14 below shows the cost assumptions that Minnesota Power incorporated into its four energy savings scenarios. For the Existing scenario (46.5 GWh or 1.50 percent), MP assumed annual first-year energy savings costs of $0.15/kWh. This assumed cost is 65 percent higher than MP's 2010-2014 average cost of approximately $0.09/kWh (If large projects are excluded, MP's assumed average cost of $0.12/kWh is approximately 25 percent higher for the 46.5 GWh scenario are than the 2010-2014 average cost).

Further, MP's cost assumptions begin to climb in the higher-savings scenarios, reaching a total annual cost of $0.23/kWh at an incremental cost of $0.35/kWh for the 76.5 GWh savings scenario. When evaluating the additions of savings in the different proposed plans, the Company's cost projections for the incremental additions are significantly higher than the total annual cost. These cost assumptions represent as much as a threefold increase over costs per kWh of energy savings that MP experienced in recent years.

Table 14: Minnesota Power Energy Efficiency Cost Assumptions

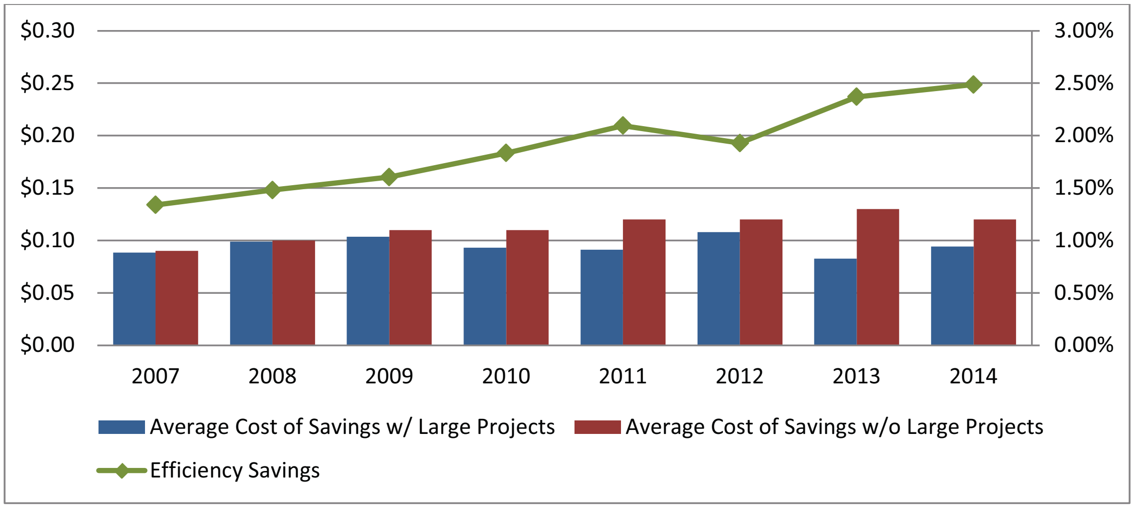
Scenarios		*Annual Program Costs (million $)*					*Company Assumed Incremental $/kWh*	*Company Assumed Total Annual Cost $/kWh*
Annual First Year GWh Savings	*Plan*	*Incentives*	*Admin*	*Nonimpact*	*Total*	*Total Incremental Costs*		
46.5	Existing	$3.4	$1.2	$2.4	$7.1	$0.0	N/A	$0.15
57.3	+ 11 GWh	$4.8	$1.7	$3.2	$9.7	$2.7	$0.24	$0.17
61.5	+ 15 GWh	$5.6	$1.9	$3.6	$11.1	$4.1	$0.27	$0.18
76.5	+ 30 GWh	$9.4	$2.9	$5.3	$17.6	$10.5	$0.35	$0.23

Table 15 and Figure 14 show Minnesota Power's last seven years of CIP energy savings and related costs. The Company has consistently exceeded the statutory 1.5 percent energy savings goal since 2009 and has met or exceeded 1.87 percent of energy savings since 2010.

Table 15: Historical Minnesota Power CIP Achievements and Costs

Year	kWh	CIP Expenditures	Net Benefits	Incentive	Savings as % of Retail Sales	$/ first year kWh	Incentive/Spending
2007	44,168,014	$3,908,223	$13,617,215	$349,334	1.34%	$0.09	9%
2008	48,845,282	$4,826,410	$18,669,840	$607,169	1.48%	$0.10	13%
2009	52,897,732	$5,483,230	$23,391,755	$878,709	1.60%	$0.10	16%
2010	60,503,220	$5,635,000	$29,675,047	$6,806,612	1.83%	$0.09	121%
2011	69,091,422	$6,295,187	$16,611,526	$7,772,785	2.09%	$0.09	123%
2012	63,159,196	$6,813,817	$16,543,789	$7,105,410	1.93%	$0.11	104%
2013	77,630,645	$6,405,828	$17,757,678	$8,733,448	2.37%	$0.08	136%
2014	76,338,363	$7,200,833	$20,792,339	$6,237,702	2.49%	$0.09	87%

Figure 14 Historical Minnesota Power CIP Achievements and Costs



As discussed above, the Company excluded certain large one-time C/I projects that produced large savings that the Company believed to be difficult to replicate and therefore didn't factor into the average MP energy savings costs for energy efficiency. MP's average cost of savings are plotted in Figure 14 with and without these large projects, and it is evident that the large projects allow MP to realize a much better cost per kWh when they are factored into the cost analysis. The Department concludes that it would be reasonable to start with a range of historical costs that both includes and excludes these large projects.

Order Point 12d directed MP to indicate the cost of 1 percent energy savings increments from 1.5 percent to 2.5 percent savings. The Company based these incremental percentage cost assumptions on the four savings scenarios that were proposed in its filing, existing 1.5 percent, 1.87 percent, 2 percent, and 2.5 percent, around which the rest of the energy savings curve from 1.5 percent to 2.5 percent in 0.1 percent increments was interpolated using a polynomial function based on the estimated program costs and savings levels identified in MPs four savings scenarios. Table 16 below presents these values.

Table 16: 0.1 Percent Savings Alternatives, 1.5 – 2.5 Percent

Percentage of Incremental Energy Savings	Total Energy Saving	GWh of Incremental Energy Savings Each Year	First Year Incremental Program Cost ($000)
0.10%	1.60%	3	$511
0.20%	1.70%	6	$1,199
0.30%	1.80%	9	$2,034
0.37%	1.87%	11	$2,665
0.40%	1.90%	12	$2,988
0.50%	2.00%	15	$4,064
0.60%	2.10%	18	$5,206
0.70%	2.20%	21	$6,438
0.80%	2.30%	24	$7,725
0.90%	2.40%	27	$9,057
1.00%	2.50%	30	$10,525

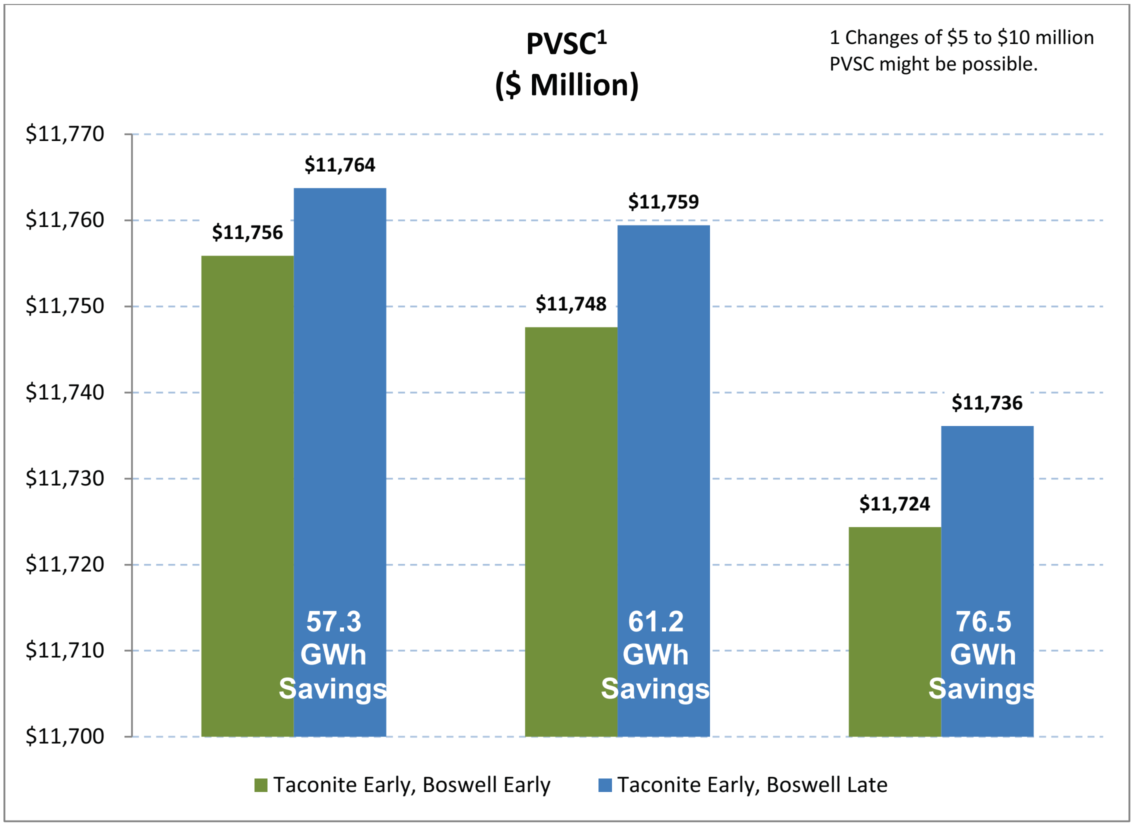
The 2017 incremental first year program cost for the 76.5 GWh savings scenario is $10.5 million, which is in addition to the existing $7.0 million 2017 first year program cost for the base plan of 46.5 GWh energy savings. With these assumptions, MP is projecting that achieving 76.5 GWh energy savings will cost the Company more than $17 million in 2017. However, in 2014 MP was able to achieve 76.3 GWh savings for a program cost of $7.2 million. Again, MP's cost assumptions appear to be high, even in the near term, almost tripling for the same level of energy savings the Company achieved in 2014.

The Department believes that the cost assumptions from MP for the incremental levels of energy efficiency are high, and represent a significant departure from historical costs per kWh for the Company. However, the Department did not conduct scenario analyses with lower cost assumptions because all of MP's energy savings scenarios, even at MP's estimated costs, were cost-effective.

d. Department Modeling

As shown in Figure 15 below, the Department's Strategist modeling of the Company's small coal scenario, based on MP's energy savings and high cost projections, indicates that cost-effectiveness increases (represented by declines in total PVSC) as MP's energy savings achievements increase, with the 76.5 GWh annual energy saving scenario delivering the plan with the lowest PVSC. Across multiple shutdown scenarios, assumptions of externality costs, market purchases on and off, and spot market price assumptions, the more energy savings that MP can procure the more beneficial it is to the overall PVSC of the Company's plan. The Department concludes that this result is reasonable given MP's large need for energy on its system.

Figure 15: Plan Costs with Increasing Energy Savings Scenarios



e. MP's Objections to Higher Energy Savings Levels

The Company concluded that the Commission should be cautious about approving higher energy savings goals. MP expressed concerns about increasing rate impacts, the ability to sustain high energy savings, and the risk that not achieving higher levels of energy savings would have on the Company's need to procure supply-side resources that take considerable time to procure[51]. The Department discusses each of these briefly below.

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[51] For example, on page 5 of Appendix B, MP stated:

> Although the Company believes it may be possible to cost-effectively sustain savings levels higher than the current 1.5 percent target in the future, careful consideration of future costs should be given, and incremental savings goals should be set with caution until more experience with these changing delivery conditions can provide further insight.

Further on page 68 of the filing, the Company states:

> Although the other scenarios contemplating even higher levels of incremental savings were also prevalent in the expansion plans, they were not included in the Preferred Plan. This was done due to a high degree of risk associated with assuming historical performance of energy efficiency programs are sustainable, and that significant new savings can be found

In Appendix B – Part 2, beginning on page ES-1, MP discussed the rate impacts that each of the different DSM scenarios would have on its customers. In general, most energy savings projects don't pass the rate impact test unless the ratio of energy savings to demand savings is low. In other words, the better a project is at energy savings, the worse it will perform in the rate impact test.

The Department notes that although MP raised the concern of rate impacts in the context of spending additional dollars on the state's preferred energy resource—energy savings—the Company has been silent on the impact that its Shared Savings DSM financial incentive mechanism has had on its customer rates. Table 17 below shows the historical Shared Savings Incentive/CIP expenditures for Minnesota's electric investor-owned utilities.

Table 17: Historical Incentive / CIP Expenditure Ratios For Minnesota's Electric IOUs

Year	Xcel Electric	Minnesota Power	Otter Tail Power	Interstate Power and Light
2010	56%	121%	70%	2%
2011	68%	123%	60%	15%
2012	62%	104%	56%	54%
2013	57%	136%	77%	12%
2014	46%	87%	57%	21%

As illustrated above, MP's Shared Savings incentive levels were higher than the Company's CIP expenditures for every year except 2014 (when the percentage was less than 100). Thus MP's incentive mechanism has doubled the cost of energy savings to customers, yet MP did not raise a concern about rate impacts due to its Shared Savings DSM financial incentive.[52]

The Department also notes that MP's rate impact analysis was based on the Company's costs, which as discussed above the Department believes will be significantly lower than projected, particularly in the next five years.

Nonetheless, the Department concedes that it is difficult to project whether MP will be able to sustain its high energy savings levels. In fact, MP has only once met the average annual savings required to meet the 76.5 GWh scenario, in 2014. However, both the Department's and MP's analyses indicate that the higher energy savings goals would result in significantly

> each year to accumulate high levels of aggregate capacity in the long term expansion plan. Relying on significant levels of energy and capacity savings to defer large long term resource decisions could put maintaining reliability and affordability for customers at risk. In the event that the energy efficiency programs do not perform as projected, additional power supply would be required, and large resource additions take years to implement.

[52] The Department notes that the Shared Savings incentives are currently undergoing revision in Docket No. E,G999/CI-08-133.

lower overall costs. Further, the high energy savings are projected to be cost-effective even with costs several times higher than historical costs.

The Department notes that the Company's five-year plan for procuring supply-side resources does not change if the Company only achieves 61.5 GWh of annual energy savings as compared to Department's recommended 76.5 GWh. Consequently, there is no risk in the Commission setting the higher energy savings goal. Further, the Commission will be re-evaluating MP's energy savings goal in its next resource plan two years from now. The Department concludes that MP's objections should be noted, but should not be a reason for the Commission not to approve higher goals.

f. Uncertainty in MP's forecast

For Minnesota Power, particularly, the opportunity to acquire more CIP energy efficiency is an attractive alternative to committing to in-the-ground generation in a time of demand uncertainty. In its filing, the Company stated:

> The Downside and Current Contract forecasts evaluate a slowdown in the key industries Minnesota Power serves, along with a continued sluggish U.S. economy that could deliver nearly 320 MW of demand destruction in northeast Minnesota. Appendix A contains additional detail on each scenario.

In its forecasting for this resource plan, the Company appears to be seriously considering scenarios that reflect significant demand reductions through the loss of customers or from impacts of international commodities markets that could affect demand in Minnesota Power's service territory. If energy savings can be procured at or below costs projected by the Company in this resource plan, it would allow Minnesota Power to increase its demand savings greatly and partially avoid investments in capital that, with possible reductions in load, could result in unnecessary generation investments.

4. Department DSM Recommendations

The Department commends MP for the high level of energy savings it has sustained over the past several years. Although the Department understands that Minnesota Power is hesitant to conclude that the Company can continue to procure its high level of energy savings in the long-term, the Department concludes that the Commission should approve the 76.5 GWh DSM scenario for the following reasons:

- The Department's analysis indicate that the 76.5 GWh would result in the lowest cost expansion plan on Minnesota Power's system;
- MP's cost assumptions provide ample opportunity for MP to spend significantly more dollars to achieve energy savings;
- The projected five year action plan does not change between different energy savings levels so not achieving the high energy savings will not adversely impact MP's ability to procure supply-side resources in a timely manner;
- Energy savings are Minnesota's preferred energy resource; and

- The Commission can and should revisit MP's energy savings goals in two years.

D. COMPLIANCE WITH THE RENEWABLE ENERGY STANDARD

1. Background

Prior to the 2007 Legislative Session, Minn. Stat. §216B.1691 required utilities to make a good faith effort to obtain 15 percent of their Minnesota retail sales from eligible energy technologies by 2015, and to obtain 0.5 percent renewable energy from biomass technologies. The 2007 Minnesota Legislature amended Minn. Stat. §216B.1691 to include a Renewable Energy Standard (RES) beginning in 2010. As amended, Minn. Stat. §216B.1691, Subd. 2 sets forth the Renewable Energy Objective in place through 2010 and requires that:

> Each electric utility shall make a good faith effort to generate or procure sufficient electricity generated by an eligible energy technology to provide its retail customers or the retail customers of a distribution utility to which the electric utility provides wholesale electric service so that commencing in 2005, at least one percent of the electric utility's total retail electric sales to retail customers in Minnesota is generated by eligible energy technologies, and seven percent of the electric utility's total retail electric sales to retail customers in Minnesota by 2010 is generated by eligible energy technologies.

Minn. Stat. §216B.1691, Subd 2a establishes the Renewable Energy Standard utilities must meet through 2025 and specifically requires that:

> … each electric utility shall generate or procure sufficient electricity generated by an eligible energy technology to provide its retail customers in Minnesota, or the retail customers of a distribution utility to which the electric utility provides wholesale electric service, so that at least the following standard percentages of the electric utility's total retail electric sales to retail customers in Minnesota is generated by eligible energy technologies by the end of the year indicated:
>
> - 2012 12 percent
> - 2016 17 percent
> - 2020 20 percent
> - 2025 25 percent

The statute no longer requires that a portion of the renewable energy generation come from biomass technologies. An eligible energy technology is defined by Minn. Stat. §216B.1691, Subd. 1 as an energy technology that:

> Generates electricity from the following energy sources: (1) solar; (2) wind; (3) hydroelectric with a capacity of less than 100 megawatts; (4) hydrogen, provided that after January 1, 2010, the hydrogen must be generated from the resources listed in this clause; or (5) biomass, which includes without limitation, landfill gas, an anaerobic digester system, and an energy recovery facility used to capture the heat value of mixed municipal solid waste or refuse-derived fuel from mixed municipal solid waste as a primary fuel.

Minn. Stat. §216B.1691, subd. 2(d) directs the Commission to "issue necessary orders detailing the criteria and standards by which it will measure an electric utility's efforts to meet the renewable energy objectives of subdivision 2 to determine whether the utility is making the required good faith effort."

The Commission set forth the criteria for determining compliance with the RES Statute after taking comments from effected parties in a number of Orders.[53] Among the resources the Commission has determined ineligible for meeting the RES are resources used for green pricing, resources that do not meet the statutory definition of eligibility, and generation assigned to compliance for other regulatory purposes such as another state's Renewable Portfolio Standard Requirements (RPS)

The 2007 amendment to Minn. Stat. §216B.1691, Subd. 4 required the Minnesota Public Utilities Commission to establish a program for tradable Renewable Energy Credits (RECs) by January 2008, and to require all electric utilities to participate in a Commission-approved REC tracking system once such a system was in operation.

The Commission subsequently adopted the use of the Midwest Renewable Energy Tracking System (M-RETS), a multi-state REC tracking system, as the REC tracking system under Minn. Stat. §216B.1691, Subd. 4(d), and required Minnesota utilities to participate.[54] Specifically, the Commission required utilities to complete the online registration process and sign the Terms of Use agreement with the M-RETS system administrator APX, Inc., and

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[53] *In the Matter of Detailing Criteria and Standards for Measuring an Electric Utility's Good Faith Efforts in Meeting the Renewable Energy Objectives Under Minn. Stat. §216B.1691,* Docket No. E999/CI-03-869, Initial Order Detailing Criteria and Standards for Determining Compliance with Minn. Stat. §216B.1691 and Requiring Customer Notification by Certain Cooperative, Municipal, and Investor-Owned Distribution Utilities. (June 1, 2004)
In the Matter of Detailing Criteria and Standards for Measuring an Electric Utility's Good Faith Efforts in Meeting the Renewable Energy Objectives Under Minn. Stat. §216B.1691, Docket No. E999/CI-03-869; *In the Matter of a Commission Investigation into a Multi-State Tracking and Trading System for Renewable Energy Credits,* Docket No. E999/CI-04-1616, Second Order Implementing Minn. Stat. §216B.1691, Opening Docket to Investigate Multi-State Program for Tracking and Trading Renewable Credits and Requesting Periodic Updates from Stakeholder Group; (October 19, 2004)
In the Matter of Detailing Criteria and Standards for Measuring an Electric Utility's Good Faith Efforts in Meeting the Renewable Energy Objectives Under Minn. Stat. §216B.1691, Docket No. E999/CI-03-869, Order After Reconsideration (August 13, 2004).
[54] *In the Matter of a Commission Investigation into a Multi-State Tracking and Trading System for Renewable Energy Credits,* Docket No. E999/CI-04-1616, Order Approving Midwest Renewable Energy Tracking System (M-RETS) Under Minn. Stat. §216B.1691, Subd. 4(d), and Requiring Utilities to Participate in M-RETS (October 9, 2007)

receive account approval from APX by January 1, 2008. In addition, the Commission directed utilities to make a substantial and good faith effort to create a system account and sub-accounts for its organization, and to register its generation units/facilities in the M-RETS system by March 1, 2008.

In its December 18, 2007 *Order Establishing Initial Protocols for Trading Renewable Energy Credits,* the Commission adopted a four-year shelf life for all renewable energy credits to be used for compliance with the Minnesota RES. A four-year shelf life allows a REC to be retired towards MN RES compliance in the year of generation and during the four years following the year of generation.

Finally, in its December 3, 2008 *Third Order Detailing Criteria and Standards for Determining Compliance under Minn. Stat. §216B.1691 and Setting Procedures for Retiring Renewable Energy Credits*, the Commission directed utilities to begin retiring RECs equivalent to one percent of their Minnesota annual retail sales for the 2008 and 2009 compliance year by May 1st of the following year. Upon retirement, RECs are transferred into a specific Minnesota RES retirement account and, once retired, are not available to meet other state or program requirements, thus addressing the statutory prohibition against double counting the RECs and promoting the environmental benefits of renewable energy. The Commission further directed the utilities to submit a compliance filing demonstrating their compliance with the RES by June 1st

In addition to amending the RES Statute, Minn. Stat. §216B.241, Subd. 1c(b) was added to establish an energy-savings goal as part of a utility's conservation improvement plan (CIP), and states:

> Each individual utility and association shall have an annual energy-savings goal equivalent to 1.5 percent of gross annual retail energy sales unless modified by the commissioner under paragraph (d). The savings goals must be calculated based on the most recent three-year weather normalized average.

The attainment of the 1.5 percent energy savings goal will reduce a utility's forecasted retail sales, and consequently lower the amount of renewable generation required to meet RES obligations.

In 2013, Minn. Stat. §216B.1691, Subd. 2(f) was amended to establish a solar energy standard (SES). Specifically, the statute requires public utilities to generate or obtain at least 1.5 percent of their electric sales to retail customers from solar energy by the end of 2020, and requires that at least 1 percent of the goal be met from distributed generation facilities with a nameplate capacity of 20 kW or less. The SES excludes retail electric sales to customers that are iron mining extraction and processing facilities, paper mills, wood products manufacturers, sawmills, or oriented strand board manufacturers.

2. *RES Compliance*

a. *2014 RES Compliance*

In Docket No. E999/PR-15-12, MP reported that it had 10,176,245 MWh of energy sales subject to the Minnesota RES requirement for 2014[55]. The Company retired 1,221,149 RECs representing 12 percent of its Minnesota sales to comply with its RES requirement. MP complied with its 2014 RES requirement.

b. *MP's Renewable Obligation*

Table 18, below, summarizes MP's RES requirement in MWh's over the forecast period.

Table 18: MP's Renewable Energy Objective

Year	MN Retail Sales + Sales to MN Muni's	REO/RES Percentage	RES Requirement (MWhs)
2015	11,236,758	12%	1,348,411
2016	11,591,051	17%	1,970,479
2017	12,135,164	17%	2,062,978
2018	12,222,147	17%	2,077,765
2019	12,278,287	20%	2,087,309
2020	12,368,891	20%	2,473,778
2021	12,379,530	20%	2,475,906
2022	12,424,405	20%	2,484,881
2023	12,479,164	20%	2,495,833
2024	12,561,284	20%	2,512,257
2025	12,583,436	25%	3,145,859
2026	12,641,473	25%	3,160,368
2027	12,701,608	25%	3,175,402
2028	12,797,604	25%	3,199,401

MP's RES requirement increases from an estimated 1,348,411 MWhs in 2015 to 3,199,401 MWhs in 2028.

[55] The RES requirements set forth in Minn. Stat. §216B.1691, Subd. 2a apply to Minnesota retail sales, as well as to the wholesale sales to other Minnesota distribution companies serving Minnesota retail sales. Consequently, MP's sales to several Minnesota municipal utilities are subject to RES requirements.

c. *Generation Resources*

MP has registered its renewable generation facilities in M-RETS. MP generates an estimated 2,137,799 RECs annually with its existing renewable generation resources.[56] The annual estimate includes MP's Bison 4 wind generation facility, which began commercial operation at year-end 2014. The Company has additional RECs available to meet green pricing obligations, as well as, generation from renewable energy sources that are not eligible for Minnesota RES compliance as defined by Minn. Stat. §216B.1691, Subd. 1 (i.e. from hydro facilities greater than 100 MW). Table 19 summarizes MP's ability to meet its future RES obligations without the additional 300 MW of wind resources that the Company proposed in its plan.

Table 19: REO Compliance with Existing Resources

Year	RES Requirement MWh	Est. Annual Existing Renew. Generation (MWh)	Existing Generation Existing less RES Req. Surplus/ (Deficit) MWh	Cumulative RES Surplus/ (Deficit) (MWh) (Prev. Yr Bal. + Col B. –Col. A)
				Beg. Balance 5,135,860
2015	1,348,411	2,137,799	789,388	5,925,248
2016	1,970,479	2,137,799	167,231	6,092,569
2017	2,062,978	2,137,799	74,821	6,167,390
2018	2,077,765	2,137,799	60,034	6,227,425
2019	2,087,309	2,137,799	50,491	6,277,915
2020	2,473,778	2,137,799	(335,979)	5,941,937
2021	2,475,906	2,137,799	(338,107)	5,603,830
2022	2,484,881	2,137,799	(347,082)	5,256,748
2023	2,495,833	2,137,799	(358,033)	4,898,715
2024	2,512,257	2,137,799	(374,457)	4,524,257
2025	3,145,859	2,137,799	(1,008,060)	3,516,198
2026	3,160,368	2,137,799	(1,022,569)	2,493,629
2027	3,175,402	2,137,799	(1,037,603)	1,456,026
2028	3,199,401	2,137,799	(1,061,602)	394,424

The Column entitled "Existing Generation less RES Requirement" reflects the Company's ability to meet its RES requirements in a given year with that year's renewable generation. The Commission adopted a four-year shelf life for RECs which enables utilities to bank excess RECs (those not necessary to meet a particular year's RES requirement), and retire the RECs up to four years after generation towards a future year's compliance requirement. MP currently has approximately three million unretired RECs available for future compliance. The Column entitled "Cumulative RES Surplus/(Need)" reflects the four-year carry forward for unretired RECs. Given MP's existing unretired RECs and annual renewable generation, the Company appears to have sufficient existing renewable generation capability to meet its RES requirement through the planning period.

[56] A REC represents 1 MWh of renewable energy.

The Department's proposed expansion plan includes the addition of 300 MW of wind in 2018 and up to 100 MW of additional wind in 2022, which would give MP further assurance of meeting its RES obligation.

E. SES COMPLIANCE

The SES Statute requires investor-owned utilities to procure 1.5 percent of their Minnesota retail sales from solar energy beginning in 2020. The SES Statute exempts retail electric sales to customers that are iron mining extraction and processing facilities, paper mills, wood products manufacturers, sawmills, or oriented strand board manufacturers. MP has significant retail sales to these exempted industrial customers. In 2014, MP reported energy sales totaling 6,336,953 MWh to SES exempt customers. Table 20, below estimates MP's total SES requirement assuming 2014 exempted sales levels over the planning period.

Table 20: MP Estimated SES Requirement

Year	Col. A Total Retail Sales	Col. B Exempted Retail Sales	Col. C Sales Subject to the SES (Col. A – Col. B)	Col. D Total SES Requirement (1.5% * Col. C)	Col. E Small Solar Carve-Out (10% * Col. D)
2015	11,236,758	6,336,953			
2016	11,591,051	6,336,953			
2017	12,135,164	6,336,953			
2018	12,222,147	6,336,953			
2019	12,278,287	6,336,953			
2020	12,368,891	6,336,953	6,031,938	90,479	9,048
2021	12,379,530	6,336,953	6,042,577	90,639	9,064
2022	12,424,405	6,336,953	6,087,452	91,312	9,131
2023	12,479,164	6,336,953	6,142,211	92,133	9,213
2024	12,561,284	6,336,953	6,224,331	93,365	9,336
2025	12,583,436	6,336,953	6,246,483	93,697	9,370
2026	12,641,473	6,336,953	6,304,520	94,568	9,457
2027	12,701,608	6,336,953	6,364,655	95,470	9,547
2028	12,797,604	6,336,953	6,460,651	96,910	9,691

MP has filed a request for approval of two solar projects in 2016: a 10 MW solar array at Camp Ripley, and a 1.04 MW community solar garden. MP's resource plan also includes the addition of 12 MW of solar in 2020 and 10 MW in 2025. Table 21 below estimates MP's ability to comply with its SES requirement assuming its proposed solar additions.

Table 21: Estimate of MP's SES Compliance

Year	Total SES Requirement (1.5% * Col. C)	Proposed Solar Additions MWs	Solar Energy Additions (MWhs) 20% Cap. Factor	Cumulative Generation	Solar Surplus/ (Need)
2015					
2016		11.04	9,671*		
2017			19,342	29,013	
2018			19,342	48,355	
2019			19,342	67,697	
2020	90,479	12.00	40,366	108,063	17,584
2021	90,639		40,366	148,429	57,791
2022	91,312		40,366	188,796	97,484
2023	92,133		40,366	229,162	137,028
2024	93,365		40,366	269,528	176,163
2025	93,697	10.00	57,886	327,414	233,717
2026	94,568		57,886	385,300	290,732
2027	95,470		57,886	443,186	347,716
2028	96,910		57,886	501,072	404,162

**Assumes the solar generation comes online mid-year*

As shown in Table 21, MP's proposed solar additions would result in its ability to meet its SES requirement in total; however, Table 21 does not estimate MP's ability to meet the Small Solar Carve-out of the SES. The Small Solar Carve-out requires that 10 percent of the total SES requirement be met through generation facilities of less than 20 kW. As reflected in Table 21, approximately 9,000 MWhs of MP's solar generation would need to come from solar facilities of less than 20 kW. In its most recent SES compliance report, MP reported that it had approximately 132 solar net metered customers on its system; however, the contract for those customers does not require transfer of the SRECs associated with the net metered solar generation to the Company. MP has requested the ability to count the solar generation from its community solar subscriptions towards its Small Solar Carve-out; however, the Commission has not yet ruled on the Company's request and concerns have been raised in that proceeding.[57]

The Department notes that its Strategist modeling resulted in an additional 50 MW of solar generation in scenarios with high (76.5 GWh) DSM, and an additional 100 MW at lower DSM levels (*e.g.*, 57.3 GWh).

F. ENVIRONMENTAL ISSUES

The Department generally reviews utility resource plans for compliance with pending state and national environmental legislation that impacts the electric utility's operations. MP provided information on the environmental regulations to which it is subject, and provided information on how it incorporated these regulations into its modeling.

[57] Docket No. E015/M-15-825.

MP specifically addressed the following regulations:

- Cross-State Air Pollution Rule (CSAPR);
- National Ambient Air Quality Standards (NAAQS);
- Mercury and Air Toxic Standards (MATS);
- National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial and Institutional Boilers (Boiler MACT);
- Minnesota Mercury Emissions Reduction Act (MERA);
- Clear Air Visibility Rule (Regional Haze);
- Clean Power Plan (CPP);
- Coal Combustion Residuals (CCR);
- 316b Rule – Standards to Protect Aquatic Ecosystems; and
- Water Effluent Regulation (Effluent Limit Guidelines, ELG)

MP indicated that it included compliance with all but three of the regulations listed above in its Base Case. The remaining three regulations, Clean Power Plan, Coal Combustion Residuals, and Effluent Limit Guidelines, were incorporated into MP's sensitivity analysis as part of its modeling. MP states that it continues to monitor and evaluate all regulations for changes and impact on its generation facilities.

As part of its IRP, MP provided a summary table outlining the potential impact of these regulations on its generation facilities.[58] As part of a consent decree with the U.S. EPA, MP is proposing to re-route the flue gas from its Boswell Units 1 & 2 through the Boswell Unit 3 scrubber as a means of reducing SO_2 emissions from Units 1 & 2 and complying with the consent decree. In addition, MP anticipates it may need to install equipment to prevent fish impingement (being trapped against screens at the point of water intake from lakes or streams) at several of its facilities, and expects additional requirements regarding entrainment (fish and eggs being drawn into the cooling water systems) to be determined by the Minnesota Pollution Control Agency (MPCA).

The Department concludes that MP is adequately considering and planning for compliance with the many environmental regulations to which the Company is subject.

G. MINNESOTA GREENHOUSE GAS EMISSIONS REDUCTION GOAL

1. Background

Minnesota Statutes 216H.01, Subdivision 2 states:

> Statewide greenhouse gas emissions include emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emitted by anthropogenic sources within the state and from the generation of electricity imported from outside the state and consumed in Minnesota.

[58] Appendix E: Environmental Policy, p. 19.

Minnesota Statutes 216H.02, Subdivision 1 states:

> It is the goal of the state to reduce statewide greenhouse gas emissions across all sectors producing those emissions to a level at least 15 percent below 2005 levels by 2015, to a level at least 30 percent below 2005 levels by 2025, and to a level at least 80 percent below 2005 levels by 2050. The levels shall be reviewed based on the climate change action plan study.

Minnesota Statutes 216H.03, Subdivision 2 states:

> For the purpose of this section, "statewide power sector carbon dioxide emissions" means the total annual emissions of carbon dioxide from the generation of electricity within the state and all emissions of carbon dioxide from the generation of electricity imported from outside the state and consumed in Minnesota. Emissions of carbon dioxide associated with transmission and distribution line losses are included in this definition. Carbon dioxide that is injected into geological formations to prevent its release to the atmosphere in compliance with applicable laws, and emissions of carbon dioxide associated with the combustion of biomass, as defined in section 216B.2411, subdivision 2, paragraph (c), clauses (1) to (4), are not counted as contributing to statewide power sector carbon dioxide emissions[59].

On August 5, 2013, the Commission issued a Notice of Information in Future Resource Plan Filings (Commission's Letter). The Commission Letter states, in part:

> **PLEASE TAKE NOTICE** that the Commission expects utilities to include in their resource plans filed after August 1, 2013 an explanation of how the resource plan helps the utility achieve the greenhouse gas reduction goals, renewable energy standard, and solar energy standard as listed in the above-referenced legislation. Parties should also be prepared to discuss the matter in comments.

2. Minnesota Power's Response to Commission's August 1, 2013 Notice

On page 75 of its 2015 resource plan, Minnesota Power stated that by implementing its preferred plan, the Company will exceed Minnesota's greenhouse gas reduction goal of 15 percent from 2005 levels by 2015 and 30 percent reduction from 2005 levels by 2025. In

[59] (1) methane or other combustible gases derived from the processing of plant or animal material;
(2) alternative fuels derived from soybean and other agricultural plant oils or animal fats;
(3) combustion of barley hulls, corn, soy-based products, or other agricultural products;
(4) wood residue from the wood products industry in Minnesota or other wood products such as short-rotation woody or fibrous agricultural crops;

DOC IR No. 9 the Department asked the Company to provide its estimated CO_2 emissions for each year of the plan. MP's response is included as Attachment 14.

In DOC IR No. 9, the Department asked MP to explain how the Company calculated its 2005 and 2015-2029 CO_2 emissions. In response, MP outlined its approach as follows:

a. Summed total CO_2 emissions from MP owned generation.
b. Added known CO_2 emission from bilateral purchases that either point to a resource or based on average CO_2 emissions from the counterparty's power supply.
c. Added emissions from unidentified purchases, which includes both bilateral and the Midcontinent Independent System Operator ("MISO") market purchases. The CO_2 rate for unidentified purchases in 2005 is from the Emissions & Generation Resource Integrated Database ("eGRID") for the Midwest Reliability Organization ("MRO") West observed in 2005. The projected CO_2 rates for unidentified purchases from 2015 thru 2029 are from the eGRID for MRO West observed in 2010 (most recent available at the time of the analysis).
d. Subtract known CO_2 emissions from sales sourced from an identified generation resource.
e. Subtract CO_2 emissions from unidentified sales, which include bilateral and MISO market sales. The CO_2 emission rate is the average for Minnesota Power's total power supply.

3. *Department's Analysis of MP's Greenhouse Gas Reduction Compliance*

a. *The Department's retail ratepayer methodology*

The State's resource planning process is geared to identify the least-cost, most robust capacity expansion plans for meeting the needs of customers in an electric utility's entire system, some of whom may reside outside of Minnesota. For this reason, the Department proposed and used a greenhouse gas accounting methodology that mirrors the resource planning methodology. That is, the retail ratepayer methodology recognizes that a utility will use utility-owned generation to supply the electric needs of both its customers and other utility customers, make purchases from entities that are located both inside and outside of the State, and make some purchases from unidentified resources, which may or may not be located in Minnesota. The Department concludes that the Minnesota ratepayer approach provides the most reasonable estimate of how an electric utility's system-wide greenhouse gas emissions are changing.

Minnesota Power used a similar ratepayer methodology in this IRP. The Department reviewed the Company's methodology and concludes that it is reasonable. As MP noted in its response to DOC IR No. 9, the Company's projected CO_2 rates for unidentified purchases from 2015 thru 2029 are from the eGRID for MRO West observed in 2010, the most recent available eGRID data at the time of MP's analysis. However, eGRID values posted in October 2015 identify lower emission outlooks for the MRO West region (1,425 lbs./MWh vs. 1,536 lbs./MWh from the 2010 value). The Department agrees that using these values would project additional reduction in Minnesota Power's CO_2 reductions. Given that eGRID values are often posted several years after the emissions occurs, MP and other parties' use of eGRID data will likely continue to overestimate future emissions from unidentified resources. This shortcoming may be overcome in the future by Xcel and other utilities providing the Department more up-to-date calculations of regional CO_2 emissions and the Department sharing this information with all of Minnesota's electric utilities. As discussed below, how much time parties put into improving this methodology is dependent on whether the Commission finds the Minnesota ratepayer methodology useful.

b. Minnesota Statutes' approach to measuring changes in greenhouse gas emissions

The Department's greenhouse gas accounting methodology is different from the methodology spelled out in Minnesota Statutes sections 216H.02 and 216H.03. Minnesota Statutes basically require counting the greenhouse gas emissions associated with electric generation sources located within the state (whether or not that electricity is consumed by Minnesota customers) as well as the emissions associated with all imports for consumption within the State, but not include emissions from certain types of biomass generation. The MPCA's methodology, based on its interpretation of Minnesota Statutes, accounts for these changes in greenhouse gas emissions in the electric utility industry by:

- Counting in-state emissions from operating facilities (which would include transmission and distribution losses);
- Adding in-state emissions of area greenhouse gas sources such as sulfur hexafluoride (SF6);
- Adding emissions associated with electricity imported for consumption in Minnesota; and
- Adding emissions due to transmission and distribution losses associated with electricity imported for consumption in Minnesota.

The MPCA does not allocate emissions associated with electricity imports to individual utilities or other power providers.

c. Department's discussion of greenhouse gas accounting methodologies

The Department notes that there are drawbacks to all of the greenhouse gas accounting methodologies. Because utility over-compliance with the CPP may result in emission allowances that can be sold, Minnesota Power's (or any other Minnesota electric utility's) estimate of CO_2 emission reductions beyond the CPP requirements may not result in national CO_2 reductions. Instead, another electric utility either inside or outside of Minnesota may purchase the allowances, negating the purchasing utility's need to reduce its CO_2 emissions.[60] Thus, in such an instance, other utilities would pay Minnesota to create the CO_2 emission reductions that the other utilities would need for compliance with CPP requirements.

[60] There are ways that a utility's over compliance could contribute to national CO_2 reductions that go beyond the CPP requirements. For example, the MPCA could decide to retire some of the State's allowances, an environmental group could purchase some of the allowances, or a utility could decide not to sell some of its allocated allowances.

The actual impact will depend on many factors including whether a mass or rate based approach is approved and whether excess allowances or credits are sold. Thus, the reductions calculated that are beyond CPP compliance may not result in net CO_2 reductions for the USA. In other words, compliance with the Minnesota greenhouse gas reduction goal, however measured, may in fact mean that Minnesota utilities will be sellers of allowances or credits, but not that their actions would result in marginal reductions in CO_2 emissions beyond the CPP requirements. Thus, over-compliance with the CPP only makes sense for ratepayers if the allowances sold compensate ratepayers for any premium incurred to achieve over-compliance.

There are also issues specific to the Minnesota ratepayer methodology and MPCA's approach. For example, the Minnesota ratepayer methodology estimates changes to a utility's system CO_2 emissions, and not Minnesota specific emissions. The methodology does not estimate changes in CO_2 emissions in the manner specified in Minnesota Statutes or the CPP. Further, using MPCA's method for counting progress towards the State's greenhouse gas reduction goal could lead to utilities increasing costs and global greenhouse gas emissions while maintaining compliance with the State's goal. For example, assume that a utility in Minnesota is exporting electricity from a combined cycle unit to another utility in Wisconsin—a sale from a particular unit and not a system sale. In response to the State's goal, the Minnesota utility could reduce generation at its plant (to stop the exports), thus decreasing its own greenhouse gas emissions but raising ratepayer costs due to the lost wholesale revenues. In turn, the Wisconsin utility might replace the lost energy with production from a higher-emitting resource such as a coal plant, thus increasing overall greenhouse gas emissions.

4. Department Recommendation

For future resource plans, the Department recommends that utility progress towards meeting the State's greenhouse gas reduction goal be measured by using the Minnesota ratepayer methodology because it is the best methodology for estimating changes in greenhouse gas emissions in the resource planning paradigm.[61] While this estimate would not comply with statutory methodology for estimating greenhouse gas reductions, this approach is the most reasonable method in this context. However, this approach does not measure actual tons of CO_2 reductions for the country as a whole, only for utilities operating in Minnesota.

If the Commission saw a benefit in doing so, the Commission could require parties at some point to include a methodology that was more in keeping with MPCA's interpretation of the Statutes. This evaluation could be done on a statewide basis, since the MPCA does not allocate emissions associated with imports to individual utilities, or on an individual utility basis, by allocating imported electricity. The Department invites direction from the Commission on this issue.

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[61] The Department, Minnesota Power and other parties have been working to improve this methodology. Basically, this approach includes the following equation: 1. Calculate CO_2 emissions from utility-owned generation. 2. Add CO_2 emissions from purchased electricity. 3. Subtract CO_2 emissions from sales. The Department's approach is similar to Xcel's. In the context of MP's IRP, the Department made a few changes. In the future, the Department will also work with MP and other parties to determine an appropriate method for reflecting that future MISO purchases will have lower CO_2 emissions associated with them.

H. IMPACT OF PLAN IMPLEMENTATION ON ELECTRIC RATES AND BILLS

In this section, the Department discusses its review of MP's analysis of "the likely effect of plan implementation on electric rates and bills" over the next five years (2015-2019)[62].

The Department notes that the Company provided a table, labelled "Estimated Average Rate Impacts of Preferred Plan Relative to 2015 Projected Base Rates" (Table), showing the average rate impact (cents/kWh, percentage change and average impact) for each of its six customer classes: Residential, General Service, Large Light and Power, Large Power, Municipal Pumping, and Lighting.[63] The information presented is reproduced in Table 22 below.

[62] Minnesota Rules, Part 7843.0400, subpart 4 requires that each "utility include in its resource plan filing a nontechnical summary, not exceeding 25 pages in length and describing the utility's resource needs,... , activities required over the next five years to implement the plan, and the likely effect of plan implementation on electric rates and bills."
[63] Source: Table 1, page 4 of Appendix L, MP's September 1, 2015 IRP filing in Docket No. E015/RP-15-690.

Table 22: MP's Estimated Average Rate Impacts of Preferred Plan Relative to 2015 Projected Base Rates

Rate Class Impacts	2015	2016	2017	2018	2019	Compounded Annual Increase
Residential (average current rate, ¢/kWh)	10.238	10.238	10.238	10.238	10.238	-
Increase (¢/kWh)	0.023	1.075	1.461	1.858	2.283	-
Increase (%)	0.22%	10.50%	14.27%	18.15%	22.30%	4.11%
Average Impact ($ / month)	$0.19	$8.75	$11.89	$15.17	$18.69	-
General Service (average current rate, ¢/kWh)	10.233	10.233	10.233	10.233	10.233	-
Increase (¢/kWh)	0.018	0.953	1.285	1.617	1.975	-
Cumulative Increase (%)	0.18%	9.31%	12.56%	15.80%	19.30%	3.59%
Average Impact ($ / month)	$0.51	$26.99	$36.33	$45.81	$55.91	-
Large Light & Power (average current rate, ¢/kWh)	8.327	8.327	8.327	8.327	8.327	-
Increase (¢/kWh)	0.014	0.790	1.050	1.289	1.562	-
Increase (%)	0.17%	9.48%	12.61%	15.47%	18.76%	3.50%
Average Impact ($ / month)	$36	$2,146	$2,810	$3,527	$4,275	-
Large Power (average current rate, ¢/kWh)	5.995	5.995	5.995	5.995	5.995	-
Increase (¢/kWh)	0.010	0.666	0.834	0.998	1.207	-
Increase (%)	0.17%	11.11%	13.91%	16.65%	20.13%	3.74%
Average Impact ($ / month)	$5,297	$353,522	$395,722	$474,334	$575,391	-
Municipal Pumping (average current rate, ¢/kWh)	9.396	9.396	9.396	9.396	9.396	-
Increase (¢/kWh)	0.043	0.887	1.178	1.466	1.792	-
Increase (%)	0.46%	9.44%	12.53%	15.60%	19.07%	3.55%
Average Impact ($ / month)	$3.73	$77.97	$102.97	$127.49	$154.52	-
Lighting (average current rate, ¢/kWh)	15.916	15.916	15.916	15.916	15.916	-
Increase (¢/kWh)	0.014	1.438	1.974	2.580	3.203	-
Increase (%)	0.09%	9.04%	12.41%	16.21%	20.12%	3.74%
Average Impact ($ / month)	$0.11	$11.60	$15.74	$20.31	$24.90	-
Average Weighted Increase (¢/kWh)	0.013	0.756	0.980	1.199	1.457	-
Average Weighted Increase (%)	0.18%	10.53%	13.64%	16.69%	20.28%	3.76%

The Department provides the following summary of MP's calculation of the "likely effect of plan implementation on electric rates and bills:" [64]

- MP calculated each customer class' 2015 average current rate by adding the estimated current cost recovery rider rates customers will be paying in 2015 to each customers class' average rates without riders from the Company's last rate case. The rider rates are for the Renewable Resources Rider, Transmission Cost Recovery Rider, Boswell 4 Environmental Rider, Fuel and Purchased Energy Adjustment and the Conservation Program Adjustment. For example, as shown in Table 22 above, the 2015 average current rate for the Residential class is 10.238 cents/kWh, which is the current average rate the residential class is paying before any IRP action plan costs are considered.

- MP's 2015-2019 annual revenue requirements (Revenue Requirements) for its Preferred Plan are an outcome of the Strategist model. The Strategist model also creates 2015 baseline revenue requirements that reflect no action in 2015.

- The Incremental Revenue Requirements for each year of the period 2015-2019 are calculated as the difference between the relevant annual Revenue Requirements and the 2015 baseline revenue requirements.

- Before allocating the annual Incremental Revenue Requirements to each customer class, MP separated the incremental costs into three categories: solar costs, energy efficiency costs and incremental power supply costs:

    - Solar costs are divided by the projected non-exempt energy usage by class to obtain the solar cost rates by class.
    - The energy efficiency costs are divided by the projected energy usage by class that is subject to the conservation program adjustment charge to obtain the energy efficiency rates by class.
    - Each of the 2015-2019 annual incremental power supply costs are allocated to the Minnesota Jurisdiction and to customer classes assuming that the 2010 rate case relationships between jurisdictional and class revenue requirements, and jurisdictional and class energy at the meter remain constant. Given this assumption, MP allocated the 2015-2019 annual incremental power supply costs to customer classes based on the forecasted energy by jurisdiction and class from MP's 2014 Annual Electric Utility Forecast Report.

- Each of the 2015-2019 class annual incremental costs are then divided by the corresponding projected annual energy usage by class to obtain the relevant annual incremental power supply cost rates by class.

- While the incremental power supply costs include the revenue requirements associated with the Great Northern Transmission Line, they do not include the

[64] MP's discussed its methodology in Appendix L of its September 1, 2015 IRP filing in Docket No. E015/RP-15-690.

other projected revenue requirements for MP's Transmission Cost Recovery (TCR) Rider projects. An adjustment was made to include these costs in the rate impacts. The TCR adjustment costs were allocated to the Minnesota jurisdiction and to customer classes based on projected power supply production transmission allocators. The TCR adjustment cost rates by class was then calculated as the ratio of the class TCR adjustment costs and the corresponding projected annual energy usage by class.

- The annual solar cost rates, energy efficiency cost rates, incremental power supply cost rates and TCR adjustment cost rates are added by class to obtain the total annual adjusted Incremental Revenue Requirements (cents/kWh) by class. For example, as shown in Table 22 above, MP estimates that the 2015 average increase from current rates for the Residential class would be 0.023 cents/kWh.

The Department concludes that the steps described above provide for a reasonable calculation of the "likely effect of plan implementation on electric rates and bills" over the next five years.

Based on the discussion above and the fact that the relevant rules only require a nontechnical summary, the Department concludes that Minnesota Power complied with the Minnesota Rules, Part 7843.0400, subpart 4's requirement that a utility must include in its resource plan filing a nontechnical summary describing "the likely effect of plan implementation on electric rates and bills" over the next five years.

IV. DEPARTMENT RECOMMENDATIONS

The Department recommends that the Commission approve:

A five-year action plan that includes MP:

- acquiring up to 300 MW of wind capacity in about 2018;
- acquiring solar units of 11 MW in 2016 and 12 MW in 2020;
- shutting down the Taconite Harbor 1 and 2 units in 2017,
- procuring average annual average energy savings of 76.5 GWh, and
- conducting a distribution study to identify interconnection points on its distribution system for small-scale distributed generation resources.

A long-term action plan that includes MP:

- procuring approximately 100 MW of wind, 50 MW of solar, and 200 MW of CC, partly to replace Boswell units 1 and 2, and
- shutting down Boswell units 1 and 2 once the CC generation is online.

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Key to Abbreviations

Scenario	
TEBE	Taconite Harbor 1 & 2 shut down early, Bosell 1 & 2 shut down early
TEBG	Taconite Harbor 1 & 2 shut down early, Bosell 1 & 2 convert to natural gas
TEBL	Taconite Harbor 1 & 2 shut down early, Bosell 1 & 2 shut down late
TLBE	Taconite Harbor 1 & 2 shut down late Bosell 1 & 2 shut down early
TLBG	Taconite Harbor 1 & 2 shut down late Bosell 1 & 2 convert to natural gas
TLBL	Taconite Harbor 1 & 2 shut down late, Bosell 1 & 2 shut down late
Forecast	
FCSLL	Low Forecast
FCSL	Mid-low forecast
FCSM	median forecast
FCSH	mid-high forecast
FCSHH	high forecast
Capital Cost	
CAPL	Low Capital Costs
CAPM	Median Capital Costs
CAPH	High Capital Costs
CO_2 Price	
CO2L	Low CO_2 and Externality Costs
CO2M	Median CO_2 and Externality Costs
CO2H	High CO_2 and Externality Costs
Coal Price	
CLL	Low Coal Cost
CLM	Median Coal Cost
CLH	High Coal Cost
Natural Gas Price	
GASLL	Low Natural Gas Cost
GASL	Mid-low Natural Gas Cost
GASM	Median Natural Gas Cost
GASH	Mid-high Natural Gas Cost
GASHH	High Natural Gas Cost
Wind Price	
WNDLL	Low Wind Cost
WNDL	Mid-low Wind Cost
WNDM	Median Wind Cost
WNDH	Mid-high Wind Cost
WNDHH	High Wind Cost
Solar Price	
SLRLL	Low Solar Cost
SLRL	Mid-low Solar Cost
SLRM	Median Solar Cost
SLRH	Mid-high Solar Cost
SLRHH	High Solar Cost

Key to Abbreviations

Market Price	
MKTL	Low Spot Market Price
MKTM	Median Spot Market Price
MKTH	High Spot Market Price

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,756	120,504	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,779	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,764	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,849	124,818	4	2	-	1	530	1	14,529	2,699	11,830
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,886	124,383	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,894	129,655	3	2	-	1	370	-	14,538	2,656	11,882
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,040	125,142	3	-	-	2	282	3	12,391	3,292	9,099
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,057	121,546	4	1	-	2	190	-	13,261	3,182	10,078
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,050	126,902	3	1	-	2	168	-	12,385	3,301	9,084
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,107	125,963	4	1	-	2	327	1	12,810	3,188	9,623
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,156	126,782	4	1	-	2	264	-	14,445	2,756	11,690
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,153	132,142	3	1	-	2	224	-	13,739	2,793	10,946
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,353	124,914	4	2	-	2	303	3	12,875	3,302	9,574
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,372	125,604	4	-	-	2	280	2	14,099	2,910	11,189
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,363	126,520	4	2	-	2	301	-	12,781	3,318	9,464
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,429	130,405	4	-	-	2	299	3	13,939	2,831	11,107
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,480	128,221	5	-	-	2	332	-	15,627	2,534	13,092
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,462	132,190	4	-	-	2	470	-	14,468	2,724	11,744
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,466	118,104	4	-	-	1	656	3	12,114	3,411	8,703
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,497	117,853	4	-	-	1	389	-	14,602	2,777	11,825
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,484	120,955	4	-	-	1	583	-	12,968	3,103	9,865
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,525	122,236	4	-	-	1	697	1	13,131	3,052	10,079
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,559	121,776	4	-	-	1	570	-	13,623	2,938	10,685
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,571	126,969	3	-	-	1	500	-	13,157	2,986	10,171
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,195	116,346	3	-	-	1	312	1	12,567	3,241	9,325
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,238	114,280	4	-	-	1	562	-	13,406	3,130	10,276
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,227	119,580	3	-	-	1	483	-	12,587	3,170	9,417
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,259	121,826	3	-	-	1	479	-	13,211	2,966	10,245
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,288	121,554	3	-	-	1	390	-	13,205	2,957	10,248
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,306	123,861	3	-	-	1	737	-	11,886	3,367	8,519

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,829	120,504	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,845	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,830	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,908	124,818	4	2	-	1	530	1	14,529	2,699	11,830
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,946	124,383	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,953	129,655	3	2	-	1	370	-	14,538	2,656	11,882
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,651	122,236	3	-	-	2	353	3	12,065	3,359	8,706
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,678	119,033	4	-	-	2	263	-	13,111	3,203	9,908
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,667	124,369	3	-	-	2	229	-	12,223	3,297	8,926
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,758	123,544	4	-	-	2	467	1	12,640	3,215	9,425
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,800	123,450	4	-	-	2	380	-	13,525	2,999	10,526
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11,800	128,771	3	-	-	2	331	-	12,883	3,064	9,820
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,641	116,263	5	2	-	1	1,157	3	13,238	2,874	10,364
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,648	116,251	5	2	-	1	629	-	15,659	2,214	13,445
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,665	118,924	5	2	-	1	996	-	13,987	2,567	11,420
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,763	120,995	5	2	-	1	1,028	1	15,272	2,176	13,096
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,791	120,388	5	2	-	1	873	-	15,839	2,069	13,770
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,828	124,227	4	2	-	1	1,098	-	14,992	2,226	12,766
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,833	125,256	3	2	-	1	358	3	12,144	3,872	8,273
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,873	125,296	3	2	-	1	89	-	14,739	3,149	11,589
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,821	127,992	3	2	-	1	203	-	12,722	3,647	9,075
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,897	129,848	3	2	-	1	173	1	13,998	3,248	10,750
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,941	129,549	3	2	-	1	129	-	14,479	3,164	11,315
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10,906	134,585	2	2	-	1	135	-	13,726	3,316	10,410
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,304	117,611	4	-	-	2	525	3	12,840	2,664	10,176
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,327	116,450	4	-	-	2	293	-	14,534	2,248	12,286
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,339	120,618	4	2	-	1	609	-	14,842	2,120	12,722
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,447	121,187	4	-	-	2	515	1	14,195	2,213	11,982
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,484	120,124	5	2	-	1	861	-	15,919	1,981	13,938
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 12,511	123,998	4	2	-	1	1,086	-	15,076	2,146	12,930

Department Attachment 2

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,189	125,207	3	2	-	1	359	3	12,147	3,903	8,244
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,204	122,676	4	2	-	1	255	-	13,692	3,531	10,161
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,170	128,044	3	2	-	1	203	-	12,742	3,675	9,067
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,227	127,140	4	2	-	1	451	1	13,031	3,629	9,402
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,265	126,771	4	2	-	1	365	-	13,535	3,527	10,008
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 11,245	132,087	3	2	-	1	302	-	12,888	3,671	9,217
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 11,908	121,327	4	2	-	1	628	3	13,281	3,003	10,278
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 11,905	118,768	5	2	-	1	622	-	14,697	2,760	11,937
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 11,890	123,484	4	2	-	1	587	-	13,666	2,893	10,773
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 11,974	125,303	4	2	-	1	553	1	14,841	2,545	12,296
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 12,009	124,825	4	2	-	1	450	-	15,374	2,432	12,942
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 12,012	126,536	4	2	-	1	1,024	-	13,704	2,955	10,749
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 12,019	121,320	5	2	1	-	955	2	14,457	2,642	11,815
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 12,008	120,464	5	2	-	1	623	-	15,239	2,485	12,754
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 11,994	125,253	4	2	-	1	589	-	14,212	2,608	11,604
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 12,078	125,001	5	1	1	-	906	1	15,168	2,467	12,701
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 12,103	124,637	5	1	1	-	748	-	15,789	2,317	13,472
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 12,108	128,535	4	1	1	-	962	-	14,879	2,540	12,340
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,570	121,110	3	-	-	2	344	3	11,488	3,720	7,768
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,618	120,635	3	-	-	2	91	-	13,445	3,241	10,205
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,605	123,327	3	-	-	2	216	-	11,669	3,649	8,020
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,692	125,454	3	-	-	2	187	1	12,965	3,206	9,759
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,741	125,372	3	-	-	2	143	-	13,905	2,990	10,916
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 11,735	130,548	2	-	-	2	169	-	13,162	3,036	10,126
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,371	121,064	3	-	-	2	337	3	11,056	3,977	7,079
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,433	120,458	3	-	-	2	86	-	13,014	3,474	9,539
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,430	123,263	3	-	-	2	208	-	11,240	3,904	7,336
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,519	125,367	3	-	-	2	180	1	12,585	3,434	9,152
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,572	125,149	3	-	-	2	138	-	13,529	3,193	10,335
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 11,567	130,398	2	-	-	2	168	-	12,847	3,211	9,636

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 11,853	129,346	1	-	-	2	65	3	14,776	2,415	12,360
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 11,912	121,795	3	-	-	2	97	-	13,997	2,893	11,103
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 11,875	131,734	1	-	-	2	22	-	14,877	2,401	12,476
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 11,974	127,652	3	2	-	1	227	1	15,565	2,363	13,201
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 12,014	127,298	3	2	-	1	170	-	16,047	2,285	13,762
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 11,987	131,389	2	-	-	2	172	-	13,582	2,772	10,810
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 11,862	132,182	-	-	-	2	28	3	15,983	2,071	13,913
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 11,968	131,801	-	-	-	2	2	-	18,375	1,757	16,617
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 11,885	134,655	-	-	-	2	7	-	16,056	2,059	13,997
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 12,000	136,597	-	-	-	2	3	1	17,489	1,683	15,806
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 12,079	136,681	-	-	-	2	2	-	18,552	1,583	16,968
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 12,004	139,161	-	-	-	2	14	-	16,452	1,863	14,589
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,602	118,032	5	2	-	1	1,097	3	11,929	3,652	8,277
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,613	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,607	120,728	5	2	-	1	922	-	12,552	3,402	9,150
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,691	122,672	5	2	-	1	922	1	13,783	3,011	10,772
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,725	122,159	5	2	-	1	780	-	14,298	2,906	11,393
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11,740	123,782	5	2	-	1	1,620	-	12,680	3,452	9,228
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,436	118,032	5	2	-	1	1,097	3	11,929	3,652	8,277
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,447	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,441	120,728	5	2	-	1	922	-	12,552	3,402	9,150
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,525	122,672	5	2	-	1	922	1	13,783	3,011	10,772
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,559	122,159	5	2	-	1	780	-	14,298	2,906	11,393
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11,563	123,782	5	2	-	1	1,620	-	12,680	3,452	9,228
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,769	120,504	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,789	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,774	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,856	124,468	4	1	-	1	483	1	13,980	2,858	11,122
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,896	124,383	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 11,903	126,485	4	1	-	1	942	-	13,581	3,034	10,548

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,772	122,236	3	-	-	2	353	3	12,065	3,359	8,706
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,794	120,791	4	-	-	1	266	-	14,439	2,734	11,705
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,784	124,369	3	-	-	2	229	-	12,223	3,297	8,926
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,861	124,468	4	1	-	1	483	1	13,980	2,858	11,122
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,902	124,864	4	1	-	1	398	-	15,237	2,533	12,704
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 11,906	128,771	3	-	-	2	331	-	12,883	3,064	9,820
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,743	120,504	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,769	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,754	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,839	124,818	4	2	-	1	530	1	14,529	2,699	11,830
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,876	124,383	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11,884	129,655	3	2	-	1	370	-	14,538	2,656	11,882
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,728	120,298	4	2	-	1	606	3	12,671	3,323	9,349
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,754	118,195	4	6	-	1	575	-	14,451	3,041	11,410
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,744	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,821	122,802	4	6	-	1	935	1	13,936	3,034	10,902
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,866	124,383	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 11,874	129,655	3	2	-	1	370	-	14,538	2,656	11,882
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 11,932	122,203	4	2	-	1	477	3	10,816	4,667	6,150
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 11,966	119,682	5	2	-	1	471	-	12,395	4,276	8,119
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 11,944	122,462	5	2	-	1	782	-	10,618	4,783	5,834
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 12,038	125,425	4	-	-	2	377	1	10,448	4,770	5,677
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 12,078	123,913	5	2	-	1	653	-	12,357	4,225	8,132
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 12,075	127,857	4	2	-	1	847	-	11,370	4,496	6,875
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,612	120,465	3	2	-	1	574	3	16,649	1,231	15,418
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,615	118,032	4	2	-	1	456	-	17,985	1,059	16,925
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,614	123,183	3	2	-	1	401	-	17,373	1,015	16,358
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,691	122,527	4	2	-	1	747	1	17,513	1,052	16,460
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,722	122,056	4	2	-	1	617	-	18,044	972	17,073
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 11,731	127,136	3	2	-	1	553	-	17,690	902	16,789

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 23	(2,433)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 8	2,335	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 93	4,313	-	-	-	-	(48)	(2)	1,747	(574)	2,321
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 130	3,879	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 138	9,151	(1)	-	-	-	(208)	(3)	1,755	(617)	2,372
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18	(3,596)	1	1	-	-	(92)	(3)	870	(110)	980
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10	1,759	-	1	-	-	(114)	(3)	(6)	8	(14)
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 67	821	1	1	-	-	45	(2)	419	(105)	524
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 116	1,640	1	1	-	-	(18)	(3)	2,055	(536)	2,591
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 113	7,000	-	1	-	-	(59)	(3)	1,348	(500)	1,848
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19	690	-	(2)	-	-	(23)	(1)	1,224	(392)	1,616
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11	1,605	-	-	-	-	(2)	(3)	(94)	16	(110)
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 76	5,491	-	(2)	-	-	(4)	-	1,064	(470)	1,534
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 128	3,307	1	(2)	-	-	29	(3)	2,752	(767)	3,519
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 109	7,276	-	(2)	-	-	167	(3)	1,593	(578)	2,171
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 31	(251)	-	-	-	-	(268)	(3)	2,489	(634)	3,122
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18	2,851	-	-	-	-	(74)	(3)	854	(307)	1,162
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 60	4,132	-	-	-	-	41	(2)	1,017	(359)	1,376
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 93	3,672	-	-	-	-	(87)	(3)	1,509	(473)	1,982
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 106	8,865	(1)	-	-	-	(156)	(3)	1,043	(425)	1,468
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 43	(2,066)	1	-	-	-	250	(1)	839	(112)	951
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 33	3,233	-	-	-	-	171	(1)	20	(72)	92
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 64	5,480	-	-	-	-	167	(1)	644	(276)	920
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 93	5,208	-	-	-	-	78	(1)	638	(284)	922
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 111	7,515	-	-	-	-	425	(1)	(680)	126	(806)

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 15	(2,433)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 0	2,335	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 79	4,313	-	-	-	-	(48)	(2)	1,747	(574)	2,321
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 116	3,879	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 124	9,151	(1)	-	-	-	(208)	(3)	1,755	(617)	2,372
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 27	(3,203)	1	-	-	-	(90)	(3)	1,046	(156)	1,202
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 16	2,133	-	-	-	-	(124)	(3)	157	(62)	219
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 107	1,307	1	-	-	-	113	(2)	575	(144)	719
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 149	1,214	1	-	-	-	27	(3)	1,460	(360)	1,820
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 149	6,534	-	-	-	-	(22)	(3)	818	(295)	1,113
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 7	(12)	-	-	-	-	(529)	(3)	2,421	(660)	3,081
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 25	2,661	-	-	-	-	(161)	(3)	749	(307)	1,056
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 123	4,732	-	-	-	-	(130)	(2)	2,034	(698)	2,732
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 150	4,125	-	-	-	-	(284)	(3)	2,602	(805)	3,407
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 187	7,964	(1)	-	-	-	(59)	(3)	1,755	(648)	2,403
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 11	(2,735)	-	-	-	-	155	3	(578)	225	(803)
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 52	(2,696)	-	-	-	-	(115)	-	2,017	(498)	2,514
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 76	1,857	-	-	-	-	(31)	1	1,276	(399)	1,675
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 120	1,557	-	-	-	-	(74)	-	1,757	(483)	2,240
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 85	6,593	(1)	-	-	-	(69)	-	1,004	(331)	1,335
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 23	(1,161)	-	-	-	-	(232)	(3)	1,694	(416)	2,110
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 35	3,007	-	2	-	(1)	85	(3)	2,002	(544)	2,546
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 143	3,576	-	-	-	-	(10)	(2)	1,354	(452)	1,806
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 180	2,513	1	2	-	(1)	336	(3)	3,078	(683)	3,762
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 206	6,387	-	2	-	(1)	561	(3)	2,236	(518)	2,754

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19	(2,838)	-	-	-	-	156	3	(595)	229	(823)
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 35	(5,369)	1	-	-	-	52	-	950	(144)	1,094
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 58	(904)	1	-	-	-	248	1	290	(46)	335
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 95	(1,273)	1	-	-	-	162	-	793	(148)	941
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 75	4,043	-	-	-	-	99	-	146	(3)	150
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 18	(2,157)	-	-	-	-	42	3	(385)	110	(495)
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 15	(4,716)	1	-	-	-	36	-	1,031	(133)	1,164
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 84	1,819	-	-	-	-	(34)	1	1,175	(348)	1,523
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 119	1,341	-	-	-	-	(137)	-	1,708	(461)	2,169
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 122	3,052	-	-	-	-	438	-	38	61	(24)
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 25	(3,933)	1	-	1	(1)	366	2	245	34	211
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 14	(4,789)	1	-	-	-	34	-	1,027	(123)	1,150
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 84	(252)	1	(1)	1	(1)	317	1	956	(141)	1,097
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 109	(616)	1	(1)	1	(1)	159	-	1,577	(291)	1,868
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 114	3,283	-	(1)	1	(1)	373	-	667	(68)	736
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 48	(474)	-	-	-	-	(254)	(3)	1,957	(479)	2,437
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 35	2,218	-	-	-	-	(128)	(3)	181	(71)	252
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 122	4,345	-	-	-	-	(157)	(2)	1,477	(514)	1,992
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 171	4,262	-	-	-	-	(201)	(3)	2,417	(730)	3,148
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 166	9,439	(1)	-	-	-	(175)	(3)	1,674	(684)	2,359
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 63	(606)	-	-	-	-	(251)	(3)	1,958	(503)	2,461
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 59	2,199	-	-	-	-	(128)	(3)	184	(73)	257
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 148	4,303	-	-	-	-	(156)	(2)	1,529	(544)	2,073
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 202	4,085	-	-	-	-	(199)	(3)	2,472	(784)	3,257
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 197	9,334	(1)	-	-	-	(168)	(3)	1,791	(766)	2,557

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 59	(7,551)	2	-	-	-	32	(3)	(779)	478	(1,257)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 22	2,388	-	-	-	-	(43)	(3)	102	(14)	116
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 121	(1,694)	2	2	-	(1)	162	(2)	789	(52)	841
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 161	(2,048)	2	2	-	(1)	105	(3)	1,271	(130)	1,402
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 134	2,043	1	-	-	-	107	(3)	(1,194)	357	(1,550)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 105	(382)	-	-	-	-	(26)	(3)	2,391	(313)	2,705
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 23	2,472	-	-	-	-	(21)	(3)	72	(12)	84
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 138	4,415	-	-	-	-	(25)	(2)	1,505	(388)	1,893
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 217	4,498	-	-	-	-	(27)	(3)	2,568	(487)	3,056
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 142	6,979	-	-	-	-	(14)	(3)	469	(208)	677
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 11	39	-	-	-	-	(525)	(3)	2,313	(650)	2,963
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 5	2,696	-	-	-	-	(175)	(3)	623	(250)	873
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 89	4,640	-	-	-	-	(175)	(2)	1,854	(641)	2,494
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 123	4,127	-	-	-	-	(317)	(3)	2,369	(746)	3,115
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 138	5,750	-	-	-	-	523	(3)	751	(199)	950
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 11	39	-	-	-	-	(525)	(3)	2,313	(650)	2,963
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 5	2,696	-	-	-	-	(175)	(3)	623	(250)	873
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 89	4,640	-	-	-	-	(175)	(2)	1,854	(641)	2,494
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 123	4,127	-	-	-	-	(317)	(3)	2,369	(746)	3,115
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 127	5,750	-	-	-	-	523	(3)	751	(199)	950
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20	(2,433)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 5	2,335	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 87	3,964	-	(1)	-	-	(95)	(2)	1,198	(415)	1,613
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 127	3,879	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 134	5,981	-	(1)	-	-	364	(3)	799	(240)	1,039

Standard Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 23	(1,445)	1	-	-	(1)	(87)	(3)	2,373	(626)	2,999
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 12	2,133	-	-	-	-	(124)	(3)	157	(62)	219
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 90	2,232	1	1	-	(1)	130	(2)	1,915	(501)	2,416
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 130	2,628	1	1	-	(1)	44	(3)	3,172	(826)	3,998
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 135	6,534	-	-	-	-	(22)	(3)	818	(295)	1,113
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 26	(2,433)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 11	2,335	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 96	4,313	-	-	-	-	(48)	(2)	1,747	(574)	2,321
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 133	3,879	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 141	9,151	(1)	-	-	-	(208)	(3)	1,755	(617)	2,372
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 26	(2,103)	-	4	-	-	(31)	(3)	1,779	(282)	2,061
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 15	2,541	-	-	-	-	(55)	(3)	588	(221)	809
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 93	2,504	-	4	-	-	330	(2)	1,264	(288)	1,553
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 138	4,085	-	-	-	-	(176)	(3)	2,362	(713)	3,076
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 145	9,357	(1)	-	-	-	(236)	(3)	1,866	(667)	2,533
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 34	(2,521)	1	-	-	-	(6)	(3)	1,579	(391)	1,969
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 12	259	1	-	-	-	306	(3)	(199)	117	(315)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 105	3,222	-	(2)	-	1	(100)	(2)	(368)	104	(472)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 146	1,710	1	-	-	-	177	(3)	1,541	(442)	1,982
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 142	5,654	-	-	-	-	370	(3)	554	(171)	725
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 3	(2,433)	1	-	-	-	(118)	(3)	1,336	(172)	1,508
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 2	2,717	-	-	-	-	(173)	(3)	725	(216)	941
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 79	2,062	1	-	-	-	173	(2)	864	(179)	1,043
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 110	1,591	1	-	-	-	43	(3)	1,396	(259)	1,655
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 119	6,671	-	-	-	-	(21)	(3)	1,042	(329)	1,371

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,748	121,118	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,775	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,759	122,834	4	2	-	1	577	-	13,494	3,019	10,475
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,825	124,263	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,861	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,859	126,968	4	2	-	1	666	-	13,587	2,994	10,593
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,032	124,868	3	-	-	2	289	3	12,286	3,331	8,955
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,038	120,364	5	3	-	1	443	-	14,353	2,965	11,389
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,034	124,370	4	3	-	1	418	-	13,511	3,108	10,403
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,093	126,223	4	3	-	1	375	1	13,997	2,926	11,070
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,135	124,844	5	3	-	1	592	-	14,853	2,755	12,098
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,128	129,460	4	3	-	1	571	-	14,025	2,887	11,138
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,345	124,958	4	2	-	2	313	3	13,128	3,218	9,910
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,366	125,330	4	-	-	2	287	2	13,989	2,946	11,043
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,355	126,323	4	2	-	2	311	-	12,687	3,353	9,334
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,424	130,130	4	-	-	2	309	3	13,832	2,871	10,961
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,475	127,948	5	-	-	2	345	-	15,513	2,569	12,944
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,448	132,683	4	-	-	2	354	-	14,489	2,673	11,816
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,460	117,842	4	-	-	1	677	3	11,997	3,455	8,542
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,491	117,585	4	-	-	1	404	-	14,471	2,818	11,653
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,479	120,787	4	-	-	1	604	-	12,845	3,147	9,697
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,520	121,932	4	-	-	1	721	1	13,010	3,094	9,916
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,554	121,499	4	-	-	1	590	-	13,502	2,978	10,525
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,562	126,575	3	-	-	1	521	-	12,993	3,044	9,950
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,189	116,078	3	-	-	1	325	1	12,447	3,286	9,162
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,233	114,011	4	-	-	1	583	-	13,282	3,168	10,115
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,221	118,822	3	2	-	1	551	-	12,152	3,374	8,778
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,253	120,706	3	2	-	1	559	-	12,744	3,160	9,584
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,282	121,271	3	-	-	1	406	-	13,081	3,000	10,081
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,298	123,463	3	-	-	1	760	-	11,750	3,432	8,318

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,821	121,118	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,841	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,822	122,834	4	2	-	1	577	-	13,494	3,019	10,475
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,884	124,508	4	2	-	1	550	1	14,402	2,736	11,666
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,921	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,918	126,968	4	2	-	1	666	-	13,587	2,994	10,593
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,647	121,965	3	-	-	2	363	3	11,961	3,400	8,561
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,686	119,126	4	-	-	2	274	-	13,478	3,137	10,340
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,669	124,344	3	-	-	2	240	-	12,516	3,222	9,293
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,736	125,994	3	-	-	2	206	1	13,348	2,937	10,411
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,778	123,174	4	-	-	2	394	-	13,426	3,034	10,392
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,767	128,371	3	-	-	2	347	-	12,652	3,129	9,523
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,634	116,016	5	2	-	1	1,191	3	13,123	2,912	10,210
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,646	116,520	5	1	-	1	595	-	15,775	2,158	13,617
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,661	118,992	5	2	-	1	1,052	-	14,209	2,506	11,702
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,737	120,338	5	1	-	1	934	1	14,677	2,307	12,369
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,765	120,127	5	2	-	1	903	-	15,722	2,102	13,619
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,794	122,603	5	2	-	1	1,379	-	14,300	2,472	11,828
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,819	128,600	3	1	1	-	222	2	13,108	3,065	10,043
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,868	125,604	3	1	-	1	84	-	14,861	3,084	11,777
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,817	128,221	3	1	-	1	197	-	12,842	3,582	9,260
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,873	129,538	3	1	-	1	166	1	13,263	3,446	9,817
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,918	129,621	3	1	-	1	123	-	14,151	3,221	10,930
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,882	131,970	3	1	-	1	280	-	12,456	3,737	8,720
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,298	118,005	4	2	-	1	641	3	14,149	2,390	11,760
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,324	116,228	5	1	-	1	589	-	15,817	2,041	13,776
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,337	120,693	4	2	-	1	652	-	15,106	2,051	13,055
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,423	122,057	4	1	-	1	545	1	15,537	1,883	13,654
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,460	119,861	5	2	-	1	890	-	15,800	2,015	13,785
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 12,478	124,343	4	2	-	1	877	-	15,181	2,047	13,134

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,177	126,258	4	1	1	-	364	2	12,487	3,319	9,168
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,201	122,960	4	1	-	1	240	-	13,803	3,469	10,334
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,164	127,951	3	2	-	1	210	-	13,007	3,577	9,430
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,205	126,825	4	2	-	1	470	1	12,903	3,667	9,236
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,242	126,505	4	2	-	1	381	-	13,409	3,564	9,845
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 11,215	131,698	3	2	-	1	310	-	12,687	3,741	8,946
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,892	121,959	5	1	1	-	910	2	13,630	2,652	10,978
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,901	121,211	5	1	1	-	587	-	15,519	2,330	13,190
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,881	123,431	4	2	-	1	604	-	13,854	2,834	11,020
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,949	125,008	4	2	-	1	574	1	14,717	2,578	12,139
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,983	124,560	4	2	-	1	469	-	15,250	2,466	12,784
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 11,977	127,465	4	2	-	1	691	-	13,895	2,836	11,059
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 11,998	121,741	5	1	1	-	888	2	14,603	2,576	12,028
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 11,994	121,034	5	1	1	-	574	-	16,349	2,270	14,078
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 11,976	123,253	5	1	1	-	943	-	14,595	2,695	11,900
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 12,053	124,711	5	1	1	-	937	1	15,042	2,504	12,538
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 12,078	124,363	5	1	1	-	775	-	15,664	2,351	13,312
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 12,076	129,517	4	1	1	-	637	-	15,107	2,417	12,690
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,567	120,844	3	-	-	2	353	3	11,379	3,765	7,614
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,629	118,174	4	-	-	2	258	-	12,918	3,515	9,403
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,609	123,382	3	-	-	2	231	-	11,990	3,556	8,434
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,670	125,142	3	-	-	2	195	1	12,858	3,247	9,612
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,719	125,092	3	-	-	2	149	-	13,795	3,028	10,767
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 11,710	127,589	3	-	-	2	339	-	12,206	3,417	8,788
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,369	120,801	3	-	-	2	345	3	10,943	4,026	6,917
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,453	120,636	3	-	-	2	93	-	13,457	3,393	10,064
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,441	123,296	3	-	-	2	228	-	11,582	3,798	7,784
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,498	125,044	3	-	-	2	187	1	12,474	3,478	8,996
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,551	124,870	3	-	-	2	144	-	13,413	3,234	10,179
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 11,550	127,459	3	-	-	2	332	-	11,841	3,629	8,212

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,847	129,073	1	-	-	2	67	3	14,645	2,460	12,185
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,912	123,393	3	1	-	1	105	-	16,247	2,308	13,939
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,875	131,655	1	-	-	2	24	-	15,260	2,330	12,930
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,947	127,070	3	1	-	1	209	1	14,842	2,535	12,307
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,988	127,018	3	2	-	1	178	-	15,914	2,319	13,595
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 11,973	129,273	3	2	-	1	379	-	14,339	2,716	11,622
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 11,855	131,910	-	-	-	2	29	3	15,840	2,113	13,727
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 11,983	129,025	1	-	-	2	5	-	17,568	2,000	15,567
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 11,888	134,529	-	-	-	2	8	-	16,483	1,987	14,495
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 11,975	136,223	-	-	-	2	3	1	17,347	1,723	15,625
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 12,053	136,381	-	-	-	2	2	-	18,409	1,620	16,789
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 11,979	138,877	-	-	-	2	15	-	16,318	1,902	14,416
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,591	118,612	5	1	-	1	984	3	12,143	3,535	8,608
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,609	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,603	120,736	5	2	-	1	960	-	12,754	3,332	9,423
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,668	122,141	5	1	-	1	863	1	13,214	3,171	10,043
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,701	121,895	5	2	-	1	809	-	14,184	2,943	11,241
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11,708	124,497	5	1	-	1	1,173	-	12,619	3,363	9,256
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,426	118,612	5	1	-	1	984	3	12,143	3,535	8,608
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,443	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,437	120,736	5	2	-	1	960	-	12,754	3,332	9,423
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,503	122,141	5	1	-	1	863	1	13,214	3,171	10,043
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,536	121,895	5	2	-	1	809	-	14,184	2,943	11,241
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11,543	124,497	5	1	-	1	1,173	-	12,619	3,363	9,256
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,751	121,118	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,778	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,765	123,069	4	1	-	1	531	-	13,377	3,040	10,337
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,829	124,263	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,868	124,268	4	1	-	1	402	-	14,766	2,658	12,108
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 11,864	127,135	4	1	-	1	608	-	13,426	3,007	10,419

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,755	121,118	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,782	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,769	122,391	4	1	-	1	531	-	13,377	3,040	10,337
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,832	124,263	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,872	124,268	4	1	-	1	402	-	14,766	2,658	12,108
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 11,868	127,135	4	1	-	1	608	-	13,426	3,007	10,419
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,737	120,242	4	2	-	1	597	3	12,662	3,315	9,347
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,770	118,156	5	2	-	1	599	-	14,558	2,933	11,625
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,749	122,834	4	2	-	1	577	-	13,494	3,019	10,475
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,815	124,508	4	2	-	1	550	1	14,402	2,736	11,666
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,851	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 11,849	126,968	4	2	-	1	666	-	13,587	2,994	10,593
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,722	120,036	4	2	-	1	626	3	12,552	3,364	9,187
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,745	117,934	4	6	-	1	600	-	14,332	3,080	11,252
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,735	123,110	3	6	-	1	505	-	13,500	3,119	10,381
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,800	122,497	4	6	-	1	970	1	13,822	3,075	10,747
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,841	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 11,839	126,968	4	2	-	1	666	-	13,587	2,994	10,593
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 11,925	121,940	4	2	-	1	494	3	10,695	4,712	5,983
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 11,963	119,983	5	1	-	1	442	-	12,487	4,225	8,262
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 11,940	122,461	5	2	-	1	810	-	10,837	4,690	6,146
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 12,012	123,888	5	1	-	1	734	1	11,216	4,569	6,647
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 12,053	123,648	5	2	-	1	679	-	12,243	4,264	7,979
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 12,042	128,364	4	2	-	1	654	-	11,360	4,474	6,886
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,601	118,896	4	1	-	1	712	3	16,119	1,348	14,771
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,610	118,345	4	1	-	1	430	-	18,098	1,033	17,065
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,610	123,253	3	2	-	1	422	-	17,566	997	16,570
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,669	122,243	4	2	-	1	771	1	17,390	1,076	16,313
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,699	121,773	4	2	-	1	639	-	17,927	993	16,934
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 11,703	126,710	3	2	-	1	562	-	17,517	940	16,576

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 27	(2,764)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12	1,716	-	1	-	-	67	(3)	470	(127)	597
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 77	3,146	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 114	2,991	-	1	-	-	(64)	(3)	1,886	(501)	2,387
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 111	5,850	-	1	-	-	156	(3)	562	(153)	715
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 6	(4,504)	2	3	-	(1)	154	(3)	2,067	(367)	2,434
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 3	(498)	1	3	-	(1)	129	(3)	1,225	(224)	1,448
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 61	1,355	1	3	-	(1)	86	(2)	1,710	(405)	2,116
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 104	(24)	2	3	-	(1)	303	(3)	2,567	(577)	3,144
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 97	4,592	1	3	-	(1)	282	(3)	1,738	(445)	2,183
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20	372	-	(2)	-	-	(26)	(1)	862	(272)	1,133
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10	1,365	-	-	-	-	(2)	(3)	(441)	135	(576
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 78	5,172	-	(2)	-	-	(5)	-	704	(347)	1,051
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 129	2,991	1	(2)	-	-	32	(3)	2,385	(649)	3,034
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 103	7,725	-	(2)	-	-	41	(3)	1,361	(545)	1,906
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 30	(257)	-	-	-	-	(273)	(3)	2,474	(637)	3,111
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18	2,944	-	-	-	-	(73)	(3)	848	(307)	1,155
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 60	4,090	-	-	-	-	44	(2)	1,013	(361)	1,374
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 93	3,656	-	-	-	-	(87)	(3)	1,506	(477)	1,982
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 102	8,733	(1)	-	-	-	(156)	(3)	997	(411)	1,407
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 43	(2,067)	1	-	-	-	258	(1)	835	(118)	953
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 32	2,743	-	2	-	-	226	(1)	(295)	88	(383
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 64	4,628	-	2	-	-	234	(1)	297	(125)	422
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 93	5,193	-	-	-	-	81	(1)	633	(286)	919
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 109	7,385	-	-	-	-	435	(1)	(697)	146	(843

Standard Modeling Approach, Energy Efficiency +15 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20	(2,764)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 1	1,716	-	1	-	-	67	(3)	470	(127)	597
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 63	3,391	-	1	-	-	40	(2)	1,377	(410)	1,787
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 100	2,991	-	1	-	-	(64)	(3)	1,886	(501)	2,387
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 97	5,850	-	1	-	-	156	(3)	562	(153)	715
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 38	(2,839)	1	-	-	-	(88)	(3)	1,517	(263)	1,779
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21	2,379	-	-	-	-	(122)	(3)	555	(178)	733
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 88	4,029	-	-	-	-	(156)	(2)	1,387	(463)	1,850
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 131	1,210	1	-	-	-	32	(3)	1,466	(366)	1,831
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 120	6,407	-	-	-	-	(16)	(3)	691	(271)	962
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12	504	-	(1)	-	-	(595)	(3)	2,652	(754)	3,406
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 27	2,977	-	-	-	-	(139)	(3)	1,086	(406)	1,492
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 103	4,322	-	(1)	-	-	(257)	(2)	1,554	(605)	2,159
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 131	4,111	-	-	-	-	(288)	(3)	2,599	(810)	3,409
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 160	6,588	-	-	-	-	188	(3)	1,178	(440)	1,618
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 2	379	-	-	1	(1)	26	2	266	(517)	783
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 51	(2,617)	-	-	-	-	(113)	-	2,019	(498)	2,517
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 56	1,317	-	-	-	-	(31)	1	421	(135)	557
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 101	1,400	-	-	-	-	(74)	-	1,309	(361)	1,670
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 65	3,749	-	-	-	-	84	-	(385)	155	(540
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 27	(1,777)	1	(1)	-	-	(52)	(3)	1,668	(348)	2,016
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 39	2,688	-	-	-	-	11	(3)	957	(339)	1,296
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 126	4,052	-	(1)	-	-	(97)	(2)	1,388	(506)	1,895
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 162	1,856	1	-	-	-	249	(3)	1,651	(374)	2,025
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 180	6,338	-	-	-	-	236	(3)	1,032	(343)	1,375

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 13	(1,693)	1	(1)	1	(1)	153	2	(520)	(258)	(262
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 36	(4,990)	1	(1)	-	-	30	-	796	(108)	904
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 40	(1,126)	1	-	-	-	260	1	(104)	90	(194
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 77	(1,445)	1	-	-	-	171	-	402	(13)	415
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 51	3,747	-	-	-	-	100	-	(320)	164	(484
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10	(1,472)	1	(1)	1	(1)	306	2	(224)	(181)	(42
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 19	(2,220)	1	(1)	1	(1)	(17)	-	1,666	(504)	2,170
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 68	1,577	-	-	-	-	(30)	1	864	(256)	1,119
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 102	1,129	-	-	-	-	(136)	-	1,396	(368)	1,764
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 96	4,034	-	-	-	-	86	-	41	3	39
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 22	(1,512)	-	-	-	-	(55)	2	9	(119)	128
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 18	(2,219)	-	-	-	-	(369)	-	1,754	(424)	2,178
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 77	1,458	-	-	-	-	(6)	1	447	(191)	638
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 102	1,110	-	-	-	-	(169)	-	1,069	(343)	1,412
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 100	6,264	(1)	-	-	-	(306)	-	513	(278)	790
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 62	(2,670)	1	-	-	-	(96)	(3)	1,540	(249)	1,789
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 42	2,538	-	-	-	-	(122)	(3)	612	(209)	820
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 103	4,298	-	-	-	-	(158)	(2)	1,480	(518)	1,998
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 152	4,248	-	-	-	-	(204)	(3)	2,417	(736)	3,153
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 143	6,745	-	-	-	-	(14)	(3)	827	(347)	1,174
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 84	(165)	-	-	-	-	(252)	(3)	2,514	(632)	3,147
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 72	2,495	-	-	-	-	(117)	(3)	639	(228)	867
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 129	4,243	-	-	-	-	(157)	(2)	1,531	(547)	2,078
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 182	4,069	-	-	-	-	(201)	(3)	2,470	(791)	3,262
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 181	6,658	-	-	-	-	(13)	(3)	899	(396)	1,295

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 65	(5,679)	2	1	-	(1)	38	(3)	1,602	(152)	1,754
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 28	2,582	-	-	-	-	(43)	(3)	615	(130)	745
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 100	(2,002)	2	1	-	(1)	143	(2)	198	75	123
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 141	(2,054)	2	2	-	(1)	111	(3)	1,269	(141)	1,410
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 125	200	2	2	-	(1)	312	(3)	(306)	256	(563
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 127	(2,885)	1	-	-	-	(24)	(3)	1,728	(112)	1,840
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 33	2,618	-	-	-	-	(22)	(3)	643	(126)	769
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 119	4,313	-	-	-	-	(26)	(2)	1,508	(390)	1,898
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 198	4,471	-	-	-	-	(28)	(3)	2,570	(493)	3,062
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 124	6,967	-	-	-	-	(14)	(3)	478	(211)	689
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 18	(258)	-	-	-	-	(444)	(3)	2,206	(593)	2,799
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 11	2,124	-	1	-	-	(24)	(3)	611	(204)	815
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 77	3,528	-	-	-	-	(121)	(2)	1,071	(364)	1,435
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 110	3,283	-	1	-	-	(175)	(3)	2,041	(593)	2,634
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 117	5,885	-	-	-	-	188	(3)	476	(172)	648
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 18	(258)	-	-	-	-	(444)	(3)	2,206	(593)	2,799
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 11	2,124	-	1	-	-	(24)	(3)	611	(204)	815
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 77	3,528	-	-	-	-	(121)	(2)	1,071	(364)	1,435
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 110	3,283	-	1	-	-	(175)	(3)	2,041	(593)	2,634
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 117	5,885	-	-	-	-	188	(3)	476	(172)	648
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 27	(2,764)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 14	1,952	-	-	-	-	20	(3)	353	(106)	459
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 77	3,146	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 116	3,151	-	-	-	-	(108)	(3)	1,741	(488)	2,230
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 113	6,018	-	-	-	-	97	(3)	402	(139)	540

Standard Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 27	(2,764)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 14	1,273	-	-	-	-	20	(3)	353	(106)	459
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 77	3,146	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 116	3,151	-	-	-	-	(108)	(3)	1,741	(488)	2,230
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 113	6,018	-	-	-	-	97	(3)	402	(139)	540
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 33	(2,086)	1	-	-	-	2	(3)	1,896	(382)	2,278
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 12	2,592	-	-	-	-	(20)	(3)	832	(296)	1,128
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 78	4,266	-	-	-	-	(47)	(2)	1,740	(579)	2,318
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 114	3,867	-	-	-	-	(151)	(3)	2,248	(670)	2,918
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 112	6,726	-	-	-	-	68	(3)	925	(321)	1,246
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 22	(2,102)	-	4	-	-	(26)	(3)	1,780	(284)	2,065
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 12	3,074	(1)	4	-	-	(121)	(3)	948	(245)	1,194
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 78	2,461	-	4	-	-	344	(2)	1,270	(290)	1,560
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 119	4,073	-	-	-	-	(179)	(3)	2,358	(720)	3,078
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 117	6,932	-	-	-	-	40	(3)	1,035	(371)	1,406
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 38	(1,956)	1	(1)	-	-	(51)	(3)	1,792	(487)	2,279
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 15	521	1	-	-	-	316	(3)	142	(22)	163
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 87	1,949	1	(1)	-	-	240	(2)	521	(143)	664
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 128	1,708	1	-	-	-	185	(3)	1,548	(448)	1,996
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 117	6,425	-	-	-	-	160	(3)	665	(238)	903
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 9	(550)	-	-	-	-	(282)	(3)	1,978	(315)	2,294
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 8	4,357	(1)	1	-	-	(290)	(3)	1,447	(352)	1,799
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 67	3,347	-	1	-	-	60	(2)	1,270	(272)	1,542
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 97	2,877	-	1	-	-	(73)	(3)	1,807	(356)	2,163
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 101	7,815	(1)	1	-	-	(150)	(3)	1,397	(408)	1,805

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,724	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,746	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,736	121,979	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,801	123,958	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,836	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,837	126,394	4	1	-	1	710	-	13,325	3,060	10,265
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,996	123,315	4	2	-	1	451	3	13,603	3,043	10,560
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,011	119,794	5	2	-	1	473	-	14,067	3,034	11,034
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,008	124,493	4	2	-	1	449	-	13,228	3,171	10,057
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,066	126,089	4	2	-	1	408	1	14,051	2,869	11,182
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,109	126,395	4	2	-	1	339	-	15,243	2,568	12,675
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,103	128,887	4	2	-	1	609	-	13,754	2,950	10,804
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,332	124,290	4	2	-	2	357	3	13,094	3,248	9,846
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,345	123,814	4	1	-	2	327	2	13,427	3,158	10,269
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,344	125,929	4	2	-	2	361	-	13,040	3,265	9,775
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,407	128,767	4	1	-	2	360	3	13,325	3,084	10,240
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,455	128,840	4	1	-	2	206	-	15,635	2,524	13,111
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,432	131,304	4	1	-	2	412	-	13,960	2,884	11,076
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,450	119,049	3	-	-	1	531	3	12,258	3,332	8,925
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,478	116,555	4	-	-	1	471	-	13,980	2,975	11,005
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,469	121,875	3	-	-	1	399	-	13,130	3,001	10,129
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,510	124,085	3	-	-	1	397	1	13,859	2,751	11,108
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,545	120,867	4	-	-	1	682	-	13,392	3,018	10,374
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,553	125,943	3	-	-	1	596	-	12,919	3,071	9,848
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,174	115,452	3	-	-	1	385	1	12,399	3,315	9,084
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,212	115,235	3	1	-	1	319	-	13,611	3,053	10,557
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,201	117,922	3	1	-	1	594	-	11,892	3,458	8,435
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,232	120,144	3	1	-	1	601	-	12,472	3,242	9,231
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,262	119,831	3	1	-	1	492	-	12,482	3,232	9,250
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,283	122,068	3	1	-	1	882	-	11,181	3,663	7,518

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,798	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,812	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,802	122,262	4	1	-	1	635	-	13,159	3,114	10,045
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,860	123,958	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,895	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,896	126,394	4	1	-	1	710	-	13,325	3,060	10,265
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,651	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,680	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,670	121,979	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,741	123,958	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,777	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,776	128,286	3	-	-	2	397	-	13,445	2,958	10,487
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,607	115,668	5	1	-	1	1,192	3	12,929	2,933	9,996
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,611	115,412	5	1	-	1	696	-	15,244	2,304	12,940
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,634	118,091	5	1	-	1	1,089	-	13,605	2,670	10,935
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,711	120,165	5	1	-	1	1,122	1	14,881	2,278	12,603
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,736	119,542	5	1	-	1	956	-	15,451	2,164	13,287
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,769	122,038	5	1	-	1	1,451	-	14,049	2,535	11,514
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,798	128,082	3	-	1	-	245	2	12,829	3,145	9,684
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,845	124,493	3	1	-	1	105	-	14,253	3,258	10,995
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,799	127,152	3	1	-	1	232	-	12,275	3,749	8,526
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,853	129,007	3	1	-	1	200	1	13,546	3,349	10,198
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,896	128,688	3	1	-	1	152	-	14,025	3,265	10,760
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,865	131,085	3	1	-	1	329	-	12,385	3,785	8,600
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,270	117,658	4	1	-	1	639	3	13,960	2,409	11,551
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,295	115,120	5	1	-	1	688	-	15,285	2,191	13,094
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,308	119,758	4	1	-	1	672	-	14,451	2,227	12,224
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,400	121,919	4	1	-	1	672	1	15,799	1,844	13,955
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,434	121,339	4	1	-	1	553	-	16,351	1,747	14,604
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,453	123,759	4	1	-	1	929	-	14,921	2,109	12,813

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,155	125,724	4	-	1	-	398	2	12,224	3,397	8,827
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,175	121,871	4	1	-	1	292	-	13,247	3,643	9,604
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,142	127,208	3	1	-	1	233	-	12,289	3,782	8,507
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,182	129,100	3	1	-	1	208	1	13,550	3,387	10,163
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,219	125,934	4	1	-	1	413	-	13,113	3,634	9,479
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,193	131,166	3	1	-	1	338	-	12,402	3,815	8,587
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,869	121,385	5	-	1	-	974	2	13,380	2,715	10,665
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,875	117,961	5	1	-	1	690	-	14,293	2,863	11,430
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,860	122,845	4	1	-	1	663	-	13,518	2,919	10,599
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,924	124,466	4	1	-	1	615	1	14,436	2,640	11,795
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,957	123,978	4	1	-	1	504	-	14,967	2,527	12,440
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 11,954	126,901	4	1	-	1	736	-	13,630	2,899	10,730
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 11,975	121,172	5	-	1	-	950	2	14,316	2,637	11,680
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 11,970	120,329	5	-	1	-	633	-	15,983	2,344	13,639
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 11,960	122,928	5	-	1	-	1,012	-	14,164	2,766	11,397
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 12,029	126,361	4	-	1	-	585	1	15,609	2,238	13,371
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 12,055	123,646	5	-	1	-	850	-	15,335	2,429	12,906
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 12,053	128,802	4	-	1	-	706	-	14,797	2,500	12,297
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,578	121,409	3	1	-	1	399	3	12,834	3,306	9,528
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,623	118,799	4	1	-	1	317	-	14,218	3,057	11,161
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,618	121,455	4	1	-	1	584	-	12,519	3,449	9,069
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,685	123,608	4	1	-	1	571	1	13,835	2,995	10,840
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,723	123,029	4	1	-	1	465	-	14,336	2,901	11,435
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 11,724	127,735	3	-	-	2	387	-	13,122	3,170	9,952
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,405	121,379	3	-	-	2	379	3	12,360	3,548	8,812
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,484	121,258	3	-	-	2	110	-	14,813	2,917	11,896
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,476	123,998	3	-	-	2	257	-	12,998	3,306	9,692
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,540	125,686	3	-	-	2	231	1	13,917	3,009	10,908
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,576	125,025	3	-	-	2	169	-	14,383	2,923	11,460
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 11,580	127,578	3	-	-	2	378	-	12,869	3,317	9,552

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,829	126,941	2	1	-	1	88	3	15,230	2,349	12,881
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,875	122,221	3	1	-	1	128	-	15,648	2,470	13,178
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,851	124,754	3	1	-	1	282	-	13,800	2,862	10,938
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,920	126,775	3	1	-	1	260	1	15,120	2,461	12,659
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,959	126,411	3	1	-	1	196	-	15,608	2,377	13,231
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 11,947	128,699	3	1	-	1	409	-	14,057	2,780	11,277
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 11,870	132,238	-	-	-	2	33	3	17,418	1,840	15,578
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 11,972	129,400	1	1	-	1	6	-	19,178	1,613	17,565
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 11,900	132,157	1	1	-	1	29	-	16,924	1,949	14,975
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 11,996	134,149	1	1	-	1	21	1	18,399	1,583	16,816
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 12,059	133,816	1	1	-	1	13	-	18,936	1,582	17,355
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 11,990	138,787	-	-	-	2	18	-	17,412	1,751	15,660
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,575	117,457	5	1	-	1	1,130	3	11,634	3,734	7,900
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,585	117,240	5	1	-	1	638	-	13,836	3,113	10,723
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,584	119,895	5	1	-	1	1,014	-	12,176	3,520	8,656
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,647	121,841	5	1	-	1	1,014	1	13,401	3,126	10,275
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,679	121,313	5	1	-	1	861	-	13,920	3,015	10,904
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 11,690	123,785	5	1	-	1	1,337	-	12,514	3,425	9,089
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,409	117,457	5	1	-	1	1,130	3	11,634	3,734	7,900
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,419	117,240	5	1	-	1	638	-	13,836	3,113	10,723
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,418	119,895	5	1	-	1	1,014	-	12,176	3,520	8,656
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,482	121,841	5	1	-	1	1,014	1	13,401	3,126	10,275
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,513	121,313	5	1	-	1	861	-	13,920	3,015	10,904
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 11,524	123,785	5	1	-	1	1,337	-	12,514	3,425	9,089
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,729	120,362	4	-	-	1	567	3	12,657	3,267	9,389
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,750	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,741	121,979	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,805	123,958	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,840	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 11,841	126,394	4	1	-	1	710	-	13,325	3,060	10,265

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,729	120,362	4	-	-	1	567	3	12,657	3,267	9,389
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,755	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,744	122,711	4	-	-	1	601	-	13,359	3,032	10,326
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,808	123,886	4	-	-	1	563	1	13,895	2,862	11,033
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,844	123,429	4	-	-	1	458	-	14,403	2,762	11,641
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 11,844	126,322	4	-	-	1	684	-	13,099	3,115	9,984
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,719	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,741	119,409	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,732	121,979	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,796	123,958	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,831	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 11,832	126,394	4	1	-	1	710	-	13,325	3,060	10,265
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,706	120,220	3	5	-	1	509	2	13,630	3,186	10,444
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,727	117,235	4	5	-	1	640	-	13,971	3,171	10,800
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,718	122,517	3	5	-	1	546	-	13,148	3,205	9,942
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,784	124,625	3	5	-	1	509	1	14,476	2,775	11,701
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,827	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11,827	126,394	4	1	-	1	710	-	13,325	3,060	10,265
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 11,896	121,665	4	1	-	1	489	3	10,470	4,767	5,703
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 11,933	118,867	5	1	-	1	530	-	11,974	4,410	7,563
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 11,912	123,802	4	1	-	1	500	-	10,830	4,616	6,214
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 11,986	125,803	4	1	-	1	474	1	12,083	4,166	7,917
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 12,028	125,355	4	1	-	1	385	-	12,587	4,044	8,542
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 12,016	128,356	4	1	-	1	578	-	11,209	4,498	6,710
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,580	119,801	3	1	-	1	585	3	16,373	1,253	15,120
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,587	117,148	4	1	-	1	509	-	17,585	1,119	16,466
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,586	122,258	3	1	-	1	444	-	16,992	1,068	15,925
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,645	124,372	3	1	-	1	424	1	18,206	821	17,385
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,676	121,154	4	1	-	1	678	-	17,666	1,033	16,632
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 11,680	126,082	3	1	-	1	596	-	17,271	981	16,290

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21	(511)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12	2,059	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 76	4,038	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 111	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 112	6,474	-	-	-	-	116	(3)	859	(290)	1,149
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 16	(3,522)	1	-	-	-	23	(3)	464	(9)	473
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13	1,178	-	-	-	-	(2)	(3)	(375)	128	(503)
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 70	2,774	-	-	-	-	(43)	(2)	448	(173)	622
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 113	3,079	-	-	-	-	(112)	(3)	1,640	(475)	2,115
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 107	5,571	-	-	-	-	159	(3)	151	(93)	244
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13	(475)	-	(1)	-	-	(29)	(1)	334	(90)	423
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12	1,639	-	-	-	-	4	(3)	(54)	17	(71)
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 74	4,478	-	(1)	-	-	3	-	231	(163)	394
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 122	4,550	-	(1)	-	-	(151)	(3)	2,541	(724)	3,265
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 99	7,014	-	(1)	-	-	55	(3)	867	(364)	1,230
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 28	(2,494)	1	-	-	-	(60)	(3)	1,722	(357)	2,080
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19	2,826	-	-	-	-	(132)	(3)	872	(331)	1,204
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 60	5,037	-	-	-	-	(134)	(2)	1,601	(581)	2,182
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 95	1,818	1	-	-	-	151	(3)	1,134	(315)	1,449
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 103	6,894	-	-	-	-	65	(3)	662	(261)	923
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 37	(216)	-	1	-	-	(65)	(1)	1,212	(261)	1,473
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 27	2,470	-	1	-	-	209	(1)	(507)	143	(649)
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 58	4,692	-	1	-	-	216	(1)	73	(73)	147
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 88	4,379	-	1	-	-	108	(1)	83	(83)	166
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 109	6,616	-	1	-	-	497	(1)	(1,218)	348	(1,566)

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 14	(511)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 4	2,342	-	-	-	-	40	(3)	693	(236)	929
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 62	4,038	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 97	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 98	6,474	-	-	-	-	116	(3)	859	(290)	1,149
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 29	(511)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19	2,059	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 90	4,038	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 126	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 125	8,366	(1)	(1)	-	1	(197)	(3)	979	(392)	1,371
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 4	(255)	-	-	-	-	(496)	(3)	2,315	(629)	2,944
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 27	2,423	-	-	-	-	(102)	(3)	676	(263)	939
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 105	4,497	-	-	-	-	(70)	(2)	1,952	(655)	2,607
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 130	3,874	-	-	-	-	(236)	(3)	2,522	(769)	3,291
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 162	6,370	-	-	-	-	259	(3)	1,120	(398)	1,517
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 47	(3,589)	-	1	(1)	1	(140)	(2)	1,425	113	1,312
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 1	(929)	-	1	(1)	1	(13)	(2)	(554)	604	(1,158)
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 56	925	-	1	(1)	1	(45)	(1)	718	204	514
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 98	607	-	1	(1)	1	(94)	(2)	1,196	119	1,076
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 67	3,003	-	1	(1)	1	83	(2)	(444)	639	(1,084)
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 26	(2,538)	1	-	-	-	49	(3)	1,324	(219)	1,543
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 38	2,101	-	-	-	-	33	(3)	490	(182)	673
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 131	4,262	-	-	-	-	33	(2)	1,838	(566)	2,404
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 165	3,682	-	-	-	-	(86)	(3)	2,390	(663)	3,053
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 183	6,101	-	-	-	-	290	(3)	961	(300)	1,261

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 13	(1,484)	1	(1)	1	(1)	165	2	(65)	(386)	320
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 34	(5,337)	1	-	-	-	59	-	958	(139)	1,097
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 40	1,892	-	-	-	-	(25)	1	1,261	(395)	1,656
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 78	(1,274)	1	-	-	-	180	-	823	(148)	972
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 51	3,958	-	-	-	-	105	-	113	33	80
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 8	(1,460)	1	(1)	1	(1)	310	2	(139)	(204)	65
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 15	(4,884)	1	-	-	-	27	-	775	(56)	831
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 64	1,620	-	-	-	-	(48)	1	917	(279)	1,196
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 97	1,133	-	-	-	-	(160)	-	1,449	(392)	1,841
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 94	4,056	-	-	-	-	73	-	111	(20)	131
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 15	(1,756)	-	-	-	-	(62)	2	153	(130)	282
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10	(2,599)	-	-	-	-	(379)	-	1,820	(422)	2,242
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 69	3,433	(1)	-	-	-	(427)	1	1,446	(528)	1,974
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 96	718	-	-	-	-	(163)	-	1,171	(337)	1,509
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 93	5,874	(1)	-	-	-	(306)	-	634	(266)	899
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 45	(2,610)	1	-	-	-	(82)	(3)	1,383	(250)	1,633
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 40	46	1	-	-	-	186	(3)	(315)	143	(458)
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 107	2,199	1	-	-	-	172	(2)	1,001	(311)	1,313
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 145	1,620	1	-	-	-	66	(3)	1,502	(405)	1,907
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 145	6,326	-	(1)	-	1	(12)	(3)	287	(137)	424
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 79	(121)	-	-	-	-	(270)	(3)	2,453	(631)	3,084
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 71	2,619	-	-	-	-	(122)	(3)	638	(242)	880
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 135	4,308	-	-	-	-	(149)	(2)	1,557	(539)	2,095
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 172	3,646	-	-	-	-	(210)	(3)	2,023	(625)	2,647
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 175	6,199	-	-	-	-	(2)	(3)	509	(231)	740

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency		PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	46	(4,720)	1	-	-	-	40	(3)	418	122	297
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	21	(2,187)	1	-	-	-	194	(3)	(1,430)	513	(1,944)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	91	(166)	1	-	-	-	172	(2)	(110)	113	(222)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	129	(530)	1	-	-	-	108	(3)	378	28	350
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	118	1,758	1	-	-	-	321	(3)	(1,173)	432	(1,605)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	103	(2,838)	1	1	-	(1)	(27)	(3)	1,760	(227)	1,987
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	30	(81)	1	1	-	(1)	(4)	(3)	(494)	109	(603)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	126	1,912	1	1	-	(1)	(12)	(2)	982	(257)	1,238
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	189	1,578	1	1	-	(1)	(20)	(3)	1,519	(258)	1,777
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	120	6,549	-	-	-	-	(15)	(3)	(6)	(88)	83
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	10	(217)	-	-	-	-	(491)	(3)	2,202	(621)	2,823
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	9	2,438	-	-	-	-	(115)	(3)	541	(215)	756
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	73	4,384	-	-	-	-	(115)	(2)	1,767	(608)	2,375
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	104	3,856	-	-	-	-	(268)	(3)	2,285	(719)	3,004
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	115	6,328	-	-	-	-	208	(3)	880	(310)	1,189
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	10	(217)	-	-	-	-	(491)	(3)	2,202	(621)	2,823
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	9	2,438	-	-	-	-	(115)	(3)	541	(215)	756
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	73	4,384	-	-	-	-	(115)	(2)	1,767	(608)	2,375
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	104	3,856	-	-	-	-	(268)	(3)	2,285	(719)	3,004
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	115	6,328	-	-	-	-	208	(3)	880	(310)	1,189
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	22	(953)	-	1	-	-	(229)	(3)	1,922	(447)	2,370
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	12	1,617	-	1	-	-	44	(3)	203	(52)	254
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	77	3,596	-	1	-	-	23	(2)	1,464	(460)	1,924
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	112	3,147	-	1	-	-	(87)	(3)	1,971	(557)	2,528
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	113	6,032	-	1	-	-	143	(3)	669	(207)	876

Standard Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 27	(953)	-	1	-	-	(229)	(3)	1,922	(447)	2,370
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 16	2,349	-	-	-	-	33	(3)	702	(235)	937
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 79	3,524	-	-	-	-	(4)	(2)	1,239	(405)	1,644
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 115	3,067	-	-	-	-	(110)	(3)	1,746	(505)	2,251
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 115	5,960	-	-	-	-	116	(3)	443	(152)	595
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 22	(511)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 13	2,059	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 77	4,038	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 112	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 113	6,474	-	-	-	-	116	(3)	859	(290)	1,149
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 20	(2,985)	1	-	-	-	132	(2)	341	(15)	356
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 11	2,297	-	-	-	-	38	(2)	(483)	19	(502)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 78	4,405	-	-	-	-	1	(1)	846	(411)	1,257
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 120	3,289	1	(4)	-	-	(28)	(2)	997	(475)	1,473
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 121	6,174	1	(4)	-	-	202	(2)	(305)	(126)	(179)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 36	(2,798)	1	-	-	-	41	(3)	1,504	(357)	1,861
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 16	2,137	-	-	-	-	11	(3)	360	(152)	512
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 90	4,137	-	-	-	-	(15)	(2)	1,613	(602)	2,215
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 131	3,689	-	-	-	-	(104)	(3)	2,117	(723)	2,840
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 120	6,690	-	-	-	-	89	(3)	739	(269)	1,007
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 7	(2,652)	1	-	-	-	(76)	(3)	1,212	(134)	1,346
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 6	2,458	-	-	-	-	(141)	(3)	620	(185)	804
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 65	4,572	-	-	-	-	(161)	(2)	1,834	(432)	2,265
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 96	1,353	1	-	-	-	94	(3)	1,293	(220)	1,512
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 100	6,281	-	-	-	-	12	(3)	898	(272)	1,170

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,494	128,379	3	-	-	1	68.951	0	13455.4	3614	9,841
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,501	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,546	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,669	10,669	1	-	-	2	26.751	3	12970.5	3538.8	9,432
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,736	132,074	3	-	1	1	51.231	0	12682	3669.2	9,013
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,663	141,074	1	-	-	2	6.638	0	12838.9	3585.1	9,254
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,730	142,024	1	1	-	2	1.5293	1	14004.9	3244.6	10,760
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,783	135,938	3	-	1	1	54.917	0	13509.6	3488.1	10,021
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,724	147,161	-	1	-	2	1.0122	0	15164.3	2873.5	12,291
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,986	10,986	1	2	-	2	19.161	3	14326.6	3248.1	11,078
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	11,009	135,802	3	-	1	1	64.639	1	13638.9	3206.1	10,433
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,951	144,713	1	-	-	2	12.934	2	14006.3	3220.5	10,786
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	11,011	140,324	3	-	1	1	91.412	2	13025.8	3360.3	9,665
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	11,082	138,628	3	-	-	2	27.267	0	15153.1	3214.2	11,939
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	11,011	141,305	3	-	-	2	90.728	0	13055.9	3782.3	9,274
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,168	10,168	1	-	-	1	60.356	3	13819.7	3310.2	10,510
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,236	124,890	3	-	-	1	102.08	0	13712.4	3647.9	10,065
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,174	132,443	2	-	-	1	45.532	0	13713.9	3427.9	10,286
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,203	129,343	3	-	-	1	219.63	1	11801.8	4179.4	7,622
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,244	129,041	3	-	-	1	165.89	0	12257.1	4070.6	8,186
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,203	138,523	1	-	-	1	45.79	0	13502.6	3549.3	9,953
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	9,942	9,942	1	-	-	1	11.861	1	13473	3430.2	10,043
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,007	121,470	3	-	-	1	164.97	0	12342.1	4079.3	8,263
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	9,935	131,151	1	-	-	1	38.808	0	13319.5	3489.9	9,830
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	9,959	132,919	1	-	-	1	32.032	0	14016.2	3324.8	10,691
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	9,993	132,882	1	-	-	1	21.356	0	13909	3385.4	10,524
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	9,945	135,891	1	-	-	1	55.578	0	12198.3	3944.9	8,253

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,523	10,523	2	2	-	1	57.605	3	13640.7	3508.4	10,132
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,564	127,561	3	2	-	1	75.509	0	14201.5	3542.8	10,659
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,505	130,476	3	2	-	1	176.32	0	12119.5	4145.7	7,974
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,560	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,602	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,559	135,075	3	1	1	0	237.21	0	12247.8	3921.7	8,326
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,306	10,306	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,393	128,303	3	-	-	2	69.173	0	12047.4	4146	7,901
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,305	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,403	139,157	1	-	-	2	4.8586	1	13972.2	3292.9	10,679
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,464	132,174	3	-	-	2	97.398	0	12101.3	4131.5	7,970
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,385	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,494	128,379	3	-	-	1	68.951	0	13455.4	3614	9,841
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,501	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,546	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,494	128,379	3	-	-	1	68.951	0	13455.4	3614	9,841
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,501	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,546	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,049	11,049	1	-	-	2	49.036	3	13517.6	3015.1	10,502
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,108	124,865	3	-	-	1	87.224	0	14366.7	2920.6	11,446
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,068	126,964	3	2	-	1	212.95	0	13125.1	3330.9	9,794
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,163	128,735	3	1	-	1	166.78	1	13807.3	3124.2	10,683
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,210	128,628	3	2	-	1	135.01	0	14930.4	2865.3	12,065
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	11,182	131,028	3	2	-	1	299.54	0	13252.2	3351.2	9,901

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,751	9,751	-	-	-	2	8.4449	3	13562.1	3465.3	10,097
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,846	128,962	3	-	-	1	51.007	0	12918	4040.5	8,878
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,719	140,652	-	-	-	2	0.6202	0	13463.1	3538.7	9,924
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,787	142,380	-	-	-	2	0.1517	1	14795.6	3151.5	11,644
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,862	133,466	3	1	1	0	79.698	0	13306.9	3921.5	9,385
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	9,745	145,038	-	-	-	2	2.9225	0	13364.7	3663.4	9,701
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,580	10,580	2	2	-	1	56.195	3	14312.6	3053.5	11,259
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,605	127,343	3	2	-	1	73.057	0	14721.6	3189.7	11,532
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,541	130,289	3	2	-	1	173.04	0	12586.6	3832.7	8,754
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,614	131,760	3	2	-	1	143.52	1	13718	3529	10,189
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,656	131,440	3	2	-	1	106.61	0	14212.2	3404.1	10,808
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	10,611	133,904	3	2	-	1	252.45	0	12437.5	4024.2	8,413
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,712	10,712	3	2	-	1	315.33	3	12872.6	3519.2	9,353
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,717	127,109	3	2	-	1	70.197	0	15392	2872.7	12,519
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,650	130,062	3	2	-	1	169.56	0	13155.1	3528.6	9,626
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,726	131,582	3	2	-	1	141.04	1	14175.7	3304.3	10,871
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,764	131,251	3	2	-	1	104.59	0	14707.5	3169.5	11,538
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	10,716	133,737	3	2	-	1	250.12	0	12884.4	3805	9,079
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,228	10,228	-	-	-	2	13.188	3	13323	3682.5	9,640
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,349	131,614	1	-	-	2	2.0246	0	14535	3641.4	10,894
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,247	137,562	-	-	-	2	2.5074	0	13322.3	3684.6	9,638
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,341	139,527	-	-	-	2	0.1565	1	14748.5	3230	11,518
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,428	139,450	-	-	-	2	0.0213	0	15899.1	3073.9	12,825
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	10,328	142,389	-	-	-	2	3.6856	0	13508.7	3623.1	9,886
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,022	10,022	-	-	-	2	13.523	3	13094.7	3870.6	9,224
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,166	129,925	1	-	-	2	2.0627	0	14276.8	3855.6	10,421
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,065	135,982	-	-	-	2	2.5439	0	13089.1	3866.4	9,223
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,164	138,261	-	-	-	2	0.1565	1	14520.6	3392.4	11,128
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,258	138,144	-	-	-	2	0.0213	0	15676.5	3236.9	12,440
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	10,164	141,207	-	-	-	2	3.6921	0	13318.2	3768.4	9,550

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,537	136,664	-	-	-	2	1.4384	0	16568.7	2670.3	13,898
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,516	141,542	-	-	-	2	0.1565	1	15234.6	2834.9	12,400
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,595	141,213	-	-	-	2	0.0213	0	16434.6	2651.1	13,784
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,537	136,664	-	-	-	2	1.4384	0	16568.7	2670.3	13,898
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,516	141,542	-	-	-	2	0.1565	1	15234.6	2834.9	12,400
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,595	141,213	-	-	-	2	0.0213	0	16434.6	2651.1	13,784
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,338	10,338	4	1	1	0	306.51	2	11690.8	3874.6	7,816
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,376	124,864	4	2	-	1	223.35	0	13114.8	3952.1	9,163
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,330	130,476	3	2	-	1	176.32	0	12119.5	4145.7	7,974
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,384	130,087	4	1	1	0	362.97	1	12253.9	3875.9	8,378
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,427	129,646	4	1	1	0	289.25	0	13027.6	3714.7	9,313
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	10,394	132,653	4	1	1	0	448.15	0	11561.4	4226.5	7,335
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,180	10,180	5	1	1	0	680.64	2	10886.5	4295.3	6,591
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,218	122,635	5	2	-	1	458.95	0	12410.5	4260.6	8,150
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,178	126,392	5	1	1	0	701.34	0	11115.9	4356	6,760
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,229	127,749	5	1	1	0	689.06	1	11623.3	4189.9	7,433
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,269	127,263	5	1	1	0	570.86	0	12367.5	4032.1	8,335
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	10,244	129,762	5	1	1	0	952.81	0	10872	4571.6	6,300
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,494	128,379	3	-	-	1	68.951	0	13455.4	3614	9,841
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,505	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,551	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,494	128,379	3	-	-	1	68.951	0	13455.4	3614	9,841
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,509	132,519	3	-	-	1	133.15	1	12400.9	3938.1	8,463
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,555	132,249	3	-	-	1	97.239	0	13268.3	3709.7	9,559
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,427	10,427	-	-	-	2	13.079	3	13910.2	3196.3	10,714
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,488	127,561	3	2	-	1	75.509	0	14201.5	3542.8	10,659
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,422	140,186	-	-	-	2	2.4505	0	13870.5	3235.7	10,635
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,496	133,006	3	1	1	0	133.07	1	13193.1	3483.9	9,709
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,542	132,603	3	1	1	0	97.918	0	13999.1	3320.4	10,679
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	10,492	144,129	-	-	-	2	3.6768	0	13946.7	3234.2	10,712
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,422	10,422	2	2	-	1	63.014	3	13490.5	3556.3	9,934
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,478	127,561	3	2	-	1	75.509	0	14201.5	3542.8	10,659
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,419	130,476	3	2	-	1	176.32	0	12119.5	4145.7	7,974
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,489	131,828	3	2	-	1	145.84	1	13351.7	3765.2	9,586
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,533	131,537	3	2	-	1	108.78	0	13816.5	3677	10,140
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	10,491	133,970	3	2	-	1	254.78	0	12081.7	4269	7,813
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,554	10,554	1	-	-	2	32.056	3	11580.1	4569.5	7,011
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,628	129,177	3	-	-	1	52.504	0	12367.5	4499	7,868
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,550	138,598	1	-	-	2	6.5901	0	11545.4	4634.6	6,911
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,639	133,533	3	-	-	1	109.21	1	11270.7	4928.9	6,342
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,690	133,254	3	-	-	1	79.943	0	12171	4651.7	7,519
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	10,629	142,437	1	-	-	2	17.434	0	11696.5	4602.7	7,094
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,309	10,309	-	-	-	2	19.236	3	15974.9	1835.5	14,139
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,381	127,056	3	-	-	1	89.841	0	15251.6	2296.4	12,955
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,304	139,152	-	-	-	2	4.7453	0	15914.7	1873.6	14,041
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,383	131,354	3	1	1	0	166.28	1	15048.3	2210	12,838
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,424	130,986	3	1	1	0	122.34	0	15800	2093.7	13,706
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	10,371	142,896	-	-	-	2	5.5606	0	15965.4	1901	14,064

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 72	(11,807)	3	-	-	(1)	67	-	(415)	378	(793)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 79	(7,180)	3	1	1	(2)	131	1	(677)	248	(926)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 124	(7,583)	3	1	1	(2)	95	-	129	85	44
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 6	(130,405)	-	-	-	-	20	3	132	(46)	178
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 73	(9,000)	2	-	1	(1)	45	-	(157)	84	(241)
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 68	950	-	1	-	-	(5)	1	1,166	(340)	1,507
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 121	(5,136)	2	-	1	(1)	48	-	671	(97)	768
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 61	6,087	(1)	1	-	-	(6)	-	2,325	(712)	3,037
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 35	(133,727)	-	2	-	-	6	1	320	28	293
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 59	(8,911)	2	-	1	(1)	52	(1)	(367)	(14)	(353)
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 60	(4,389)	2	-	1	(1)	78	-	(981)	140	(1,120)
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 132	(6,085)	2	-	-	-	14	(2)	1,147	(6)	1,153
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 60	(3,408)	2	-	-	-	78	(2)	(950)	562	(1,512)
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 67	114,722	2	-	-	-	42	(3)	(107)	338	(445)
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 6	122,275	1	-	-	-	(15)	(3)	(106)	118	(223)
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 34	119,175	2	-	-	-	159	(2)	(2,018)	869	(2,887)
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 76	118,872	2	-	-	-	106	(3)	(1,563)	760	(2,323)
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 35	128,355	-	-	-	-	(15)	(3)	(317)	239	(556)
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 7	(121,209)	-	-	-	-	(27)	1	154	(60)	213
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 72	(9,681)	2	-	-	-	126	-	(977)	589	(1,567)
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 24	1,769	-	-	-	-	(7)	-	697	(165)	862
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 58	1,731	-	-	-	-	(17)	-	589	(104)	694
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10	4,741	-	-	-	-	17	-	(1,121)	455	(1,576)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18	(119,953)	(1)	-	-	-	(119)	3	1,521	(637)	2,159
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 59	(2,916)	-	-	-	-	(101)	-	2,082	(603)	2,685
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 55	2,529	-	(1)	1	(1)	(43)	1	1,074	(662)	1,735
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 97	2,127	-	(1)	1	(1)	(78)	-	1,880	(825)	2,705
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 54	4,599	-	(1)	1	(1)	61	-	128	(224)	352
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 1	(129,879)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 88	(11,883)	3	-	-	-	67	-	(1,823)	910	(2,733)
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 98	(1,028)	1	-	-	-	2	1	102	57	45
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 159	(8,012)	3	-	-	-	95	-	(1,769)	896	(2,665)
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 80	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 72	(11,807)	3	-	-	(1)	67	-	(415)	378	(793)
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 79	(7,180)	3	1	1	(2)	131	1	(677)	248	(926)
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 124	(7,583)	3	1	1	(2)	95	-	129	85	44
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 72	(11,807)	3	-	-	(1)	67	-	(415)	378	(793)
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 79	(7,180)	3	1	1	(2)	131	1	(677)	248	(926)
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 124	(7,583)	3	1	1	(2)	95	-	129	85	44
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 60	113,817	2	-	-	(1)	38	(3)	849	(94)	944
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 19	115,916	2	2	-	(1)	164	(3)	(392)	316	(708)
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 114	117,687	2	1	-	(1)	118	(2)	290	109	181
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 161	117,579	2	2	-	(1)	86	(3)	1,413	(150)	1,563
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 133	119,979	2	2	-	(1)	251	(3)	(265)	336	(601)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 32	(130,901)	-	-	-	-	8	3	99	(73)	173
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 127	(11,690)	3	-	-	(1)	50	-	(545)	502	(1,047)
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 68	1,728	-	-	-	-	(0)	1	1,333	(387)	1,720
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 143	(7,186)	3	1	1	(2)	79	-	(156)	383	(539)
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 26	4,386	-	-	-	-	2	-	(98)	125	(223)
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 39	(119,709)	(1)	-	-	-	(117)	3	1,726	(779)	2,505
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 64	(2,946)	-	-	-	-	(100)	-	2,135	(643)	2,778
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 73	1,472	-	-	-	-	(30)	1	1,131	(304)	1,435
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 115	1,151	-	-	-	-	(66)	-	1,626	(429)	2,054
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 69	3,615	-	-	-	-	79	-	(149)	191	(341)
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 62	(119,351)	-	-	-	-	146	3	(282)	(9)	(273)
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 67	(2,953)	-	-	-	-	(99)	-	2,237	(656)	2,893
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 76	1,520	-	-	-	-	(29)	1	1,021	(224)	1,245
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 114	1,188	-	-	-	-	(65)	-	1,552	(359)	1,912
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 66	3,675	-	-	-	-	81	-	(271)	276	(547)
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 122	121,387	1	-	-	-	(11)	(3)	1,212	(41)	1,253
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19	127,334	-	-	-	-	(11)	(3)	(1)	2	(3)
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 113	129,299	-	-	-	-	(13)	(2)	1,425	(453)	1,878
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 200	129,223	-	-	-	-	(13)	(3)	2,576	(609)	3,185
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 101	132,161	-	-	-	-	(10)	(3)	186	(59)	245
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 144	119,903	1	-	-	-	(11)	(3)	1,182	(15)	1,197
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 43	125,960	-	-	-	-	(11)	(3)	(6)	(4)	(1)
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 142	128,239	-	-	-	-	(13)	(2)	1,426	(478)	1,904
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 235	128,122	-	-	-	-	(14)	(3)	2,582	(634)	3,216
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 141	131,184	-	-	-	-	(10)	(3)	224	(102)	326

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 115	(3,521)	-	-	-	-	(1)	-	2,698	(565)	3,264
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 94	1,356	-	-	-	-	(2)	1	1,364	(401)	1,765
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 173	1,028	-	-	-	-	(2)	-	2,564	(585)	3,149
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 115	(3,521)	-	-	-	-	(1)	-	2,698	(565)	3,264
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 94	1,356	-	-	-	-	(2)	1	1,364	(401)	1,765
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 173	1,028	-	-	-	-	(2)	-	2,564	(585)	3,149
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 8	(120,138)	1	(1)	1	(1)	130	2	(429)	(271)	(158)
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 46	(5,613)	1	-	-	-	47	-	995	(194)	1,189
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 55	(389)	1	(1)	1	(1)	187	1	134	(270)	404
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 98	(830)	1	(1)	1	(1)	113	-	908	(431)	1,339
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 64	2,177	1	(1)	1	(1)	272	-	(558)	81	(639)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 2	(116,211)	-	-	-	-	(21)	2	(229)	(61)	(169)
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 40	(3,756)	-	1	(1)	1	(242)	-	1,295	(95)	1,390
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 51	1,357	-	-	-	-	(12)	1	507	(166)	674
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 91	871	-	-	-	-	(130)	-	1,252	(324)	1,575
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 66	3,371	-	-	-	-	251	-	(244)	216	(459)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 72	(11,807)	3	-	-	(1)	67	-	(415)	378	(793)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 83	(7,180)	3	1	1	(2)	131	1	(677)	248	(926)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 129	(7,583)	3	1	1	(2)	95	-	129	85	44
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 72	(11,807)	3	-	-	(1)	67	-	(415)	378	(793)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 87	(7,667)	3	-	-	(1)	131	1	(1,470)	702	(2,172)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 133	(7,937)	3	-	-	(1)	95	-	(602)	474	(1,076)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 5	(129,759)	-	-	-	-	11	3	40	(39)	79
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 66	(12,625)	3	2	-	(1)	73	-	331	307	24
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 74	(7,180)	3	1	1	(2)	131	1	(677)	248	(926)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 120	(7,583)	3	1	1	(2)	95	-	129	85	44
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 70	3,944	-	-	-	-	1	-	76	(1)	78
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 3	(120,055)	(1)	-	-	-	(113)	3	1,371	(589)	1,960
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 59	(2,916)	-	-	-	-	(101)	-	2,082	(603)	2,685
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 70	1,352	-	-	-	-	(30)	1	1,232	(380)	1,613
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 115	1,061	-	-	-	-	(68)	-	1,697	(469)	2,166
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 73	3,493	-	-	-	-	78	-	(38)	123	(161)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 3	(128,044)	-	-	-	-	25	3	35	(65)	100
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 78	(9,421)	2	-	-	(1)	46	-	822	(136)	958
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 88	(5,065)	2	-	-	(1)	103	1	(275)	294	(569)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 140	(5,344)	2	-	-	(1)	73	-	626	17	608
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 79	3,839	-	-	-	-	11	-	151	(32)	183
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 5	(128,843)	-	-	-	-	14	3	60	(38)	98
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 77	(12,097)	3	-	-	(1)	85	-	(663)	423	(1,086)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 79	(7,798)	3	1	1	(2)	162	1	(866)	336	(1,203)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 120	(8,166)	3	1	1	(2)	118	-	(115)	220	(335)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 68	3,743	-	-	-	-	1	-	51	27	23

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,490	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,479	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,525	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,663	140,575	-	-	-	2	9	3	14,075	3,147	10,928
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,730	131,913	3	-	1	1	53	-	12,567	3,715	8,853
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,656	143,226	-	-	-	2	3	-	13,881	3,202	10,680
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,724	142,067	1	-	-	2	2	1	14,011	3,221	10,789
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,777	135,606	3	-	1	1	58	-	13,386	3,534	9,852
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,717	147,189	-	-	-	2	1	-	15,169	2,845	12,324
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,984	140,096	1	2	-	2	20	3	14,713	3,145	11,568
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,006	135,644	3	-	1	1	66	1	13,520	3,250	10,270
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,946	144,613	1	-	-	2	13	2	13,862	3,268	10,594
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,008	140,071	3	-	1	1	95	2	12,911	3,407	9,504
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,079	138,299	3	-	-	2	29	-	15,017	3,258	11,759
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11,009	141,060	3	-	-	2	95	-	12,930	3,828	9,102
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,163	132,265	1	-	-	1	63	3	13,650	3,361	10,289
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,232	124,741	3	-	-	1	108	-	13,563	3,692	9,871
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,169	134,413	1	-	-	1	21	-	14,643	3,108	11,535
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,200	136,059	1	-	-	1	15	1	14,803	3,056	11,747
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,243	128,697	3	-	-	1	174	-	12,123	4,116	8,007
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,199	138,277	1	-	-	1	48	-	13,350	3,603	9,747
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 9,938	128,575	1	-	-	1	13	1	13,319	3,481	9,838
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,004	121,310	3	-	-	1	174	-	12,206	4,126	8,080
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 9,931	131,019	1	-	-	1	41	-	13,160	3,539	9,621
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 9,955	132,669	1	-	-	1	34	-	13,851	3,374	10,477
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 9,990	132,515	1	-	-	1	23	-	13,746	3,435	10,311
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 9,942	137,834	-	-	-	1	28	-	13,146	3,612	9,534

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,503	129,297	3	1	1	-	197	2	12,364	3,570	8,793
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,548	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,488	131,346	3	1	1	-	168	-	12,634	3,643	8,991
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,538	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,580	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,538	134,799	3	1	1	-	247	-	12,124	3,964	8,160
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,303	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,405	128,080	3	-	-	2	71	-	12,488	4,050	8,438
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,313	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,383	138,916	1	-	-	2	5	1	13,838	3,344	10,494
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,446	131,849	3	-	-	2	103	-	11,997	4,173	7,824
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,365	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,490	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,479	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,525	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,490	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,479	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,525	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,046	130,724	1	-	-	2	51	3	13,387	3,063	10,324
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,104	124,600	3	1	-	1	91	-	15,238	2,780	12,457
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,063	127,332	3	1	-	1	207	-	13,251	3,264	9,987
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,137	128,568	3	1	-	1	171	1	13,708	3,143	10,566
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,185	128,469	3	1	-	1	128	-	14,597	2,925	11,672
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 11,158	130,996	3	1	-	1	289	-	12,918	3,418	9,500

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,749	138,034	-	-	-	2	9	3	13,407	3,520	9,886
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,847	128,577	3	1	-	1	54	-	13,789	3,912	9,877
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,725	140,497	-	-	-	2	1	-	13,934	3,428	10,506
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,767	142,153	-	-	-	2	0	1	14,641	3,207	11,434
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,840	132,730	3	1	-	1	84	-	12,797	4,335	8,462
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 9,726	144,800	-	-	-	2	3	-	13,217	3,717	9,500
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,568	133,074	2	1	-	1	44	3	14,631	2,904	11,727
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,599	127,725	3	1	-	1	70	-	14,871	3,112	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,536	130,637	3	1	-	1	168	-	12,720	3,762	8,958
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,593	131,502	3	2	-	1	151	1	13,578	3,570	10,009
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,633	131,675	3	1	-	1	102	-	13,932	3,414	10,518
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 10,588	134,244	3	1	-	1	245	-	12,154	4,042	8,112
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,699	128,239	3	1	-	1	278	3	13,166	3,368	9,798
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,711	127,484	3	1	-	1	67	-	15,551	2,800	12,751
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,643	129,867	3	2	-	1	175	-	13,324	3,511	9,813
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,704	131,325	3	2	-	1	149	1	14,028	3,348	10,680
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,741	130,899	3	2	-	1	111	-	14,562	3,209	11,353
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10,695	133,474	3	2	-	1	261	-	12,753	3,850	8,903
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,226	134,941	-	-	-	2	14	3	13,174	3,737	9,436
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,370	131,652	1	-	-	2	2	-	15,115	3,507	11,607
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,256	137,684	-	-	-	2	3	-	13,824	3,541	10,283
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,322	139,245	-	-	-	2	0	1	14,598	3,281	11,317
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,408	139,013	-	-	-	2	0	-	15,746	3,124	12,621
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 10,309	142,096	-	-	-	2	4	-	13,369	3,669	9,700
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,021	133,295	-	-	-	2	14	3	12,945	3,926	9,019
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,193	130,114	1	-	-	2	2	-	14,852	3,719	11,133
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,081	136,262	-	-	-	2	3	-	13,589	3,720	9,869
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,145	137,967	-	-	-	2	0	1	14,370	3,444	10,926
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,238	137,685	-	-	-	2	0	-	15,523	3,287	12,235
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 10,145	140,905	-	-	-	2	4	-	13,176	3,818	9,359

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,559	136,508	-	-	-	2	1	-	17,155	2,576	14,579
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,495	141,311	-	-	-	2	0	1	15,083	2,887	12,196
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,574	140,840	-	-	-	2	0	-	16,279	2,702	13,578
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,559	136,508	-	-	-	2	1	-	17,155	2,576	14,579
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,495	141,311	-	-	-	2	0	1	15,083	2,887	12,196
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,574	140,840	-	-	-	2	0	-	16,279	2,702	13,578
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,319	126,986	4	1	1	-	320	2	11,568	3,920	7,648
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,362	125,690	4	1	1	-	208	-	13,603	3,481	10,122
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,315	128,470	4	1	1	-	411	-	11,664	4,056	7,608
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,364	129,814	4	1	1	-	378	1	12,133	3,917	8,215
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,407	129,301	4	1	1	-	302	-	12,904	3,755	9,149
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 10,373	134,799	3	1	1	-	247	-	12,124	3,964	8,160
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,162	124,220	5	1	1	-	705	2	10,774	4,340	6,434
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,199	123,385	5	1	1	-	429	-	12,849	3,838	9,011
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,159	126,180	5	1	1	-	727	-	11,000	4,403	6,597
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,210	127,480	5	1	1	-	716	1	11,511	4,233	7,278
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,250	126,928	5	1	1	-	594	-	12,254	4,074	8,180
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 10,225	129,489	5	1	1	-	985	-	10,768	4,612	6,156
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,494	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,484	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,529	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,499	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,426	140,010	-	-	-	2	3	-	14,342	3,123	11,220
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,488	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,534	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,424	137,625	-	-	-	2	14	3	13,761	3,249	10,512
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,485	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,425	131,346	3	1	1	-	168	-	12,634	3,643	8,991
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,475	132,736	3	1	1	-	140	1	13,061	3,526	9,534
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,520	132,251	3	1	1	-	103	-	13,863	3,362	10,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 10,472	143,900	-	-	-	2	4	-	13,804	3,284	10,520
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,417	132,303	2	2	-	1	66	3	13,342	3,599	9,743
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,480	128,484	3	1	1	-	69	-	14,739	3,030	11,709
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,416	130,250	3	2	-	1	182	-	12,372	4,056	8,316
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,468	131,571	3	2	-	1	154	1	13,212	3,807	9,404
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,512	131,173	3	2	-	1	115	-	13,679	3,718	9,961
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 10,471	133,705	3	2	-	1	266	-	11,957	4,312	7,645
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,551	136,077	1	-	-	2	33	3	11,443	4,629	6,815
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,632	128,766	3	1	-	1	55	-	13,374	4,274	9,100
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,554	138,422	1	-	-	2	7	-	11,994	4,499	7,495
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,616	133,065	3	1	-	1	117	1	11,576	4,912	6,664
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,667	132,679	3	1	-	1	86	-	12,472	4,634	7,839
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 10,608	144,670	-	-	-	2	3	-	12,758	4,102	8,656
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,307	137,143	-	-	1	1	20	3	16,410	1,560	14,850
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,365	127,077	3	1	1	-	91	-	16,462	1,925	14,537
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,306	139,463	-	-	1	1	5	-	16,887	1,511	15,375
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,363	131,078	3	1	1	-	174	1	14,921	2,249	12,672
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,403	130,644	3	1	1	-	129	-	15,671	2,131	13,540
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 10,352	143,062	-	-	1	1	6	-	16,270	1,692	14,578

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 65	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 55	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 100	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 7	(2,651)	-	-	-	-	6	3	194	(55)	249
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 75	(11,313)	3	-	1	(1)	51	-	(1,314)	513	(1,827)
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 68	(1,159)	1	-	-	-	(1)	1	129	20	110
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 121	(7,619)	3	-	1	(1)	55	-	(495)	332	(828)
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 61	3,963	-	-	-	-	(2)	-	1,288	(357)	1,644
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 38	(4,517)	-	2	-	-	7	1	851	(123)	974
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 59	(8,969)	2	-	1	(1)	53	(1)	(342)	(18)	(324)
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 62	(4,542)	2	-	1	(1)	81	-	(951)	140	(1,090)
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 133	(6,314)	2	-	-	-	15	(2)	1,156	(10)	1,165
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 63	(3,553)	2	-	-	-	81	(2)	(931)	560	(1,492)
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 69	(7,524)	2	-	-	-	45	(3)	(88)	331	(418)
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 6	2,148	-	-	-	-	(42)	(3)	993	(253)	1,246
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 37	3,794	-	-	-	-	(48)	(2)	1,152	(305)	1,458
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 80	(3,567)	2	-	-	-	111	(3)	(1,528)	754	(2,282)
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 36	6,012	-	-	-	-	(14)	(3)	(301)	241	(542)
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 7	(2,444)	-	-	-	-	(28)	1	160	(58)	218
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 73	(9,710)	2	-	-	-	133	-	(953)	587	(1,541)
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 24	1,650	-	-	-	-	(7)	-	691	(165)	856
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 59	1,496	-	-	-	-	(18)	-	586	(104)	691
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 11	6,815	(1)	-	-	-	(13)	-	(14)	73	(87)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 15	(2,049)	-	-	-	-	29	2	(271)	(73)	(198)
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 60	(2,862)	-	-	-	-	(99)	-	2,105	(613)	2,718
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 50	1,390	-	-	-	-	(28)	1	427	(117)	544
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 92	905	-	-	-	-	(65)	-	1,229	(281)	1,511
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 50	3,453	-	-	-	-	79	-	(510)	321	(831)
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 101	(9,545)	3	-	-	-	57	(3)	(1,273)	801	(2,074)
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 10	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 79	1,291	1	-	-	-	(8)	(2)	78	96	(18)
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 142	(5,775)	3	-	-	-	89	(3)	(1,764)	925	(2,689)
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 62	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 65	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 55	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 100	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 65	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 55	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 100	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 58	(6,124)	2	1	-	(1)	41	(3)	1,851	(283)	2,134
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 16	(3,392)	2	1	-	(1)	156	(3)	(136)	201	(337)
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 91	(2,156)	2	1	-	(1)	121	(2)	322	80	242
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 139	(2,255)	2	1	-	(1)	77	(3)	1,211	(138)	1,348
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 111	272	2	1	-	(1)	239	(3)	(469)	355	(824)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 24	(2,464)	-	-	-	-	8	3	(527)	93	(619)
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 122	(11,920)	3	1	-	(1)	53	-	(145)	485	(629)
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 43	1,656	-	-	-	-	(1)	1	707	(221)	928
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 115	(7,768)	3	1	-	(1)	83	-	(1,137)	908	(2,044)
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 1	4,302	-	-	-	-	3	-	(717)	289	(1,006)
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 32	2,437	(1)	-	-	-	(124)	3	1,910	(858)	2,768
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 63	(2,911)	-	-	-	-	(99)	-	2,151	(650)	2,800
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 57	865	-	1	-	-	(17)	1	858	(192)	1,050
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 98	1,038	-	-	-	-	(67)	-	1,212	(348)	1,559
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 52	3,607	-	-	-	-	77	-	(566)	280	(847)
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 55	(1,628)	-	(1)	-	-	102	3	(158)	(143)	(15)
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 68	(2,382)	-	(1)	-	-	(108)	-	2,227	(711)	2,938
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 61	1,459	-	-	-	-	(27)	1	704	(164)	867
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 98	1,032	-	-	-	-	(65)	-	1,238	(302)	1,540
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 51	3,607	-	-	-	-	85	-	(572)	339	(910)
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 144	(3,289)	1	-	-	-	(12)	(3)	1,941	(230)	2,171
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 29	2,743	-	-	-	-	(11)	(3)	650	(196)	846
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 95	4,304	-	-	-	-	(14)	(2)	1,424	(456)	1,880
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 182	4,072	-	-	-	-	(14)	(3)	2,572	(613)	3,185
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 83	7,156	-	-	-	-	(10)	(3)	195	(68)	263
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 172	(3,181)	1	-	-	-	(12)	(3)	1,907	(207)	2,114
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 60	2,967	-	-	-	-	(11)	(3)	644	(206)	850
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 123	4,672	-	-	-	-	(14)	(2)	1,425	(482)	1,907
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 217	4,391	-	-	-	-	(14)	(3)	2,578	(639)	3,217
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 124	7,610	-	-	-	-	(10)	(3)	231	(109)	340

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 135	(1,117)	-	-	-	-	(12)	(3)	3,394	(673)	4,066
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 71	3,686	-	-	-	-	(13)	(2)	1,322	(361)	1,684
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 150	3,215	-	-	-	-	(13)	(3)	2,518	(547)	3,065
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 135	(1,117)	-	-	-	-	(12)	(3)	3,394	(673)	4,066
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 71	3,686	-	-	-	-	(13)	(2)	1,322	(361)	1,684
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 150	3,215	-	-	-	-	(13)	(3)	2,518	(547)	3,065
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 4	(1,485)	-	-	-	-	(91)	2	(95)	(136)	41
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 47	(2,780)	-	-	-	-	(203)	-	1,940	(575)	2,515
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 49	1,344	-	-	-	-	(32)	1	469	(138)	607
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 92	831	-	-	-	-	(109)	-	1,241	(301)	1,542
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 58	6,328	(1)	-	-	-	(164)	-	461	(92)	552
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 3	(1,960)	-	-	-	-	(22)	2	(226)	(62)	(163)
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 40	(2,795)	-	-	-	-	(298)	-	1,849	(565)	2,414
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 51	1,301	-	-	-	-	(11)	1	511	(169)	681
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 90	748	-	-	-	-	(133)	-	1,254	(329)	1,583
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 66	3,309	-	-	-	-	258	-	(232)	210	(441)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 70	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 60	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 105	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 75	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 2	2,385	-	-	-	-	(11)	(3)	581	(126)	707
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 64	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 110	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 61	(9,141)	3	1	1	(2)	56	(3)	978	(218)	1,196
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 1	(6,279)	3	1	1	(2)	155	(3)	(1,127)	395	(1,521)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 50	(4,889)	3	1	1	(2)	126	(2)	(700)	278	(978)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 96	(5,373)	3	1	1	(2)	90	(3)	102	113	(11)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 48	6,276	-	-	-	-	(9)	(3)	43	36	8
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 1	2,053	(1)	-	-	-	(116)	3	970	(457)	1,427
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 64	(1,766)	-	(1)	1	(1)	(113)	-	2,368	(1,025)	3,393
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 52	1,321	-	-	-	-	(28)	1	840	(249)	1,089
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 96	923	-	-	-	-	(67)	-	1,308	(338)	1,646
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 55	3,455	-	-	-	-	84	-	(414)	256	(670)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 81	(7,310)	2	1	-	(1)	22	(3)	1,931	(355)	2,285
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 3	2,345	-	-	-	-	(26)	(3)	550	(130)	680
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 65	(3,012)	2	1	-	(1)	83	(2)	133	283	(150)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 115	(3,398)	2	1	-	(1)	52	(3)	1,029	5	1,024
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 57	8,593	(1)	-	-	-	(30)	(3)	1,314	(527)	1,841
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 1	(2,320)	-	-	-	-	15	3	(477)	48	(525)
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 59	(12,386)	3	1	-	(1)	86	-	(425)	413	(838)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 57	(8,384)	3	1	-	(1)	169	1	(1,966)	738	(2,704)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 97	(8,819)	3	1	-	(1)	124	-	(1,216)	619	(1,836)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 46	3,600	-	-	-	-	1	-	(617)	181	(798)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Import (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,472	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,416	134,526	2	1	-	1	34	-	13,770	3,489	10,281
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,658	139,817	-	-	-	2	11	3	14,063	3,184	10,879
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,714	130,129	3	2	-	1	68	-	13,893	3,618	10,276
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,646	142,431	-	-	-	2	3	-	13,331	3,405	9,926
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,713	134,157	3	2	-	1	114	1	12,805	3,942	8,863
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,760	133,945	3	2	-	1	78	-	14,096	3,572	10,524
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,701	146,325	-	-	-	2	2	-	14,570	3,036	11,534
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,960	141,398	1	-	1	1	9	2	15,087	2,497	12,589
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,996	134,715	3	-	1	1	74	1	13,077	3,416	9,661
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,934	145,311	-	1	-	2	16	2	14,110	3,203	10,907
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,001	138,785	3	1	1	1	112	2	12,374	3,668	8,705
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,070	137,852	3	-	1	1	37	-	14,814	3,186	11,628
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,006	140,482	3	-	1	1	112	-	12,774	3,760	9,014
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,156	131,379	1	-	-	1	72	3	13,025	3,551	9,474
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,232	123,772	3	-	-	1	132	-	12,997	3,867	9,130
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,162	133,501	1	-	-	1	26	-	13,982	3,297	10,685
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,192	135,171	1	-	-	1	19	1	14,680	3,088	11,593
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,245	127,788	3	-	-	1	208	-	11,977	4,149	7,828
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,196	137,908	1	-	-	1	37	-	13,469	3,551	9,918
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,931	127,586	1	-	-	1	17	1	13,302	3,503	9,799
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,998	120,697	3	-	1	-	206	-	12,156	3,939	8,217
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,919	132,414	-	1	-	1	13	-	13,751	3,360	10,392
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,945	131,373	1	1	-	1	46	-	13,067	3,641	9,426
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,982	131,327	1	1	-	1	31	-	12,975	3,702	9,273
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,930	136,571	-	1	-	1	36	-	12,332	3,909	8,424

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Import (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,481	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,531	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,476	130,644	3	-	1	-	193	-	12,279	3,744	8,534
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,521	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,564	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,526	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,335	134,601	1	-	-	2	46	3	14,024	3,306	10,717
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,408	126,893	3	1	-	1	90	-	13,699	3,664	10,035
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,341	136,870	1	-	-	2	14	-	14,560	3,210	11,350
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,409	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,452	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,398	143,042	-	-	-	2	6	-	15,027	3,052	11,975
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,472	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,416	134,526	2	1	-	1	34	-	13,770	3,489	10,281
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,472	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,416	134,526	2	1	-	1	34	-	13,770	3,489	10,281
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,034	123,573	3	1	-	1	373	3	12,167	3,634	8,533
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,082	123,417	3	1	-	1	113	-	14,627	2,953	11,673
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,046	126,148	3	1	-	1	243	-	12,682	3,431	9,250
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,121	128,124	3	1	-	1	209	1	14,002	3,037	10,965
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,165	127,723	3	1	-	1	158	-	14,477	2,961	11,517
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 11,143	130,132	3	1	-	1	340	-	12,847	3,454	9,393

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Import (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,755	134,743	1	1	-	1	39	3	13,803	3,595	10,208
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,834	127,527	3	1	-	1	70	-	13,145	4,110	9,036
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,727	137,214	1	1	-	1	9	-	14,332	3,523	10,810
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,777	138,982	1	-	-	1	6	1	15,330	3,204	12,126
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,829	132,522	3	-	1	-	101	-	12,780	4,084	8,696
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 9,746	141,634	1	1	-	1	13	-	14,172	3,697	10,475
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,548	131,965	2	1	-	1	55	3	13,883	3,139	10,744
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,579	126,663	3	1	-	1	87	-	14,222	3,307	10,914
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,521	129,545	3	1	-	1	200	-	12,120	3,948	8,173
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,574	130,949	3	1	-	1	169	1	13,249	3,644	9,606
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,614	130,610	3	1	-	1	127	-	13,740	3,516	10,224
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 10,573	133,072	3	1	-	1	289	-	12,019	4,146	7,873
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,679	128,030	3	-	1	-	209	2	14,101	2,982	11,120
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,689	126,413	3	1	-	1	84	-	14,885	2,985	11,900
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,628	129,184	3	1	-	1	201	-	12,926	3,600	9,325
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,684	130,768	3	1	-	1	166	1	13,693	3,418	10,275
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,720	130,415	3	1	-	1	125	-	14,226	3,276	10,950
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10,677	132,903	3	1	-	1	287	-	12,463	3,923	8,541
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,267	134,880	-	-	-	2	16	3	15,035	3,225	11,810
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,364	124,846	3	1	-	1	91	-	13,277	4,031	9,247
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,296	137,618	-	-	-	2	3	-	15,675	3,030	12,645
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,360	132,404	3	-	1	-	166	1	12,321	4,013	8,308
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,407	132,116	3	-	1	-	125	-	12,756	3,932	8,824
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 10,347	141,691	-	-	-	2	6	-	14,680	3,332	11,348
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,083	133,812	-	-	-	2	17	3	14,825	3,374	11,451
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,239	130,809	1	-	-	2	2	-	16,451	3,138	13,313
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,142	136,782	-	-	-	2	3	-	15,464	3,170	12,294
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,215	135,719	1	-	-	2	7	1	14,826	3,405	11,421
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,285	137,971	-	-	-	2	0	-	16,796	2,932	13,864
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 10,198	140,928	-	-	-	2	6	-	14,499	3,451	11,048

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Import (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,442	136,578	-	1	-	1	16	3	15,800	2,809	12,992
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,550	133,342	1	1	-	1	2	-	17,441	2,525	14,916
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,442	139,035	-	1	-	1	3	-	16,447	2,656	13,791
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,522	137,885	1	1	-	1	7	1	16,257	2,731	13,526
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,589	137,529	1	1	-	1	4	-	16,844	2,704	14,141
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 10,495	142,842	-	1	-	1	6	-	16,047	2,820	13,227
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,442	136,578	-	1	-	1	16	3	15,800	2,809	12,992
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,567	135,573	-	1	-	1	1	-	19,236	2,086	17,150
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,442	139,035	-	1	-	1	3	-	16,447	2,656	13,791
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,525	140,589	-	-	-	1	0	1	17,466	2,338	15,128
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,591	140,240	-	-	-	1	0	-	18,043	2,312	15,730
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 10,495	142,842	-	1	-	1	6	-	16,047	2,820	13,227
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,304	126,413	4	-	1	-	352	2	11,305	4,005	7,299
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,348	125,018	4	-	1	-	237	-	13,244	3,591	9,654
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,306	128,290	4	-	1	-	365	-	11,499	4,084	7,415
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,352	129,035	4	-	1	-	422	1	12,088	3,961	8,128
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,394	128,671	4	-	1	-	342	-	12,567	3,859	8,708
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 10,361	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,151	123,649	5	-	1	-	761	2	10,530	4,423	6,107
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,188	122,708	5	-	1	-	480	-	12,509	3,943	8,566
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,154	125,486	5	-	1	-	804	-	10,703	4,510	6,193
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,200	126,718	5	-	1	-	785	1	11,456	4,285	7,171
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,240	126,296	5	-	1	-	659	-	11,940	4,178	7,761
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 10,220	128,776	5	-	1	-	1,080	-	10,501	4,707	5,794
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,472	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,417	130,644	3	-	1	-	193	-	12,279	3,744	8,534
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO_2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,472	127,826	3	-	1	-	82	-	14,347	3,136	11,210
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,417	130,644	3	-	1	-	193	-	12,279	3,744	8,534
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,412	133,482	2	-	1	-	26	2	14,128	2,813	11,315
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,470	126,893	3	1	-	1	90	-	13,699	3,664	10,035
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,411	134,526	2	1	-	1	34	-	13,770	3,489	10,281
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,465	131,944	3	-	1	-	162	1	13,027	3,557	9,470
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,508	131,637	3	-	1	-	122	-	13,495	3,463	10,031
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 10,471	134,073	3	-	1	-	282	-	11,812	4,066	7,745
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,408	132,245	2	1	-	1	57	3	13,208	3,599	9,609
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,465	126,893	3	1	-	1	90	-	13,699	3,664	10,035
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,407	134,526	2	1	-	1	34	-	13,770	3,489	10,281
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,461	131,020	3	1	-	1	171	1	12,880	3,884	8,996
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,504	130,712	3	1	-	1	129	-	13,348	3,790	9,558
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 10,467	133,142	3	1	-	1	292	-	11,665	4,393	7,272
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,545	129,873	3	-	1	-	190	2	10,593	4,724	5,868
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,609	127,730	3	1	-	1	72	-	12,743	4,485	8,258
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,543	130,701	3	1	-	1	171	-	10,666	5,175	5,491
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,601	132,035	3	1	-	1	144	1	11,900	4,772	7,128
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,648	131,713	3	1	-	1	109	-	12,362	4,666	7,696
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 10,600	134,246	3	1	-	1	256	-	10,636	5,361	5,274
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,289	132,049	2	-	1	-	36	2	16,091	1,623	14,468
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,351	126,390	3	-	1	-	105	-	16,080	2,007	14,074
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,293	135,372	1	1	-	1	20	-	16,480	2,002	14,479
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,350	130,308	3	-	1	-	199	1	14,830	2,319	12,510
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,390	129,989	3	-	1	-	150	-	15,316	2,213	13,103
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10,349	139,825	1	-	1	-	39	-	16,553	1,801	14,751

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 60	(5,656)	1	-	-	-	55	(2)	218	323	(105)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 4	1,044	-	1	(1)	1	8	(2)	(358)	676	(1,034)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 53	(1,538)	1	-	-	-	136	(1)	(1,101)	744	(1,845)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 96	(1,845)	1	-	-	-	95	(2)	(634)	650	(1,284)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 59	591	1	-	-	-	256	(2)	(2,317)	1,253	(3,570)
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12	(2,614)	-	-	-	-	8	3	732	(221)	953
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 69	(12,303)	3	2	-	(1)	65	-	562	213	349
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 67	(8,274)	3	2	-	(1)	111	1	(526)	537	(1,063)
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 115	(8,487)	3	2	-	(1)	75	-	765	168	597
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 55	3,894	-	-	-	-	(1)	-	1,239	(369)	1,607
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 26	(3,914)	1	(1)	1	(1)	(7)	-	977	(705)	1,682
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 62	(10,596)	3	(1)	1	(1)	58	(1)	(1,033)	213	(1,246)
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 67	(6,526)	3	-	1	(1)	96	-	(1,736)	466	(2,202)
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 137	(7,459)	3	(1)	1	(1)	21	(2)	704	(17)	721
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 72	(4,829)	3	(1)	1	(1)	96	(2)	(1,336)	558	(1,894)
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 76	(7,607)	2	-	-	-	61	(3)	(29)	316	(345)
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 6	2,122	-	-	-	-	(45)	(3)	957	(254)	1,210
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 36	3,792	-	-	-	-	(52)	(2)	1,655	(463)	2,118
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 89	(3,591)	2	-	-	-	136	(3)	(1,048)	598	(1,646)
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 40	6,528	-	-	-	-	(35)	(3)	443	(0)	443
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12	(4,828)	1	(1)	-	-	4	1	(450)	143	(593)
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 79	(11,717)	3	(1)	1	(1)	193	-	(1,595)	579	(2,175)
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 25	(1,042)	1	-	-	-	33	-	(684)	282	(966)
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 62	(1,087)	1	-	-	-	18	-	(776)	342	(1,118)
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11	4,157	-	-	-	-	23	-	(1,419)	549	(1,968)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 5	2,838	(1)	-	-	-	(167)	2	1,850	(931)	2,781
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 55	(2,819)	-	-	-	-	(111)	-	2,068	(608)	2,676
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 45	1,299	-	-	-	-	(31)	1	748	(187)	935
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 88	993	-	-	-	-	(71)	-	1,216	(281)	1,497
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 51	3,428	-	-	-	-	89	-	(467)	322	(789)
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 73	(7,708)	2	1	-	(1)	44	(3)	(325)	358	(683)
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 6	2,270	-	-	-	-	(33)	(3)	536	(96)	632
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 74	(2,657)	2	-	1	(2)	116	(2)	(997)	251	(1,248)
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 117	(2,964)	2	-	1	(2)	76	(3)	(529)	157	(686)
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 63	8,441	(1)	-	-	-	(41)	(3)	1,003	(254)	1,257
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 60	(5,656)	1	-	-	-	55	(2)	218	323	(105)
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 4	1,044	-	1	(1)	1	8	(2)	(358)	676	(1,034)
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 53	(1,538)	1	-	-	-	136	(1)	(1,101)	744	(1,845)
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 96	(1,845)	1	-	-	-	95	(2)	(634)	650	(1,284)
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 59	591	1	-	-	-	256	(2)	(2,317)	1,253	(3,570)
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 60	(5,656)	1	-	-	-	55	(2)	218	323	(105)
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 4	1,044	-	1	(1)	1	8	(2)	(358)	676	(1,034)
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 53	(1,538)	1	-	-	-	136	(1)	(1,101)	744	(1,845)
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 96	(1,845)	1	-	-	-	95	(2)	(634)	650	(1,284)
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 59	591	1	-	-	-	256	(2)	(2,317)	1,253	(3,570)
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 48	(156)	-	-	-	-	(260)	(3)	2,460	(680)	3,140
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 12	2,576	-	-	-	-	(130)	(3)	515	(202)	717
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 87	4,552	-	-	-	-	(164)	(2)	1,835	(597)	2,432
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 131	4,151	-	-	-	-	(215)	(3)	2,310	(673)	2,984
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 108	6,559	-	-	-	-	(33)	(3)	680	(180)	859

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 29	(2,471)	-	-	-	-	30	3	(530)	73	(602)
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 108	(9,687)	2	-	-	-	60	-	(1,187)	587	(1,774)
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 50	1,768	-	(1)	-	-	(4)	1	998	(318)	1,316
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 102	(4,693)	2	(1)	1	(1)	92	-	(1,553)	561	(2,114)
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19	4,420	-	-	-	-	4	-	(160)	174	(334)
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 27	2,419	(1)	-	-	-	(145)	3	1,763	(809)	2,571
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 58	(2,883)	-	-	-	-	(112)	-	2,101	(641)	2,742
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 52	1,404	-	-	-	-	(31)	1	1,129	(304)	1,433
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 93	1,065	-	-	-	-	(73)	-	1,619	(431)	2,051
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 52	3,527	-	-	-	-	89	-	(102)	198	(300)
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 51	(1,155)	-	(1)	1	(1)	8	2	1,176	(619)	1,795
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 61	(2,772)	-	-	-	-	(116)	-	1,960	(615)	2,575
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 56	1,584	-	-	-	-	(34)	1	768	(182)	950
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 92	1,231	-	-	-	-	(76)	-	1,301	(325)	1,625
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 48	3,719	-	-	-	-	86	-	(462)	322	(785)
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 97	(10,033)	3	1	-	(1)	75	(3)	(1,757)	806	(2,564)
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 29	2,738	-	-	-	-	(13)	(3)	640	(195)	835
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 92	(2,476)	3	-	1	(2)	150	(2)	(2,714)	788	(3,502)
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 140	(2,764)	3	-	1	(2)	109	(3)	(2,279)	707	(2,986)
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 79	6,811	-	-	-	-	(11)	(3)	(355)	107	(462)
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 156	(3,003)	1	-	-	-	(14)	(3)	1,626	(236)	1,862
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 59	2,970	-	-	-	-	(14)	(3)	639	(205)	843
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 132	1,907	1	-	-	-	(9)	(2)	1	31	(30)
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 203	4,160	-	-	-	-	(17)	(3)	1,971	(443)	2,413
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 115	7,117	-	-	-	-	(11)	(3)	(327)	76	(403)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 109	(3,235)	1	-	-	-	(14)	(3)	1,640	(284)	1,924
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 0	2,457	-	-	-	-	(13)	(3)	647	(153)	800
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 80	1,307	1	-	-	-	(9)	(2)	456	(78)	534
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 147	952	1	-	-	-	(12)	(3)	1,044	(105)	1,149
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 53	6,264	-	-	-	-	(11)	(3)	247	11	236
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 125	(1,005)	-	-	-	-	(15)	(3)	3,435	(723)	4,158
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 0	2,457	-	-	-	-	(13)	(3)	647	(153)	800
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 83	4,011	-	(1)	-	-	(16)	(2)	1,665	(471)	2,136
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 149	3,662	-	(1)	-	-	(16)	(3)	2,242	(497)	2,739
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 53	6,264	-	-	-	-	(11)	(3)	247	11	236
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 44	(1,395)	-	-	-	-	(115)	(2)	1,939	(415)	2,354
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 2	1,877	-	-	-	-	13	(2)	195	79	116
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 48	2,622	-	-	-	-	70	(1)	784	(45)	828
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 90	2,258	-	-	-	-	(10)	(2)	1,262	(147)	1,408
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 57	7,660	(1)	-	-	-	(70)	(2)	507	61	446
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 38	(941)	-	-	-	-	(282)	(2)	1,980	(480)	2,459
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 3	1,837	-	-	-	-	43	(2)	173	88	85
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 49	3,069	-	-	-	-	23	(1)	926	(138)	1,064
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 89	2,647	-	-	-	-	(102)	(2)	1,410	(244)	1,654
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 69	5,127	-	-	-	-	319	(2)	(29)	284	(313)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 60	(5,656)	1	-	-	-	55	(2)	218	323	(105)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 5	(2,838)	1	-	-	-	167	(2)	(1,850)	931	(2,781)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 53	(1,538)	1	-	-	-	136	(1)	(1,101)	744	(1,845)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 96	(1,845)	1	-	-	-	95	(2)	(634)	650	(1,284)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 59	591	1	-	-	-	256	(2)	(2,317)	1,253	(3,570)

No Externalities/Carbon Cost Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 60	(5,656)	1	-	-	-	55	(2)	218	323	(105)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 5	(2,838)	1	-	-	-	167	(2)	(1,850)	931	(2,781)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 53	(1,538)	1	-	-	-	136	(1)	(1,101)	744	(1,845)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 96	(1,845)	1	-	-	-	95	(2)	(634)	650	(1,284)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 59	591	1	-	-	-	256	(2)	(2,317)	1,253	(3,570)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 0	(1,044)	-	(1)	1	(1)	(8)	2	358	(676)	1,034
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 58	(7,633)	1	-	-	-	56	-	(71)	176	(247)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 53	(2,583)	1	(1)	1	(1)	128	1	(743)	69	(812)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 97	(2,889)	1	(1)	1	(1)	88	-	(276)	(25)	(250)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 59	(454)	1	(1)	1	(1)	248	-	(1,959)	578	(2,536)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 2	(2,281)	-	-	-	-	23	3	(563)	110	(673)
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 58	(7,633)	1	-	-	-	56	-	(71)	176	(247)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 54	(3,506)	1	-	-	-	137	1	(890)	395	(1,285)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 97	(3,814)	1	-	-	-	95	-	(422)	301	(723)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 60	(1,384)	1	-	-	-	258	-	(2,105)	904	(3,009)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 2	(828)	-	(1)	1	(1)	19	2	(74)	(451)	377
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 67	(2,971)	-	-	-	-	(100)	-	2,077	(690)	2,767
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 58	1,333	-	-	-	-	(27)	1	1,234	(403)	1,637
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 105	1,012	-	-	-	-	(62)	-	1,696	(509)	2,205
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 57	3,544	-	-	-	-	85	-	(30)	186	(217)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 62	(5,659)	1	-	-	-	69	(2)	(11)	384	(395)
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 4	3,323	(1)	1	(1)	1	(17)	(2)	389	379	10
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 61	(1,741)	1	-	-	-	163	(1)	(1,262)	697	(1,958)
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 101	(2,060)	1	-	-	-	113	(2)	(775)	590	(1,365)
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 60	7,776	(1)	-	-	-	3	(2)	461	178	283

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,053	120,546	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,086	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,067	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,198	124,433	4	1	-	1	483	1	13,980	2,858	11,122
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,251	124,329	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,249	126,764	4	2	-	1	764	-	13,559	3,019	10,539
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,540	122,521	4	-	-	2	521	3	11,644	3,609	8,035
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,561	120,626	5	3	-	1	425	-	14,478	2,928	11,550
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,553	124,143	4	1	-	2	372	-	11,650	3,596	8,054
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,639	125,937	4	1	-	2	327	1	12,810	3,188	9,623
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,710	125,064	5	3	-	1	569	-	14,973	2,720	12,252
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,700	129,211	4	1	-	2	511	-	12,849	3,147	9,701
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,049	124,507	4	2	-	2	442	3	12,689	3,382	9,307
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,071	123,377	5	-	-	2	401	2	13,506	3,141	10,365
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,066	126,520	4	2	-	2	301	-	12,781	3,318	9,464
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,160	129,940	4	-	-	2	440	3	13,780	2,910	10,870
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,237	128,172	5	-	-	2	332	-	15,627	2,534	13,092
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,201	132,995	4	-	-	2	343	-	14,601	2,635	11,967
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,557	118,141	4	-	-	1	656	3	12,114	3,411	8,703
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,608	117,853	4	-	-	1	389	-	14,602	2,777	11,825
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,589	120,470	4	-	-	1	705	-	12,803	3,183	9,620
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,657	122,202	4	-	-	1	697	1	13,131	3,052	10,079
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,703	121,732	4	-	-	1	570	-	13,623	2,938	10,685
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,721	124,621	4	-	-	1	832	-	12,385	3,299	9,086
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,108	116,392	3	-	-	1	312	1	12,567	3,241	9,325
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,173	114,280	4	-	-	1	562	-	13,406	3,130	10,276
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,163	119,580	3	-	-	1	483	-	12,587	3,170	9,417
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,222	121,789	3	-	-	1	479	-	13,211	2,966	10,245
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,262	118,731	4	-	-	1	826	-	12,295	3,344	8,951
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,285	123,773	3	-	-	1	736	-	11,866	3,389	8,477

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,197	120,546	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,221	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,202	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,325	124,778	4	2	-	1	530	1	14,529	2,699	11,830
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,376	124,329	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,373	126,764	4	2	-	1	764	-	13,559	3,019	10,539
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,850	122,273	3	-	-	2	353	3	12,065	3,359	8,706
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,887	119,033	4	-	-	2	263	-	13,111	3,203	9,908
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 19,876	124,369	3	-	-	2	229	-	12,223	3,297	8,926
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,014	123,518	4	-	-	2	467	1	12,640	3,215	9,425
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,073	123,410	4	-	-	2	380	-	13,525	2,999	10,526
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 20,062	128,683	3	-	-	2	335	-	12,750	3,090	9,660
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,613	116,287	5	2	-	1	1,157	3	13,238	2,874	10,364
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,626	116,251	5	2	-	1	629	-	15,659	2,214	13,445
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,656	118,924	5	2	-	1	996	-	13,987	2,567	11,420
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,807	120,505	5	1	-	1	919	1	14,758	2,293	12,465
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,843	120,357	5	2	-	1	873	-	15,839	2,069	13,770
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21,889	122,879	5	2	-	1	1,340	-	14,414	2,437	11,977
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,413	125,323	3	2	-	1	358	3	12,144	3,872	8,273
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,478	125,296	3	2	-	1	89	-	14,739	3,149	11,589
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,402	127,992	3	2	-	1	203	-	12,722	3,647	9,075
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,512	129,698	3	1	-	1	162	1	13,364	3,427	9,937
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,581	129,452	3	2	-	1	129	-	14,478	3,164	11,314
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 18,528	132,423	3	1	-	1	271	-	12,984	3,587	9,396
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 20,961	115,977	5	2	-	1	1,148	3	13,318	2,763	10,554
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 20,990	115,958	5	2	-	1	622	-	15,701	2,098	13,602
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 21,014	118,647	5	2	-	1	987	-	14,045	2,457	11,588
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 21,176	120,252	5	1	-	1	907	1	14,833	2,211	12,622
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 21,223	120,090	5	2	-	1	861	-	15,919	1,981	13,938
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 21,259	124,636	4	2	-	1	852	-	15,298	2,010	13,288

Department Attachment 8

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,108	123,141	4	2	-	1	520	3	11,442	4,164	7,279
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,135	122,676	4	2	-	1	255	-	13,692	3,531	10,161
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,086	125,312	4	2	-	1	481	-	11,828	4,015	7,813
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,178	127,087	4	2	-	1	451	1	13,031	3,629	9,402
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,232	126,703	4	2	-	1	365	-	13,535	3,527	10,008
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 19,201	132,025	3	2	-	1	298	-	12,810	3,701	9,108
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,339	121,362	4	2	-	1	628	3	13,281	3,003	10,278
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,335	118,768	5	2	-	1	622	-	14,697	2,760	11,937
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,318	123,484	4	2	-	1	587	-	13,666	2,893	10,773
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,446	125,269	4	2	-	1	553	1	14,841	2,545	12,296
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,490	122,621	5	2	-	1	815	-	14,641	2,714	11,927
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 20,486	127,245	4	2	-	1	788	-	13,865	2,865	11,000
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,537	121,343	5	2	1	-	955	2	14,457	2,642	11,815
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,530	120,464	5	2	-	1	623	-	15,239	2,485	12,754
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,512	123,093	5	2	-	1	983	-	13,444	2,904	10,540
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,630	124,980	5	1	1	-	906	1	15,168	2,467	12,701
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,665	124,608	5	1	1	-	748	-	15,789	2,317	13,472
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 20,666	127,078	5	1	1	-	1,184	-	14,276	2,760	11,516
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,698	121,149	3	-	-	2	344	3	11,488	3,720	7,768
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,766	120,635	3	-	-	2	91	-	13,445	3,241	10,205
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,751	123,327	3	-	-	2	216	-	11,669	3,649	8,020
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,888	125,416	3	-	-	2	187	1	12,965	3,206	9,759
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,957	125,315	3	-	-	2	143	-	13,905	2,990	10,916
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 19,945	127,900	3	-	-	2	328	-	12,306	3,376	8,930
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,308	121,117	3	-	-	2	337	3	11,056	3,977	7,079
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,393	120,458	3	-	-	2	86	-	13,014	3,474	9,539
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,393	123,263	3	-	-	2	208	-	11,240	3,904	7,336
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,538	125,316	3	-	-	2	180	1	12,585	3,434	9,152
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,611	125,079	3	-	-	2	138	-	13,529	3,193	10,335
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 19,612	127,780	3	-	-	2	322	-	11,946	3,585	8,361

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,256	129,417	1	-	-	2	65	3	14,776	2,415	12,360
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,333	123,077	3	2	-	1	109	-	16,117	2,368	13,750
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,288	131,734	1	-	-	2	22	-	14,877	2,401	12,476
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,425	127,243	3	1	-	1	204	1	14,938	2,521	12,416
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,486	127,234	3	2	-	1	170	-	16,047	2,285	13,762
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 20,462	129,595	3	2	-	1	366	-	14,463	2,678	11,785
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,275	132,264	-	-	-	2	28	3	15,983	2,071	13,913
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,424	131,801	-	-	-	2	2	-	18,375	1,757	16,617
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,308	134,655	-	-	-	2	7	-	16,056	2,059	13,997
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,479	136,498	-	-	-	2	3	1	17,488	1,683	15,805
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,592	136,578	-	-	-	2	2	-	18,552	1,583	16,968
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 20,486	139,232	-	-	-	2	14	-	16,452	1,863	14,589
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,764	118,065	5	2	-	1	1,097	3	11,929	3,652	8,277
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,784	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,778	120,728	5	2	-	1	922	-	12,552	3,402	9,150
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,907	122,304	5	1	-	1	850	1	13,300	3,152	10,148
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,953	122,112	5	2	-	1	780	-	14,298	2,906	11,393
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 19,965	124,630	5	2	-	1	1,228	-	12,867	3,315	9,552
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,461	118,065	5	2	-	1	1,097	3	11,929	3,652	8,277
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,482	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,476	120,728	5	2	-	1	922	-	12,552	3,402	9,150
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,605	122,304	5	1	-	1	850	1	13,300	3,152	10,148
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,651	122,112	5	2	-	1	780	-	14,298	2,906	11,393
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 19,663	124,630	5	2	-	1	1,228	-	12,867	3,315	9,552
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,078	120,546	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,107	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,088	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,208	124,433	4	1	-	1	483	1	13,980	2,858	11,122
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,268	122,572	5	1	-	1	726	-	14,488	2,828	11,660
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 20,265	127,234	4	1	-	1	721	-	13,747	2,940	10,807

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,094	121,745	4	-	-	1	488	3	12,799	3,129	9,669
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,124	118,580	5	-	-	1	508	-	13,734	3,027	10,707
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,109	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,218	124,433	4	1	-	1	483	1	13,980	2,858	11,122
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,277	122,572	5	1	-	1	726	-	14,488	2,828	11,660
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 20,274	127,234	4	1	-	1	721	-	13,747	2,940	10,807
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,028	120,546	4	2	-	1	578	3	12,783	3,273	9,509
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,065	118,071	5	2	-	1	572	-	14,242	3,002	11,240
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,047	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,180	124,778	4	2	-	1	530	1	14,529	2,699	11,830
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,231	124,329	4	2	-	1	429	-	15,034	2,609	12,424
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 20,228	126,764	4	2	-	1	764	-	13,559	3,019	10,539
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,001	118,225	4	5	-	1	823	2	12,378	3,567	8,811
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,040	118,195	4	6	-	1	575	-	14,451	3,041	11,410
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,026	122,839	4	2	-	1	550	-	13,259	3,101	10,158
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,143	122,756	4	6	-	1	935	1	13,936	3,034	10,902
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,206	122,249	4	6	-	1	787	-	14,459	2,919	11,540
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 20,207	126,764	4	2	-	1	764	-	13,559	3,019	10,539
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,351	119,690	5	2	-	1	956	3	10,066	5,038	5,028
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,401	119,682	5	2	-	1	471	-	12,395	4,276	8,119
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,373	122,462	5	2	-	1	782	-	10,618	4,783	5,834
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,512	124,047	5	1	-	1	721	1	11,303	4,543	6,760
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,569	123,844	5	2	-	1	653	-	12,357	4,225	8,132
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 20,561	128,695	4	2	-	1	631	-	11,475	4,434	7,041
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,814	118,284	4	2	-	1	799	3	15,868	1,427	14,440
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,820	118,032	4	2	-	1	456	-	17,985	1,059	16,925
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,823	120,471	4	2	-	1	765	-	16,333	1,302	15,031
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,941	122,097	4	1	-	1	684	1	17,119	1,078	16,041
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,984	122,039	4	2	-	1	617	-	18,044	972	17,073
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 19,999	127,013	3	2	-	1	545	-	17,635	920	16,714

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 33	(2,475)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 15	2,293	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 146	3,886	-	(1)	-	-	(95)	(2)	1,198	(415)	1,613
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 199	3,783	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 196	6,218	-	-	-	-	187	(3)	776	(254)	1,030
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 21	(1,895)	1	3	-	(1)	(97)	(3)	2,833	(681)	3,514
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13	1,622	-	1	-	-	(150)	(3)	5	(13)	18
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 99	3,416	-	1	-	-	(195)	(2)	1,166	(421)	1,587
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 170	2,543	1	3	-	(1)	48	(3)	3,328	(889)	4,217
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 161	6,690	-	1	-	-	(10)	(3)	1,204	(462)	1,666
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 23	(1,130)	1	(2)	-	-	(40)	(1)	818	(241)	1,058
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 17	2,013	-	-	-	-	(141)	(3)	92	(64)	157
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 111	5,433	-	(2)	-	-	(1)	-	1,092	(472)	1,563
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 188	3,665	1	(2)	-	-	(110)	(3)	2,938	(848)	3,785
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 153	8,488	-	(2)	-	-	(99)	(3)	1,912	(747)	2,660
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 51	(288)	-	-	-	-	(268)	(3)	2,489	(634)	3,122
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 32	2,329	-	-	-	-	49	(3)	689	(227)	917
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 100	4,061	-	-	-	-	41	(2)	1,017	(359)	1,376
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 146	3,591	-	-	-	-	(87)	(3)	1,509	(473)	1,982
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 164	6,480	-	-	-	-	175	(3)	271	(112)	383
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 65	(2,111)	1	-	-	-	250	(1)	839	(112)	951
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 55	3,188	-	-	-	-	171	(1)	20	(72)	92
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 114	5,397	-	-	-	-	167	(1)	644	(276)	920
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 154	2,339	1	-	-	-	514	(1)	(272)	102	(374)
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 177	7,381	-	-	-	-	424	(1)	(700)	147	(848)

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 24	(2,475)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 5	2,293	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 129	4,231	-	-	-	-	(48)	(2)	1,747	(574)	2,321
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 179	3,783	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 176	6,218	-	-	-	-	187	(3)	776	(254)	1,030
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 37	(3,240)	1	-	-	-	(90)	(3)	1,046	(156)	1,202
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 26	2,096	-	-	-	-	(124)	(3)	157	(62)	219
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 163	1,245	1	-	-	-	113	(2)	575	(144)	719
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 223	1,137	1	-	-	-	27	(3)	1,460	(360)	1,820
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 212	6,410	-	-	-	-	(18)	(3)	684	(269)	954
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13	(37)	-	-	-	-	(529)	(3)	2,421	(660)	3,081
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 43	2,636	-	-	-	-	(161)	(3)	749	(307)	1,056
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 195	4,218	-	(1)	-	-	(238)	(2)	1,520	(581)	2,101
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 230	4,070	-	-	-	-	(284)	(3)	2,602	(805)	3,407
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 276	6,591	-	-	-	-	182	(3)	1,176	(437)	1,613
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 10	(2,669)	-	-	-	-	155	3	(578)	225	(803)
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 76	(2,696)	-	-	-	-	(115)	-	2,017	(498)	2,514
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 110	1,706	-	(1)	-	-	(42)	1	642	(220)	862
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 179	1,460	-	-	-	-	(74)	-	1,756	(483)	2,239
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 126	4,431	-	(1)	-	-	68	-	262	(59)	321
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 30	(19)	-	-	-	-	(526)	(3)	2,383	(665)	3,048
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 53	2,670	-	-	-	-	(161)	(3)	728	(306)	1,034
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 216	4,276	-	(1)	-	-	(241)	(2)	1,515	(552)	2,067
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 263	4,113	-	-	-	-	(287)	(3)	2,601	(782)	3,383
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 298	8,660	(1)	-	-	-	(296)	(3)	1,981	(754)	2,734

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 23	(2,171)	-	-	-	-	40	3	(386)	148	(534)
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 49	(2,636)	-	-	-	-	(226)	-	1,864	(484)	2,348
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 93	1,775	-	-	-	-	(29)	1	1,204	(386)	1,590
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 146	1,392	-	-	-	-	(115)	-	1,707	(488)	2,196
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 115	6,713	(1)	-	-	-	(183)	-	982	(314)	1,295
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 21	(2,122)	-	-	-	-	42	3	(385)	110	(495)
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 17	(4,716)	1	-	-	-	36	-	1,031	(133)	1,164
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 128	1,785	-	-	-	-	(34)	1	1,175	(348)	1,523
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 172	(863)	1	-	-	-	228	-	975	(179)	1,154
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 168	3,761	-	-	-	-	201	-	199	(28)	227
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 25	(1,750)	-	-	1	(1)	(27)	2	1,013	(262)	1,275
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 18	(2,629)	-	-	-	-	(359)	-	1,795	(420)	2,215
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 118	1,888	-	(1)	1	(1)	(77)	1	1,724	(437)	2,161
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 153	1,515	-	(1)	1	(1)	(235)	-	2,345	(588)	2,933
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 154	3,985	-	(1)	1	(1)	202	-	832	(145)	977
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 68	(514)	-	-	-	-	(254)	(3)	1,957	(479)	2,437
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 53	2,178	-	-	-	-	(128)	(3)	181	(71)	252
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 190	4,267	-	-	-	-	(157)	(2)	1,477	(514)	1,992
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 259	4,166	-	-	-	-	(201)	(3)	2,417	(730)	3,148
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 247	6,751	-	-	-	-	(16)	(3)	818	(344)	1,163
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 85	(660)	-	-	-	-	(251)	(3)	1,958	(503)	2,461
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 85	2,145	-	-	-	-	(128)	(3)	184	(73)	257
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 230	4,199	-	-	-	-	(156)	(2)	1,529	(544)	2,073
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 303	3,961	-	-	-	-	(199)	(3)	2,472	(784)	3,257
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 305	6,663	-	-	-	-	(15)	(3)	890	(393)	1,283

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 77	(6,340)	2	2	-	(1)	44	(3)	1,342	(48)	1,389
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 32	2,317	-	-	-	-	(43)	(3)	102	(14)	116
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 169	(2,174)	2	1	-	(1)	139	(2)	162	106	56
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 230	(2,183)	2	2	-	(1)	105	(3)	1,271	(130)	1,402
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 206	178	2	2	-	(1)	301	(3)	(313)	263	(576)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 148	(464)	-	-	-	-	(26)	(3)	2,391	(313)	2,705
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 33	2,391	-	-	-	-	(21)	(3)	72	(12)	84
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 203	4,234	-	-	-	-	(25)	(2)	1,504	(388)	1,892
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 317	4,314	-	-	-	-	(27)	(3)	2,568	(487)	3,056
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 210	6,968	-	-	-	-	(14)	(3)	469	(208)	677
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 20	6	-	-	-	-	(525)	(3)	2,313	(650)	2,963
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 14	2,662	-	-	-	-	(175)	(3)	623	(250)	873
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 143	4,238	-	(1)	-	-	(248)	(2)	1,371	(500)	1,871
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 190	4,046	-	-	-	-	(317)	(3)	2,369	(746)	3,115
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 202	6,565	-	-	-	-	131	(3)	938	(337)	1,275
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 20	6	-	-	-	-	(525)	(3)	2,313	(650)	2,963
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 14	2,662	-	-	-	-	(175)	(3)	623	(250)	873
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 143	4,238	-	(1)	-	-	(248)	(2)	1,371	(500)	1,871
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 190	4,046	-	-	-	-	(317)	(3)	2,369	(746)	3,115
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 202	6,565	-	-	-	-	131	(3)	938	(337)	1,275
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 29	(2,475)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 10	2,293	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 130	3,886	-	(1)	-	-	(95)	(2)	1,198	(415)	1,613
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 190	2,026	1	(1)	-	-	148	(3)	1,705	(445)	2,150
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 186	6,688	-	(1)	-	-	143	(3)	964	(334)	1,298

Societal Discount Modeling Approach, Energy Efficiency +11 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 30	(3,166)	1	-	-	-	20	(3)	936	(102)	1,038
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 15	1,094	-	2	-	-	62	(3)	461	(28)	488
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 123	2,687	-	1	-	-	(5)	(2)	1,182	(271)	1,453
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 183	826	1	1	-	-	238	(3)	1,689	(301)	1,990
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 180	5,489	-	1	-	-	233	(3)	948	(190)	1,138
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 38	(2,475)	1	-	-	-	(5)	(3)	1,459	(271)	1,731
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 19	2,293	-	-	-	-	(27)	(3)	477	(172)	648
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 153	4,231	-	-	-	-	(48)	(2)	1,747	(574)	2,321
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 203	3,783	-	-	-	-	(149)	(3)	2,251	(664)	2,915
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 200	6,218	-	-	-	-	187	(3)	776	(254)	1,030
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 40	(30)	-	1	-	-	(248)	(2)	2,073	(526)	2,599
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 25	4,614	-	(3)	-	-	(273)	(2)	881	(466)	1,347
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 143	4,531	-	1	-	-	113	(1)	1,558	(533)	2,091
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 205	4,024	-	1	-	-	(35)	(2)	2,081	(648)	2,729
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 207	8,539	-	(3)	-	-	(58)	(2)	1,181	(548)	1,728
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 50	(7)	-	-	-	-	(485)	(3)	2,329	(762)	3,091
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 22	2,772	-	-	-	-	(174)	(3)	551	(255)	806
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 161	4,358	-	(1)	-	-	(234)	(2)	1,237	(495)	1,732
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 218	4,154	-	-	-	-	(303)	(3)	2,291	(813)	3,104
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 210	9,005	(1)	-	-	-	(324)	(3)	1,409	(603)	2,012
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 6	(253)	-	-	-	-	(342)	(3)	2,117	(368)	2,485
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 9	2,187	-	-	-	-	(34)	(3)	465	(126)	590
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 127	3,812	-	(1)	-	-	(114)	(2)	1,251	(350)	1,601
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 170	3,754	-	-	-	-	(182)	(3)	2,176	(456)	2,632
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 185	8,728	(1)	-	-	-	(254)	(3)	1,767	(507)	2,274

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,030	121,157	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,070	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,053	123,128	4	1	-	1	531	-	13,377	3,040	10,337
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,146	124,299	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,202	124,268	4	1	-	1	402	-	14,766	2,658	12,108
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,199	126,655	4	1	-	1	731	-	13,282	3,070	10,211
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,511	120,994	5	3	-	1	889	3	12,849	3,396	9,453
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,514	120,364	5	3	-	1	443	-	14,353	2,965	11,389
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,515	122,952	5	3	-	1	721	-	12,826	3,377	9,450
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,601	126,258	4	3	-	1	375	1	13,997	2,926	11,070
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,664	124,844	5	3	-	1	592	-	14,853	2,755	12,098
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,660	129,495	4	3	-	1	571	-	14,025	2,887	11,138
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,032	124,554	4	2	-	2	454	3	12,943	3,299	9,644
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,057	123,109	5	-	-	2	414	2	13,402	3,175	10,227
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,045	126,245	4	2	-	2	311	-	12,687	3,353	9,334
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,147	129,697	4	-	-	2	452	3	13,674	2,950	10,724
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,223	127,948	5	-	-	2	345	-	15,513	2,569	12,944
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,188	132,716	4	-	-	2	354	-	14,489	2,673	11,816
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,543	117,879	4	-	-	1	677	3	11,997	3,455	8,542
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,592	117,585	4	-	-	1	404	-	14,471	2,818	11,653
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,575	120,203	4	-	-	1	728	-	12,681	3,227	9,453
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,643	121,965	4	-	-	1	721	1	13,010	3,094	9,916
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,689	121,499	4	-	-	1	590	-	13,502	2,978	10,525
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,709	124,345	4	-	-	1	858	-	12,274	3,337	8,937
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,093	116,123	3	-	-	1	325	1	12,447	3,286	9,162
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,158	114,011	4	-	-	1	583	-	13,282	3,168	10,115
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,147	118,519	3	2	-	1	551	-	12,152	3,374	8,778
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,206	120,742	3	2	-	1	559	-	12,744	3,160	9,584
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,249	121,271	3	-	-	1	406	-	13,081	3,000	10,081
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,272	123,492	3	-	-	1	760	-	11,750	3,432	8,318

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,174	121,157	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,204	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,186	122,968	4	2	-	1	577	-	13,494	3,019	10,475
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,278	124,548	4	2	-	1	550	1	14,402	2,736	11,666
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,328	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,327	126,491	4	2	-	1	789	-	13,442	3,057	10,386
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,839	122,001	3	-	-	2	363	3	11,961	3,400	8,561
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,895	119,126	4	-	-	2	274	-	13,478	3,137	10,340
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,875	124,516	3	-	-	2	240	-	12,516	3,222	9,293
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19,972	123,273	4	-	-	2	483	1	12,542	3,251	9,291
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,031	123,174	4	-	-	2	394	-	13,426	3,034	10,392
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20,020	128,399	3	-	-	2	347	-	12,652	3,129	9,523
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,594	116,827	5	1	-	1	1,043	3	13,468	2,745	10,723
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,615	116,520	5	1	-	1	595	-	15,775	2,158	13,617
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,644	119,179	5	1	-	1	955	-	14,105	2,510	11,595
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,753	120,357	5	1	-	1	934	1	14,677	2,307	12,369
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,793	120,127	5	2	-	1	903	-	15,722	2,102	13,619
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 21,839	122,698	5	1	-	1	1,266	-	14,164	2,473	11,691
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,384	125,940	3	1	-	1	317	3	12,377	3,742	8,634
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,460	125,588	3	1	-	1	84	-	14,860	3,084	11,776
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,384	128,281	3	1	-	1	197	-	12,842	3,582	9,260
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,463	129,598	3	1	-	1	166	1	13,263	3,446	9,817
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,529	129,606	3	1	-	1	123	-	14,150	3,221	10,929
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 18,477	132,024	3	1	-	1	280	-	12,456	3,737	8,720
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 20,937	116,519	5	1	-	1	1,034	3	13,548	2,634	10,915
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 20,976	116,228	5	1	-	1	589	-	15,817	2,041	13,776
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 20,998	118,903	5	1	-	1	947	-	14,164	2,398	11,766
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 21,124	120,106	5	1	-	1	920	1	14,751	2,225	12,526
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 21,170	119,915	5	1	-	1	798	-	15,668	2,018	13,651
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 21,206	124,435	4	1	-	1	805	-	15,015	2,043	12,973

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,083	123,750	4	1	-	1	454	3	11,663	4,048	7,616
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,119	122,960	4	1	-	1	240	-	13,803	3,469	10,334
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,070	125,597	4	1	-	1	462	-	11,934	3,960	7,974
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,130	126,895	4	1	-	1	433	1	12,394	3,808	8,586
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,185	126,846	4	1	-	1	347	-	13,250	3,581	9,669
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 19,153	132,083	3	1	-	1	288	-	12,476	3,762	8,714
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,301	121,976	5	1	1	-	910	2	13,630	2,652	10,978
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,320	119,042	5	1	-	1	586	-	14,810	2,707	12,102
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,300	123,534	4	2	-	1	604	-	13,854	2,834	11,020
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,398	125,041	4	2	-	1	574	1	14,717	2,578	12,139
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,443	124,508	5	1	1	-	784	-	15,036	2,405	12,631
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 20,439	126,982	4	2	-	1	814	-	13,750	2,900	10,850
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,494	121,761	5	1	1	-	888	2	14,603	2,576	12,028
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,497	121,034	5	1	1	-	574	-	16,349	2,270	14,078
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,474	123,490	5	1	1	-	943	-	14,595	2,695	11,900
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,583	124,732	5	1	1	-	937	1	15,042	2,504	12,538
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,617	124,363	5	1	1	-	775	-	15,664	2,351	13,312
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 20,620	126,806	5	1	1	-	1,220	-	14,159	2,796	11,364
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,689	120,883	3	-	-	2	353	3	11,379	3,765	7,614
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,784	120,815	3	-	-	2	97	-	13,869	3,167	10,703
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,755	123,572	3	-	-	2	231	-	11,990	3,556	8,434
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,846	125,180	3	-	-	2	195	1	12,858	3,247	9,612
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,915	125,092	3	-	-	2	149	-	13,795	3,028	10,767
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 19,905	127,620	3	-	-	2	339	-	12,206	3,417	8,788
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,301	120,854	3	-	-	2	345	3	10,943	4,026	6,917
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,422	120,636	3	-	-	2	93	-	13,457	3,393	10,064
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,408	123,499	3	-	-	2	228	-	11,582	3,798	7,784
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,498	125,095	3	-	-	2	187	1	12,474	3,478	8,996
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,570	124,870	3	-	-	2	144	-	13,413	3,234	10,179
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 19,574	127,503	3	-	-	2	332	-	11,841	3,629	8,212

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,241	129,143	1	-	-	2	67	3	14,645	2,460	12,185
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,321	123,393	3	1	-	1	105	-	16,247	2,308	13,939
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,277	125,941	3	1	-	1	243	-	14,369	2,696	11,672
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,371	127,114	3	1	-	1	209	1	14,842	2,535	12,307
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,435	127,018	3	2	-	1	178	-	15,914	2,319	13,595
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 20,412	129,486	3	1	-	1	350	-	14,146	2,727	11,420
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,258	131,991	-	-	-	2	29	3	15,840	2,113	13,727
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,449	131,805	-	-	-	2	2	-	18,895	1,705	17,189
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,309	134,787	-	-	-	2	8	-	16,483	1,987	14,495
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,429	136,301	-	-	-	2	3	1	17,347	1,723	15,625
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,542	136,381	-	-	-	2	2	-	18,409	1,620	16,789
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 20,437	138,947	-	-	-	2	15	-	16,318	1,902	14,416
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,737	118,643	5	1	-	1	984	3	12,143	3,535	8,608
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,768	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,761	121,001	5	1	-	1	883	-	12,657	3,346	9,312
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,856	122,171	5	1	-	1	863	1	13,214	3,171	10,043
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,903	122,046	5	1	-	1	734	-	14,062	2,953	11,110
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 19,915	124,522	5	1	-	1	1,173	-	12,619	3,363	9,256
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,435	118,643	5	1	-	1	984	3	12,143	3,535	8,608
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,466	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,459	121,001	5	1	-	1	883	-	12,657	3,346	9,312
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,554	122,171	5	1	-	1	863	1	13,214	3,171	10,043
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,601	122,046	5	1	-	1	734	-	14,062	2,953	11,110
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 19,613	124,522	5	1	-	1	1,173	-	12,619	3,363	9,256
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,039	121,157	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,078	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,062	123,128	4	1	-	1	531	-	13,377	3,040	10,337
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,154	124,299	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,210	124,268	4	1	-	1	402	-	14,766	2,658	12,108
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 20,208	126,655	4	1	-	1	731	-	13,282	3,070	10,211

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,047	121,157	4	1	-	1	510	3	13,024	3,146	9,878
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,087	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,070	123,128	4	1	-	1	531	-	13,377	3,040	10,337
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,163	124,299	4	1	-	1	492	1	13,892	2,875	11,018
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,219	124,268	4	1	-	1	402	-	14,766	2,658	12,108
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 20,216	126,655	4	1	-	1	731	-	13,282	3,070	10,211
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,012	120,283	4	2	-	1	597	3	12,662	3,315	9,347
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,061	118,354	5	1	-	1	540	-	14,349	2,942	11,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,036	122,968	4	2	-	1	577	-	13,494	3,019	10,475
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,133	124,548	4	2	-	1	550	1	14,402	2,736	11,666
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,183	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 20,182	126,491	4	2	-	1	789	-	13,442	3,057	10,386
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 19,985	120,077	4	2	-	1	626	3	12,552	3,364	9,187
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 20,017	117,934	4	6	-	1	600	-	14,332	3,080	11,252
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 20,006	120,597	4	6	-	1	980	-	12,586	3,482	9,104
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 20,103	122,543	4	6	-	1	970	1	13,822	3,075	10,747
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 20,162	124,109	4	2	-	1	446	-	14,910	2,645	12,265
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 20,161	126,491	4	2	-	1	789	-	13,442	3,057	10,386
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,328	120,299	5	1	-	1	850	3	10,250	4,936	5,314
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,387	119,983	5	1	-	1	442	-	12,487	4,225	8,262
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,358	122,754	5	1	-	1	747	-	10,708	4,737	5,971
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,459	123,939	5	1	-	1	734	1	11,216	4,569	6,647
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,518	123,830	5	1	-	1	615	-	12,073	4,312	7,761
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 20,510	128,611	4	1	-	1	607	-	11,153	4,523	6,629
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,786	118,903	4	1	-	1	712	3	16,119	1,348	14,771
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,802	118,345	4	1	-	1	430	-	18,098	1,033	17,065
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,805	120,768	4	1	-	1	734	-	16,455	1,273	15,182
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,891	121,927	4	1	-	1	695	1	17,037	1,089	15,948
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,934	121,904	4	1	-	1	576	-	17,867	973	16,894
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 19,949	126,864	3	1	-	1	515	-	17,417	928	16,489

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 39	(2,803)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 23	1,971	-	-	-	-	20	(3)	353	(106)	459
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 115	3,141	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 171	3,111	-	-	-	-	(108)	(3)	1,741	(488)	2,230
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 169	5,498	-	-	-	-	221	(3)	257	(76)	333
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 3	(629)	-	-	-	-	(446)	(3)	1,505	(431)	1,936
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 4	1,958	-	-	-	-	(168)	(3)	(23)	(19)	(3)
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 90	5,265	(1)	-	-	-	(514)	(2)	1,148	(470)	1,618
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 153	3,850	-	-	-	-	(297)	(3)	2,004	(641)	2,645
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 149	8,501	(1)	-	-	-	(318)	(3)	1,176	(509)	1,685
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 26	(1,444)	1	(2)	-	-	(40)	(1)	459	(123)	582
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14	1,692	-	-	-	-	(143)	(3)	(256)	55	(311)
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 115	5,144	-	(2)	-	-	(3)	-	731	(349)	1,080
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 191	3,395	1	(2)	-	-	(109)	(3)	2,570	(730)	3,300
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 156	8,163	-	(2)	-	-	(100)	(3)	1,546	(625)	2,172
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 49	(294)	-	-	-	-	(273)	(3)	2,474	(637)	3,111
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 33	2,324	-	-	-	-	51	(3)	684	(227)	911
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 101	4,086	-	-	-	-	44	(2)	1,013	(361)	1,374
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 146	3,620	-	-	-	-	(87)	(3)	1,506	(477)	1,982
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 166	6,466	-	-	-	-	181	(3)	278	(117)	395
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 65	(2,112)	1	-	-	-	258	(1)	835	(118)	953
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 54	2,396	-	2	-	-	226	(1)	(295)	88	(383)
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 113	4,620	-	2	-	-	234	(1)	297	(125)	422
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 156	5,148	-	-	-	-	81	(1)	633	(286)	919
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 179	7,369	-	-	-	-	435	(1)	(697)	146	(843)

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 30	(2,803)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12	1,810	-	1	-	-	67	(3)	470	(127)	597
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 104	3,391	-	1	-	-	40	(2)	1,377	(410)	1,787
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 153	2,952	-	1	-	-	(64)	(3)	1,886	(501)	2,387
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 153	5,334	-	1	-	-	279	(3)	418	(90)	507
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 56	(2,875)	1	-	-	-	(88)	(3)	1,517	(263)	1,779
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 36	2,515	-	-	-	-	(122)	(3)	555	(178)	733
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 133	1,272	1	-	-	-	121	(2)	581	(149)	730
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 191	1,174	1	-	-	-	32	(3)	1,466	(366)	1,831
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 181	6,398	-	-	-	-	(16)	(3)	691	(271)	962
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 20	(307)	-	-	-	-	(448)	(3)	2,307	(587)	2,894
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 49	2,353	-	-	-	-	(87)	(3)	637	(235)	872
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 159	3,530	-	-	-	-	(109)	(2)	1,209	(438)	1,647
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 198	3,300	-	1	-	-	(140)	(3)	2,254	(643)	2,897
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 244	5,871	-	-	-	-	223	(3)	697	(272)	968
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 76	(352)	-	-	-	-	(233)	(3)	2,483	(658)	3,142
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 0	2,340	-	-	-	-	(120)	(3)	465	(161)	625
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 79	3,658	-	-	-	-	(151)	(2)	886	(296)	1,182
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 146	3,666	-	-	-	-	(194)	(3)	1,774	(522)	2,295
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 93	6,084	-	-	-	-	(36)	(3)	80	(6)	85
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 39	(290)	-	-	-	-	(446)	(3)	2,269	(592)	2,861
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 61	2,384	-	-	-	-	(87)	(3)	615	(236)	851
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 187	3,588	-	-	-	-	(114)	(2)	1,203	(409)	1,611
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 233	3,396	-	-	-	-	(236)	(3)	2,120	(616)	2,736
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 269	7,916	(1)	-	-	-	(229)	(3)	1,467	(591)	2,058

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 13	(1,847)	-	-	-	-	(8)	3	(270)	88	(358)
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 49	(2,637)	-	-	-	-	(222)	-	1,869	(491)	2,360
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 61	1,297	-	-	-	-	(29)	1	460	(151)	612
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 115	1,249	-	-	-	-	(115)	-	1,316	(379)	1,695
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 83	6,486	(1)	-	-	-	(174)	-	542	(198)	740
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 2	(1,559)	1	(1)	1	(1)	306	2	(224)	(181)	(42)
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 21	(4,492)	1	(1)	-	-	(19)	-	956	(126)	1,082
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 98	1,507	-	-	-	-	(30)	1	864	(256)	1,119
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 144	974	1	(1)	1	(1)	179	-	1,182	(429)	1,611
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 139	3,447	-	-	-	-	210	-	(104)	67	(170)
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 19	(1,729)	-	-	-	-	(55)	2	9	(119)	128
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 23	(2,457)	-	-	-	-	(369)	-	1,754	(424)	2,178
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 108	1,242	-	-	-	-	(6)	1	447	(191)	638
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 142	873	-	-	-	-	(169)	-	1,069	(343)	1,412
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 145	3,316	-	-	-	-	277	-	(435)	101	(536)
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 95	(68)	-	-	-	-	(257)	(3)	2,491	(598)	3,089
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 66	2,689	-	-	-	-	(122)	(3)	612	(209)	820
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 157	4,297	-	-	-	-	(158)	(2)	1,480	(518)	1,998
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 226	4,209	-	-	-	-	(204)	(3)	2,417	(736)	3,153
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 216	6,738	-	-	-	-	(14)	(3)	827	(347)	1,174
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 121	(218)	-	-	-	-	(252)	(3)	2,514	(632)	3,147
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 107	2,645	-	-	-	-	(117)	(3)	639	(228)	867
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 198	4,241	-	-	-	-	(157)	(2)	1,531	(547)	2,078
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 270	4,016	-	-	-	-	(201)	(3)	2,470	(791)	3,262
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 273	6,649	-	-	-	-	(13)	(3)	899	(396)	1,295

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 80	(5,749)	2	1	-	(1)	38	(3)	1,602	(152)	1,754
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 36	(3,202)	2	1	-	(1)	176	(3)	(276)	236	(513)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 130	(2,028)	2	1	-	(1)	143	(2)	198	75	123
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 194	(2,124)	2	2	-	(1)	111	(3)	1,269	(141)	1,410
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 171	343	2	1	-	(1)	283	(3)	(498)	267	(765)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 191	(187)	-	-	-	-	(27)	(3)	3,055	(407)	3,462
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 51	2,796	-	-	-	-	(22)	(3)	643	(126)	769
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 171	4,309	-	-	-	-	(26)	(2)	1,508	(390)	1,898
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 284	4,390	-	-	-	-	(28)	(3)	2,570	(493)	3,062
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 179	6,955	-	-	-	-	(14)	(3)	478	(211)	689
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 30	(289)	-	-	-	-	(444)	(3)	2,206	(593)	2,799
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 24	2,359	-	-	-	-	(101)	(3)	514	(190)	704
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 119	3,528	-	-	-	-	(121)	(2)	1,071	(364)	1,435
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 166	3,403	-	-	-	-	(251)	(3)	1,919	(582)	2,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 178	5,879	-	-	-	-	188	(3)	476	(172)	648
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 30	(289)	-	-	-	-	(444)	(3)	2,206	(593)	2,799
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 24	2,359	-	-	-	-	(101)	(3)	514	(190)	704
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 119	3,528	-	-	-	-	(121)	(2)	1,071	(364)	1,435
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 166	3,403	-	-	-	-	(251)	(3)	1,919	(582)	2,502
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 178	5,879	-	-	-	-	188	(3)	476	(172)	648
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 39	(2,803)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 23	1,971	-	-	-	-	20	(3)	353	(106)	459
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 115	3,141	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 171	3,111	-	-	-	-	(108)	(3)	1,741	(488)	2,230
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 169	5,498	-	-	-	-	221	(3)	257	(76)	333

Societal Discount Modeling Approach, Energy Efficiency +15 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 39	(2,803)	1	-	-	-	30	(3)	1,325	(204)	1,529
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 23	1,971	-	-	-	-	20	(3)	353	(106)	459
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 115	3,141	-	-	-	-	(18)	(2)	868	(272)	1,140
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 171	3,111	-	-	-	-	(108)	(3)	1,741	(488)	2,230
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 169	5,498	-	-	-	-	221	(3)	257	(76)	333
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 50	(1,929)	1	(1)	-	-	(57)	(3)	1,687	(373)	2,060
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 24	2,684	-	-	-	-	(20)	(3)	832	(296)	1,128
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 121	4,265	-	-	-	-	(47)	(2)	1,740	(579)	2,318
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 171	3,825	-	-	-	-	(151)	(3)	2,248	(670)	2,918
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 170	6,207	-	-	-	-	192	(3)	780	(258)	1,038
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 32	(2,143)	-	4	-	-	(26)	(3)	1,780	(284)	2,065
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 21	519	-	4	-	-	354	(3)	34	118	(84)
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 118	2,465	-	4	-	-	344	(2)	1,270	(290)	1,560
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 177	4,031	-	-	-	-	(179)	(3)	2,358	(720)	3,078
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 176	6,413	-	-	-	-	164	(3)	891	(308)	1,198
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 59	(316)	-	-	-	-	(408)	(3)	2,237	(711)	2,948
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 30	2,455	-	-	-	-	(103)	(3)	458	(199)	657
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 131	3,640	-	-	-	-	(117)	(2)	965	(367)	1,333
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 189	3,530	-	-	-	-	(235)	(3)	1,823	(624)	2,447
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 182	8,312	(1)	-	-	-	(243)	(3)	902	(413)	1,315
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 16	(558)	-	-	-	-	(282)	(3)	1,978	(315)	2,294
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 18	1,865	-	-	-	-	22	(3)	335	(75)	411
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 105	3,024	-	-	-	-	(17)	(2)	918	(259)	1,177
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 148	3,001	-	-	-	-	(135)	(3)	1,748	(376)	2,123
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 163	7,961	(1)	-	-	-	(197)	(3)	1,298	(420)	1,718

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,967	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,000	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,987	121,943	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,086	123,920	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,133	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,138	125,855	4	1	-	1	840	-	13,183	3,123	10,060
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,427	122,888	4	2	-	1	613	3	13,431	3,133	10,298
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,442	119,744	5	2	-	1	473	-	14,067	3,034	11,034
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,443	124,458	4	2	-	1	449	-	13,228	3,171	10,057
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,530	126,054	4	2	-	1	408	1	14,051	2,869	11,182
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,593	124,135	5	2	-	1	645	-	14,520	2,836	11,684
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,587	128,854	4	2	-	1	609	-	13,754	2,950	10,804
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,987	123,849	4	2	-	2	505	3	12,911	3,331	9,580
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,998	123,764	4	1	-	2	327	2	13,427	3,158	10,269
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,003	126,946	4	1	-	2	421	2	12,119	3,510	8,609
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,093	128,274	4	1	-	2	510	3	13,169	3,160	10,009
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,167	128,840	4	1	-	2	206	-	15,635	2,524	13,111
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,135	131,272	4	1	-	2	412	-	13,960	2,884	11,076
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,507	119,049	3	-	-	1	531	3	12,258	3,332	8,925
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,550	116,498	4	-	-	1	471	-	13,980	2,975	11,005
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,542	119,144	4	-	-	1	824	-	12,227	3,397	8,830
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,608	121,307	4	-	-	1	826	1	12,899	3,137	9,762
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,653	120,867	4	-	-	1	682	-	13,392	3,018	10,374
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,673	125,909	3	-	-	1	596	-	12,919	3,071	9,848
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,045	115,452	3	-	-	1	385	1	12,399	3,315	9,084
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,099	115,171	3	1	-	1	319	-	13,611	3,053	10,557
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,085	117,881	3	1	-	1	594	-	11,892	3,458	8,435
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,145	120,109	3	1	-	1	601	-	12,472	3,242	9,231
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,188	119,831	3	1	-	1	492	-	12,482	3,232	9,250
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,218	122,042	3	1	-	1	882	-	11,181	3,663	7,518

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,111	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,135	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,121	121,943	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,210	123,920	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,258	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,262	125,855	4	1	-	1	840	-	13,183	3,123	10,060
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,823	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,866	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,852	121,943	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,961	123,920	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,009	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,013	125,855	4	1	-	1	840	-	13,183	3,123	10,060
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,521	115,668	5	1	-	1	1,192	3	12,929	2,933	9,996
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,530	115,378	5	1	-	1	696	-	15,244	2,304	12,940
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,568	118,070	5	1	-	1	1,089	-	13,605	2,670	10,935
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,689	120,147	5	1	-	1	1,122	1	14,881	2,278	12,603
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,717	119,542	5	1	-	1	956	-	15,451	2,164	13,287
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,771	122,022	5	1	-	1	1,451	-	14,049	2,535	11,514
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,327	128,082	3	-	1	-	245	2	12,829	3,145	9,684
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,399	124,405	3	1	-	1	105	-	14,253	3,258	10,995
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,332	127,090	3	1	-	1	232	-	12,275	3,749	8,526
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,413	128,945	3	1	-	1	200	1	13,546	3,349	10,198
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,474	128,688	3	1	-	1	152	-	14,025	3,265	10,760
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 18,428	131,030	3	1	-	1	329	-	12,385	3,785	8,600
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,871	117,658	4	1	-	1	639	3	13,960	2,409	11,551
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,904	115,081	5	1	-	1	688	-	15,285	2,191	13,094
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 20,928	119,731	4	1	-	1	672	-	14,451	2,227	12,224
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,067	121,895	4	1	-	1	672	1	15,799	1,844	13,955
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,107	119,272	5	1	-	1	943	-	15,532	2,076	13,456
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 21,140	123,737	4	1	-	1	929	-	14,921	2,109	12,813

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,023	125,246	4	-	1	-	523	2	12,086	3,469	8,617
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,055	121,798	4	1	-	1	292	-	13,247	3,643	9,604
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,010	127,144	3	1	-	1	233	-	12,289	3,782	8,507
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,071	126,262	4	1	-	1	507	1	12,610	3,741	8,869
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,122	125,934	4	1	-	1	413	-	13,113	3,634	9,479
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 19,090	131,111	3	1	-	1	338	-	12,402	3,815	8,587
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,235	121,385	5	-	1	-	974	2	13,380	2,715	10,665
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,253	117,920	5	1	-	1	690	-	14,293	2,863	11,430
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,234	122,622	4	1	-	1	651	-	13,267	2,996	10,271
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,328	124,434	4	1	-	1	615	1	14,436	2,640	11,795
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,374	123,978	4	1	-	1	504	-	14,967	2,527	12,440
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 20,372	126,368	4	1	-	1	866	-	13,487	2,963	10,524
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,426	121,172	5	-	1	-	950	2	14,316	2,637	11,680
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,429	120,298	5	-	1	-	633	-	15,983	2,344	13,639
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,416	122,909	5	-	1	-	1,012	-	14,164	2,766	11,397
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,515	124,121	5	-	1	-	1,002	1	14,764	2,566	12,197
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,551	123,646	5	-	1	-	850	-	15,335	2,429	12,906
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 20,556	128,277	4	-	1	-	836	-	14,656	2,563	12,092
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,690	119,238	4	1	-	1	560	3	12,062	3,629	8,433
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,754	118,734	4	1	-	1	317	-	14,218	3,057	11,161
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,748	121,414	4	1	-	1	584	-	12,519	3,449	9,069
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,851	123,408	4	-	-	1	540	1	13,583	3,069	10,515
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,901	122,856	4	-	-	1	437	-	14,085	2,974	11,112
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 19,911	125,332	4	-	-	1	790	-	12,660	3,377	9,283
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,357	121,379	3	-	-	2	379	3	12,360	3,548	8,812
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,472	121,169	3	-	-	2	110	-	14,813	2,917	11,896
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,463	123,940	3	-	-	2	257	-	12,998	3,306	9,692
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,565	125,628	3	-	-	2	231	1	13,917	3,009	10,908
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,609	125,025	3	-	-	2	169	-	14,383	2,923	11,460
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 19,618	127,528	3	-	-	2	378	-	12,869	3,317	9,552

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,175	122,151	3	1	-	1	413	3	13,210	3,070	10,140
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,234	122,149	3	1	-	1	128	-	15,648	2,470	13,178
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,199	124,708	3	1	-	1	282	-	13,800	2,862	10,938
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,305	126,727	3	1	-	1	260	1	15,120	2,461	12,659
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,358	126,411	3	1	-	1	196	-	15,608	2,377	13,231
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 20,341	128,659	3	1	-	1	409	-	14,057	2,780	11,277
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,271	129,301	1	1	-	1	75	3	16,253	2,095	14,158
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,418	129,288	1	1	-	1	6	-	19,178	1,613	17,565
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,314	132,077	1	1	-	1	29	-	16,924	1,949	14,975
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,455	134,075	1	1	-	1	21	1	18,399	1,583	16,816
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,541	133,816	1	1	-	1	13	-	18,936	1,582	17,355
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 20,445	138,713	-	-	-	2	18	-	17,412	1,751	15,660
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,686	117,878	5	-	-	1	1,079	3	11,810	3,655	8,155
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,705	117,189	5	1	-	1	638	-	13,836	3,113	10,723
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,707	119,864	5	1	-	1	1,014	-	12,176	3,520	8,656
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,804	121,809	5	1	-	1	1,014	1	13,401	3,126	10,275
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,845	121,313	5	1	-	1	861	-	13,920	3,015	10,904
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19,864	123,759	5	1	-	1	1,337	-	12,514	3,425	9,089
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,384	117,878	5	-	-	1	1,079	3	11,810	3,655	8,155
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,403	117,189	5	1	-	1	638	-	13,836	3,113	10,723
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,405	119,864	5	1	-	1	1,014	-	12,176	3,520	8,656
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,502	121,809	5	1	-	1	1,014	1	13,401	3,126	10,275
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,543	121,313	5	1	-	1	861	-	13,920	3,015	10,904
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19,562	123,759	5	1	-	1	1,337	-	12,514	3,425	9,089
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 19,971	120,362	4	-	-	1	567	3	12,657	3,267	9,389
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 20,010	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 19,997	121,943	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 20,092	123,851	4	-	-	1	563	1	13,895	2,862	11,033
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 20,141	123,429	4	-	-	1	458	-	14,403	2,762	11,641
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 20,144	125,786	4	-	-	1	813	-	12,958	3,178	9,780

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 19,971	120,362	4	-	-	1	567	3	12,657	3,267	9,389
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 20,020	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 19,999	122,674	4	-	-	1	601	-	13,359	3,032	10,326
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 20,092	123,851	4	-	-	1	563	1	13,895	2,862	11,033
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 20,141	123,429	4	-	-	1	458	-	14,403	2,762	11,641
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 20,144	125,786	4	-	-	1	813	-	12,958	3,178	9,780
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 19,956	119,920	4	1	-	1	595	3	12,466	3,350	9,116
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 19,991	119,351	4	1	-	1	338	-	14,579	2,820	11,759
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 19,977	121,943	4	1	-	1	612	-	12,859	3,216	9,644
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 20,076	123,920	4	1	-	1	590	1	14,121	2,807	11,314
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 20,123	123,509	4	1	-	1	481	-	14,628	2,711	11,917
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 20,128	125,855	4	1	-	1	840	-	13,183	3,123	10,060
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 19,934	117,656	4	5	-	1	972	2	12,664	3,544	9,120
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 19,963	117,172	4	5	-	1	640	-	13,971	3,171	10,800
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 19,955	122,465	3	5	-	1	546	-	13,148	3,205	9,942
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 20,054	121,902	4	5	-	1	1,000	1	13,526	3,148	10,378
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 20,112	121,435	4	5	-	1	843	-	14,052	3,025	11,026
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 20,118	125,855	4	1	-	1	840	-	13,183	3,123	10,060
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,263	121,228	4	1	-	1	671	3	10,332	4,844	5,488
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,313	118,793	5	1	-	1	530	-	11,974	4,410	7,563
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,288	123,741	4	1	-	1	500	-	10,830	4,616	6,214
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,399	125,743	4	1	-	1	474	1	12,083	4,166	7,917
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,452	123,080	5	1	-	1	727	-	11,967	4,355	7,612
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 20,440	127,767	4	1	-	1	700	-	11,091	4,551	6,540
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,731	119,801	3	1	-	1	585	3	16,373	1,253	15,120
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,741	117,129	4	1	-	1	509	-	17,585	1,119	16,466
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,746	122,246	3	1	-	1	444	-	16,992	1,068	15,925
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,838	121,636	4	1	-	1	817	1	17,124	1,121	16,003
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,875	121,154	4	1	-	1	678	-	17,666	1,033	16,632
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 19,888	126,075	3	1	-	1	596	-	17,271	981	16,290

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 34	(569)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 20	2,023	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 119	4,000	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 166	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 171	5,935	-	-	-	-	245	(3)	717	(227)	944
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 15	(3,143)	1	-	-	-	(140)	(3)	637	(99)	736
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 15	1,570	-	-	-	-	(165)	(3)	(203)	38	(241)
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 103	3,167	-	-	-	-	(205)	(2)	620	(264)	884
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 165	1,247	1	-	-	-	31	(3)	1,090	(296)	1,386
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 160	5,966	-	-	-	-	(4)	(3)	324	(183)	507
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11	(85)	-	(1)	-	-	(178)	(1)	516	(173)	689
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 17	3,097	-	(1)	-	-	(85)	(1)	(792)	179	(971)
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 107	4,425	-	(1)	-	-	5	-	258	(171)	429
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 180	4,991	-	(1)	-	-	(300)	(3)	2,724	(807)	3,531
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 149	7,423	-	(1)	-	-	(94)	(3)	1,049	(447)	1,496
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 43	(2,550)	1	-	-	-	(60)	(3)	1,722	(357)	2,080
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 35	96	1	-	-	-	293	(3)	(31)	65	(96)
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 101	2,258	1	-	-	-	295	(2)	641	(195)	836
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 147	1,818	1	-	-	-	151	(3)	1,134	(315)	1,449
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 166	6,861	-	-	-	-	65	(3)	662	(261)	923
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 54	(280)	-	1	-	-	(65)	(1)	1,212	(261)	1,473
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 41	2,429	-	1	-	-	209	(1)	(507)	143	(649)
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 100	4,658	-	1	-	-	216	(1)	73	(73)	147
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 143	4,379	-	1	-	-	108	(1)	83	(83)	166
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 173	6,590	-	1	-	-	497	(1)	(1,218)	348	(1,566)

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 24	(569)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 11	2,023	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 100	4,000	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 147	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 151	5,935	-	-	-	-	245	(3)	717	(227)	944
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 43	(569)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 30	2,023	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 138	4,000	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 186	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 190	5,935	-	-	-	-	245	(3)	717	(227)	944
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9	(290)	-	-	-	-	(496)	(3)	2,315	(629)	2,944
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 47	2,402	-	-	-	-	(102)	(3)	676	(263)	939
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 168	4,479	-	-	-	-	(70)	(2)	1,952	(655)	2,607
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 196	3,874	-	-	-	-	(236)	(3)	2,522	(769)	3,291
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 249	6,354	-	-	-	-	259	(3)	1,120	(398)	1,517
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 72	(3,676)	-	1	(1)	1	(140)	(2)	1,425	113	1,312
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 5	(991)	-	1	(1)	1	(13)	(2)	(554)	604	(1,158)
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 86	863	-	1	(1)	1	(45)	(1)	718	204	514
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 147	607	-	1	(1)	1	(94)	(2)	1,196	119	1,076
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 101	2,948	-	1	(1)	1	83	(2)	(444)	639	(1,084)
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 33	(2,577)	1	-	-	-	49	(3)	1,324	(219)	1,543
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 57	2,074	-	-	-	-	33	(3)	490	(182)	673
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 196	4,237	-	-	-	-	33	(2)	1,838	(566)	2,404
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 236	1,615	1	-	-	-	305	(3)	1,572	(333)	1,905
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$ 269	6,080	-	-	-	-	290	(3)	961	(300)	1,261

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 13	(1,899)	1	(1)	1	(1)	290	2	(203)	(313)	110
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 44	(5,346)	1	-	-	-	59	-	958	(139)	1,097
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 61	(882)	1	-	-	-	274	1	321	(41)	361
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 112	(1,210)	1	-	-	-	180	-	823	(148)	972
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$ 79	3,966	-	-	-	-	105	-	113	33	80
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 0	(1,236)	1	(1)	1	(1)	323	2	113	(280)	394
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 19	(4,702)	1	-	-	-	39	-	1,026	(132)	1,159
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 93	1,812	-	-	-	-	(35)	1	1,169	(355)	1,524
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 139	1,357	-	-	-	-	(147)	-	1,701	(468)	2,169
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$ 137	3,746	-	-	-	-	215	-	220	(33)	253
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 10	(1,737)	-	-	-	-	(62)	2	153	(130)	282
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 13	(2,611)	-	-	-	-	(379)	-	1,820	(422)	2,242
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 99	1,213	-	-	-	-	(11)	1	600	(200)	800
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 135	738	-	-	-	-	(163)	-	1,171	(337)	1,509
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$ 140	5,368	(1)	-	-	-	(176)	-	492	(203)	695
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 64	(504)	-	-	-	-	(243)	(3)	2,155	(572)	2,728
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 58	2,176	-	-	-	-	25	(3)	457	(180)	636
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 161	4,170	-	(1)	-	-	(19)	(2)	1,521	(560)	2,081
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 211	3,618	-	(1)	-	-	(122)	(3)	2,023	(655)	2,679
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$ 221	6,095	-	(1)	-	-	230	(3)	598	(252)	850
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 115	(209)	-	-	-	-	(270)	(3)	2,453	(631)	3,084
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 106	2,561	-	-	-	-	(122)	(3)	638	(242)	880
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 208	4,250	-	-	-	-	(149)	(2)	1,557	(539)	2,095
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 251	3,646	-	-	-	-	(210)	(3)	2,023	(625)	2,647
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$ 260	6,149	-	-	-	-	(2)	(3)	509	(231)	740

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 60	(2)	-	-	-	-	(285)	(3)	2,439	(600)	3,038
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 24	2,557	-	-	-	-	(131)	(3)	590	(208)	798
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 130	4,576	-	-	-	-	(153)	(2)	1,911	(609)	2,519
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 183	4,260	-	-	-	-	(217)	(3)	2,398	(693)	3,091
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$ 166	6,508	-	-	-	-	(4)	(3)	847	(290)	1,137
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 147	(13)	-	-	-	-	(69)	(3)	2,925	(482)	3,407
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 43	2,776	-	-	-	-	(46)	(3)	670	(146)	817
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 184	4,774	-	-	-	-	(54)	(2)	2,146	(512)	2,658
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 270	4,515	-	-	-	-	(61)	(3)	2,683	(513)	3,196
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$ 174	9,413	(1)	(1)	-	1	(56)	(3)	1,159	(344)	1,502
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 19	(689)	-	1	-	-	(441)	(3)	2,026	(542)	2,568
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 22	1,986	-	1	-	-	(65)	(3)	366	(135)	501
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 119	3,930	-	1	-	-	(65)	(2)	1,591	(529)	2,120
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 159	3,435	-	1	-	-	(218)	(3)	2,110	(640)	2,750
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$ 178	5,881	-	1	-	-	258	(3)	704	(230)	934
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 19	(689)	-	1	-	-	(441)	(3)	2,026	(542)	2,568
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 21	1,986	-	1	-	-	(65)	(3)	366	(135)	501
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 119	3,930	-	1	-	-	(65)	(2)	1,591	(529)	2,120
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 159	3,435	-	1	-	-	(218)	(3)	2,110	(640)	2,750
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$ 178	5,881	-	1	-	-	258	(3)	704	(230)	934
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 39	(1,011)	-	1	-	-	(229)	(3)	1,922	(447)	2,370
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 26	1,580	-	1	-	-	44	(3)	203	(52)	254
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 122	3,489	-	-	-	-	(4)	(2)	1,239	(405)	1,644
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 170	3,067	-	-	-	-	(110)	(3)	1,746	(505)	2,251
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$ 174	5,424	-	-	-	-	246	(3)	301	(90)	391

Societal Discount Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 49	(1,011)	-	1	-	-	(229)	(3)	1,922	(447)	2,370
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 29	2,312	-	-	-	-	33	(3)	702	(235)	937
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 122	3,489	-	-	-	-	(4)	(2)	1,239	(405)	1,644
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 170	3,067	-	-	-	-	(110)	(3)	1,746	(505)	2,251
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$ 174	5,424	-	-	-	-	246	(3)	301	(90)	391
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 35	(569)	-	-	-	-	(256)	(3)	2,113	(530)	2,643
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 22	2,023	-	-	-	-	17	(3)	393	(134)	528
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 120	4,000	-	-	-	-	(5)	(2)	1,655	(543)	2,198
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 168	3,589	-	-	-	-	(114)	(3)	2,162	(639)	2,801
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$ 172	5,935	-	-	-	-	245	(3)	717	(227)	944
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 29	(485)	-	-	-	-	(332)	(2)	1,307	(373)	1,680
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 22	4,809	(1)	-	-	-	(426)	(2)	484	(339)	823
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 120	4,246	-	-	-	-	28	(1)	862	(396)	1,259
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 179	3,778	-	-	-	-	(129)	(2)	1,388	(518)	1,906
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$ 185	8,198	-	(4)	-	-	(132)	(2)	519	(421)	940
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 51	(2,435)	1	-	-	-	(140)	(3)	1,642	(433)	2,075
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 25	2,513	-	-	-	-	(171)	(3)	498	(228)	726
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 137	4,515	-	-	-	-	(197)	(2)	1,751	(678)	2,429
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 189	1,851	1	-	-	-	56	(3)	1,635	(489)	2,124
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$ 178	6,539	-	-	-	-	29	(3)	759	(293)	1,052
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 10	(2,672)	1	-	-	-	(76)	(3)	1,212	(134)	1,346
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 16	2,446	-	-	-	-	(141)	(3)	620	(185)	804
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 107	1,836	1	-	-	-	233	(2)	751	(132)	883
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 144	1,353	1	-	-	-	94	(3)	1,293	(220)	1,512
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$ 157	6,274	-	-	-	-	12	(3)	898	(272)	1,170

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,958	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,185	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,985	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,204	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,343	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,165	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,298	114,666	5	-	-	2	1,205	3	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,499	113,011	5	1	-	2	685	-	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,304	116,390	5	1	-	2	1,063	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,496	118,085	5	1	-	2	1,001	1	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,693	117,415	5	2	-	2	988	-	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,510	120,472	5	2	-	2	1,537	-	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,729	117,964	5	-	-	2	869	3	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,915	120,567	5	2	1	1	628	1	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,737	120,234	5	-	-	2	938	1	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,923	121,587	5	1	-	2	857	2	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,245	119,747	5	3	-	2	769	-	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,023	122,969	5	3	-	2	1,219	-	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,768	109,660	5	1	-	1	1,752	2	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,057	108,104	5	3	-	1	1,559	-	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,856	111,471	5	3	-	1	2,264	-	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,949	113,707	5	3	-	1	2,178	-	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,062	114,327	5	-	-	1	1,508	-	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,920	117,181	5	-	-	1	2,241	-	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,495	105,716	5	1	-	1	1,980	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,665	104,438	5	3	-	1	2,031	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,488	107,914	5	3	-	1	2,827	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,558	110,063	5	3	-	1	2,862	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,576	109,574	5	3	-	1	2,521	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,488	113,216	5	2	-	1	3,180	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,079	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,302	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,102	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,314	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,450	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,271	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,838	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,069	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,868	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,094	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,237	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,058	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,846	111,113	5	-	-	2	1,533	3	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,064	109,783	5	-	-	2	871	-	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 13,889	113,216	5	-	-	2	1,352	-	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,122	115,114	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,258	114,611	5	-	-	2	1,097	-	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 14,103	117,794	5	-	-	2	1,688	-	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,027	117,084	5	-	1	1	1,296	2	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,279	114,303	5	-	1	1	872	-	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,051	117,520	5	-	1	1	1,353	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,258	118,752	5	-	1	1	1,302	1	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,403	118,319	5	-	1	1	1,101	-	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 12,199	121,262	5	-	1	1	1,692	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,513	110,969	5	-	-	2	1,532	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,747	109,625	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,565	113,070	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,814	115,004	5	-	-	2	1,301	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,956	114,475	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 13,793	117,692	5	-	-	2	1,690	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,364	117,093	5	-	1	1	1,296	2	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,596	114,249	5	-	1	1	872	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,377	117,426	5	-	1	1	1,353	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,568	118,735	5	-	1	1	1,302	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,705	118,330	5	-	1	1	1,100	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 12,510	121,254	5	-	1	1	1,692	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,151	116,821	5	-	1	1	1,296	2	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,367	113,799	5	-	1	1	871	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,159	117,030	5	-	1	1	1,352	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,379	118,337	5	-	1	1	1,302	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,513	117,865	5	-	1	1	1,101	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 13,328	120,853	5	-	1	1	1,692	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,322	116,712	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,519	115,281	5	-	-	2	873	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,305	118,523	5	-	-	2	1,354	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,528	119,646	5	-	-	2	1,304	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,656	119,010	5	-	-	2	1,103	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 13,468	121,924	5	-	-	2	1,694	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 12,763	110,926	5	-	-	2	1,533	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 13,005	109,598	5	-	-	2	871	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 12,812	113,037	5	-	-	2	1,352	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 13,032	114,977	5	-	-	2	1,302	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 13,177	114,443	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 13,005	117,674	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 12,576	110,742	5	-	-	2	1,539	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 12,831	109,278	5	-	-	2	872	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 12,648	112,826	5	-	-	2	1,355	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 12,869	114,751	5	-	-	2	1,304	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 13,016	114,086	5	-	-	2	1,100	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 12,852	117,421	5	-	-	2	1,693	-	-	-	-

Department Attachment 11

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,124	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,351	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,150	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,370	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,509	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 13,330	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,276	113,929	4	-	-	2	1,093	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,514	112,725	4	-	-	2	486	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,296	115,999	4	-	-	2	841	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,519	117,833	4	-	-	2	767	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,667	117,486	4	-	-	2	624	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEM	$ 13,472	120,486	4	-	-	2	1,072	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 12,793	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 13,020	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 12,819	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 13,039	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 13,178	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 12,999	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 12,627	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 12,854	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 12,654	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 12,873	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 13,012	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 12,834	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 12,958	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 13,185	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 12,985	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 13,204	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 13,343	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 13,165	118,453	5	-	-	2	1,690	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 12,958	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 13,185	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 12,985	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 13,204	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 13,343	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 13,165	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 12,958	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 13,185	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 12,985	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 13,204	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 13,343	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 13,165	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 12,958	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 13,185	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 12,985	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 13,204	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 13,343	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 13,165	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,022	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,249	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,048	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,267	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,406	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 13,228	118,453	5	-	-	2	1,690	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 12,960	111,998	5	-	-	2	1,529	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 13,186	110,721	5	-	-	2	870	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 12,986	114,048	5	-	-	2	1,351	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 13,205	115,827	5	-	-	2	1,300	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 13,344	115,385	5	-	-	2	1,099	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 13,166	118,453	5	-	-	2	1,690	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 201	(1,655)	-	1	-	-	(521)	(3)	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 5	1,724	-	1	-	-	(143)	(3)	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 198	3,419	-	1	-	-	(205)	(2)	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 395	2,749	-	2	-	-	(217)	(3)	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 212	5,806	-	2	-	-	332	(3)	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 186	2,602	-	2	1	(1)	(241)	(2)	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 7	2,270	-	-	-	-	69	(2)	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 194	3,623	-	1	-	-	(12)	(1)	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 515	1,783	-	3	-	-	(99)	(3)	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 293	5,004	-	3	-	-	351	(3)	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 289	(1,556)	-	2	-	-	(193)	(2)	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 88	1,811	-	2	-	-	513	(2)	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 181	4,047	-	2	-	-	426	(2)	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 294	4,666	-	(1)	-	-	(244)	(2)	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 152	7,521	-	(1)	-	-	490	(2)	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 8	(2,198)	-	(2)	-	-	(847)	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 178	(3,476)	-	-	-	-	(796)	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 70	2,149	-	-	-	-	34	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 89	1,660	-	-	-	-	(306)	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 1	5,302	-	(1)	-	-	353	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 223	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 23	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 235	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 371	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 192	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 231	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 30	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 256	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 399	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 220	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 217	(1,330)	-	-	-	-	(662)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 43	2,103	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 276	4,001	-	-	-	-	(233)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 412	3,498	-	-	-	-	(436)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 257	6,681	-	-	-	-	155	(3)	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 252	(2,781)	-	-	-	-	(424)	(2)	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 24	436	-	-	-	-	58	(2)	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 232	1,668	-	-	-	-	6	(1)	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 376	1,235	-	-	-	-	(195)	(2)	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEM	$ 172	4,178	-	-	-	-	396	(2)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 235	(1,345)	-	-	-	-	(662)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 52	2,100	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 301	4,034	-	-	-	-	(231)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 443	3,505	-	-	-	-	(433)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEM	$ 281	6,723	-	-	-	-	158	(3)	-	-	-

Department Attachment 11

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 232	(2,845)	-	-	-	-	(424)	(2)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 13	332	-	-	-	-	57	(2)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 204	1,642	-	-	-	-	6	(1)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 341	1,236	-	-	-	-	(196)	(2)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEM	$ 147	4,161	-	-	-	-	396	(2)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 216	(3,021)	-	-	-	-	(424)	(2)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 8	210	-	-	-	-	57	(2)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 228	1,517	-	-	-	-	6	(1)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 362	1,045	-	-	-	-	(194)	(2)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEM	$ 178	4,033	-	-	-	-	397	(2)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 17	(1,810)	-	-	-	-	175	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 214	(3,242)	-	-	-	-	(481)	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 223	1,124	-	-	-	-	(51)	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 351	487	-	-	-	-	(251)	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEM	$ 163	3,401	-	-	-	-	340	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 242	(1,328)	-	-	-	-	(662)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 49	2,111	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 270	4,051	-	-	-	-	(231)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 414	3,517	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEM	$ 242	6,748	-	-	-	-	157	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 255	(1,463)	-	-	-	-	(667)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 72	2,085	-	-	-	-	(184)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 293	4,009	-	-	-	-	(235)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 441	3,344	-	-	-	-	(439)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEM	$ 276	6,679	-	-	-	-	154	(3)	-	-	-

Department Attachment 11
Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ 238	(1,204)	-	-	-	-	(607)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ 21	2,070	-	-	-	-	(252)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ 243	3,904	-	-	-	-	(326)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ 391	3,557	-	-	-	-	(469)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	ΛNDHI	SLRM	MKTM	EEM	$ 196	6,557	-	-	-	-	(21)	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-

Department Attachment 11

Market Off Modeling Approach, Energy Efficiency +11 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 227	(1,277)	-	-	-	-	(659)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 26	2,050	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 246	3,830	-	-	-	-	(229)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 385	3,387	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEM	$ 206	6,455	-	-	-	-	161	(3)	-	-	-

Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,945	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,227	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,004	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,177	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,315	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,138	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,279	114,427	5	-	-	2	1,239	3	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,491	113,204	5	-	-	2	666	-	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,296	116,459	5	-	-	2	1,062	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,479	117,838	5	1	-	2	1,035	1	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,676	117,170	5	2	-	2	1,023	-	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,496	120,221	5	2	-	2	1,584	-	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,737	117,981	5	-	-	2	893	3	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,893	120,313	5	2	1	1	650	1	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,718	119,980	5	-	-	2	964	1	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,906	121,333	5	1	-	2	885	2	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,224	119,506	5	3	-	2	799	-	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,004	122,721	5	3	-	2	1,259	-	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,748	109,427	5	1	-	1	1,804	2	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,038	107,877	5	3	-	1	1,610	-	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,840	111,238	5	3	-	1	2,329	-	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,930	114,097	5	2	-	1	1,998	-	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,042	114,085	5	-	-	1	1,556	-	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,902	116,938	5	-	-	1	2,303	-	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,474	105,493	5	1	-	1	2,043	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,650	104,632	5	2	-	1	1,971	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,474	107,989	5	2	-	1	2,809	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,541	109,832	5	3	-	1	2,939	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,560	109,335	5	3	-	1	2,592	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,469	112,981	5	2	-	1	3,264	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,066	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,340	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,118	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,287	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,422	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,244	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,824	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,114	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,891	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,067	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,209	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,032	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,830	110,884	5	-	-	2	1,575	3	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,104	109,792	5	-	-	2	902	-	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 13,908	113,356	5	-	-	2	1,392	-	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,092	114,835	5	-	-	2	1,345	1	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,227	114,325	5	-	-	2	1,137	-	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 14,074	117,512	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,030	115,342	5	-	1	1	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,322	114,060	5	-	1	1	903	-	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,071	117,369	5	-	1	1	1,393	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,234	118,466	5	-	1	1	1,346	1	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,378	118,029	5	-	1	1	1,140	-	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 12,175	120,973	5	-	1	1	1,742	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,498	110,742	5	-	-	2	1,573	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,791	109,649	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,586	113,223	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,785	114,723	5	-	-	2	1,345	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,926	114,187	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 13,765	117,409	5	-	-	2	1,740	-	-	-	-

Department Attachment 12
Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,363	115,214	5	-	1	1	1,572	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,636	114,064	5	-	1	1	903	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,394	117,349	5	-	1	1	1,393	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,542	118,449	5	-	1	1	1,346	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,678	118,039	5	-	1	1	1,140	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 12,485	120,966	5	-	1	1	1,742	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,139	114,818	5	-	1	1	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,403	113,628	5	-	1	1	903	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,173	116,979	5	-	1	1	1,392	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,350	118,051	5	-	1	1	1,346	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,483	117,572	5	-	1	1	1,140	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 13,300	120,563	5	-	1	1	1,743	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,306	116,487	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,552	114,865	5	-	-	2	904	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,316	118,188	5	-	-	2	1,394	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,498	119,369	5	-	-	2	1,348	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,626	118,728	5	-	-	2	1,143	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 13,439	121,643	5	-	-	2	1,745	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 12,751	110,697	5	-	-	2	1,576	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 13,053	109,628	5	-	-	2	902	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 12,838	113,199	5	-	-	2	1,392	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 13,006	114,696	5	-	-	2	1,346	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 13,150	114,155	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 12,979	117,390	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,565	110,514	5	-	-	2	1,581	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,885	109,316	5	-	-	2	903	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,680	112,990	5	-	-	2	1,395	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,844	114,471	5	-	-	2	1,348	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,990	113,797	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 12,828	117,138	5	-	-	2	1,743	-	-	-	-

Department Attachment 12
Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,111	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,393	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,170	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,342	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,481	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 13,303	120,183	4	-	-	2	1,106	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,260	113,684	4	-	-	2	1,121	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,558	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,320	116,072	4	-	-	2	867	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,490	117,534	4	-	-	2	795	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,637	117,181	4	-	-	2	648	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 13,443	120,183	4	-	-	2	1,106	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 12,779	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 13,061	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 12,839	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 13,011	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 13,150	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 12,972	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,614	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,896	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,673	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,846	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,984	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 12,807	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 12,945	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 13,227	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 13,004	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 13,177	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 13,315	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 13,138	118,165	5	-	-	2	1,740	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 12,945	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 13,227	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 13,004	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 13,177	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 13,315	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 13,138	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 12,945	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 13,227	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 13,004	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 13,177	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 13,315	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 13,138	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 12,945	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 13,227	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 13,004	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 13,177	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 13,315	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 13,138	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,008	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,290	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,068	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,240	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,379	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 13,201	118,165	5	-	-	2	1,740	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 12,946	111,763	5	-	-	2	1,571	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 13,228	110,668	5	-	-	2	901	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 13,005	114,119	5	-	-	2	1,391	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 13,178	115,542	5	-	-	2	1,344	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 13,316	115,093	5	-	-	2	1,138	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 13,139	118,165	5	-	-	2	1,740	-	-	-	-

Department Attachment 12

Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 211	(1,224)	-	-	-	-	(573)	(3)	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 16	2,032	-	-	-	-	(176)	(3)	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 199	3,411	-	1	-	-	(203)	(2)	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 397	2,742	-	2	-	-	(215)	(3)	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 216	5,794	-	2	-	-	345	(3)	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 19	(1,999)	-	-	-	-	(71)	2	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 175	333	-	2	1	(1)	(314)	-	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 189	1,353	-	1	-	-	(79)	1	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 506	(474)	-	3	-	-	(165)	(1)	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 287	2,740	-	3	-	-	295	(1)	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 290	(1,550)	-	2	-	-	(194)	(2)	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 92	1,812	-	2	-	-	525	(2)	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 182	4,671	-	1	-	-	194	(2)	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 294	4,658	-	(1)	-	-	(248)	(2)	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 155	7,511	-	(1)	-	-	499	(2)	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 5	(7,488)	-	(1)	-	-	(1,222)	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 181	(8,349)	-	-	-	-	(1,293)	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 5	(4,992)	-	-	-	-	(455)	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 72	(3,150)	-	1	-	-	(325)	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 91	(3,647)	-	1	-	-	(672)	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +15 GWh

Scenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 275	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 52	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 221	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 356	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 179	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 289	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 67	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 242	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 384	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 207	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 274	(1,092)	-	-	-	-	(673)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 79	2,471	-	-	-	-	(183)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 262	3,951	-	-	-	-	(230)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 397	3,441	-	-	-	-	(438)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 244	6,628	-	-	-	-	164	(3)	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 292	(1,282)	-	-	-	-	(668)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 42	2,027	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 204	3,125	-	-	-	-	(225)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 348	2,687	-	-	-	-	(431)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEH	$ 145	5,631	-	-	-	-	171	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 293	(1,093)	-	-	-	-	(672)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 88	2,481	-	-	-	-	(182)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 287	3,982	-	-	-	-	(228)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 428	3,445	-	-	-	-	(435)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEH	$ 267	6,668	-	-	-	-	167	(3)	-	-	-

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 273	(1,150)	-	-	-	-	(669)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 31	2,135	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 178	3,235	-	-	-	-	(226)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 315	2,825	-	-	-	-	(432)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEH	$ 121	5,752	-	-	-	-	170	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 264	(1,190)	-	-	-	-	(668)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 33	2,160	-	-	-	-	(178)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 210	3,232	-	-	-	-	(224)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 344	2,754	-	-	-	-	(430)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEH	$ 160	5,745	-	-	-	-	172	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 246	(1,622)	-	-	-	-	(667)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 10	1,701	-	-	-	-	(177)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 193	2,882	-	-	-	-	(223)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 320	2,241	-	-	-	-	(429)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEH	$ 134	5,156	-	-	-	-	173	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 302	(1,068)	-	-	-	-	(674)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 87	2,503	-	-	-	-	(183)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 256	3,999	-	-	-	-	(230)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 399	3,458	-	-	-	-	(438)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEH	$ 228	6,694	-	-	-	-	165	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 321	(1,198)	-	-	-	-	(678)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 115	2,476	-	-	-	-	(186)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 280	3,957	-	-	-	-	(233)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 426	3,283	-	-	-	-	(443)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEH	$ 263	6,624	-	-	-	-	162	(3)	-	-	-

Department Attachment 12
Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEH	$ 193	8,420	(1)	-	-	-	(465)	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 298	(3,016)	1	-	-	-	(220)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 60	2,388	-	-	-	-	(254)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 230	3,850	-	-	-	-	(326)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 377	3,497	-	-	-	-	(473)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEH	$ 183	6,499	-	-	-	-	(15)	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-

Department Attachment 12

Market Off Modeling Approach, Energy Efficiency +15 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 282	(1,095)	-	-	-	-	(670)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 59	2,356	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 232	3,779	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 370	3,330	-	-	-	-	(434)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEH	$ 193	6,402	-	-	-	-	169	(3)	-	-	-

Department Attachment 13

Market Off Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Import (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,000	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,270	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,058	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,243	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,344	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,177	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,250	113,753	5	-	-	2	1,376	3	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,426	112,276	5	-	-	2	765	-	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,242	115,511	5	-	-	2	1,197	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,463	117,563	5	-	-	2	1,130	1	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,638	117,052	5	1	-	2	1,011	-	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,450	120,565	5	-	-	2	1,467	-	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,706	117,289	5	-	-	2	997	3	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,832	119,688	5	1	1	1	708	1	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,669	122,773	5	1	1	1	1,131	1	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,864	119,842	5	2	-	2	1,279	3	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 14,159	119,007	5	2	-	2	838	-	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 13,948	122,189	5	2	-	2	1,316	-	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,712	109,478	5	-	-	1	2,203	3	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,974	107,406	5	2	-	1	1,691	-	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,785	110,743	5	2	-	1	2,437	-	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,872	113,183	5	2	-	1	2,247	-	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,988	111,357	5	3	-	1	2,209	-	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,876	114,223	5	3	-	1	3,120	-	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,451	105,283	5	-	-	1	2,161	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,587	103,738	5	2	-	1	2,195	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,422	107,086	5	2	-	1	3,089	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,489	109,236	5	2	-	1	3,123	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,508	108,717	5	2	-	1	2,759	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 12,419	112,060	5	2	-	1	3,585	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,108	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,371	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,159	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,340	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,441	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,274	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,891	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,169	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,957	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,145	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,246	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,079	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,880	111,005	5	-	-	2	1,747	3	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	14,142	110,050	5	-	-	2	1,033	-	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	13,957	113,458	5	-	-	2	1,563	-	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	14,153	115,036	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	14,248	114,205	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	14,105	117,283	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,096	113,625	5	-	1	1	1,739	3	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,376	112,357	5	-	1	1	1,030	-	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,137	115,630	5	-	1	1	1,560	-	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,310	117,090	5	-	1	1	1,517	1	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,418	116,430	5	-	1	1	1,293	-	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	12,225	119,353	5	-	1	1	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,556	110,901	5	-	-	2	1,742	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,837	109,958	5	-	-	2	1,032	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,643	113,365	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,855	114,958	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,955	114,102	5	-	-	2	1,293	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	13,804	117,204	5	-	-	2	1,940	-	-	-	-

Department Attachment 13

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,419	113,498	5	-	1	1	1,739	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,679	112,362	5	-	1	1	1,029	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,449	115,610	5	-	1	1	1,560	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,606	117,084	5	-	1	1	1,517	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,708	116,441	5	-	1	1	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	12,525	119,346	5	-	1	1	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,177	113,097	5	-	1	1	1,739	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,429	111,918	5	-	1	1	1,029	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,210	115,236	5	-	1	1	1,559	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,398	116,688	5	-	1	1	1,517	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,497	115,967	5	-	1	1	1,293	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	13,324	118,940	5	-	1	1	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,335	115,120	5	-	-	2	1,736	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,569	113,514	5	-	-	2	1,030	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,345	116,797	5	-	-	2	1,559	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,537	118,050	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,634	117,408	5	-	-	2	1,295	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	13,457	120,303	5	-	-	2	1,942	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	12,822	110,918	5	-	-	2	1,747	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	13,113	109,964	5	-	-	2	1,032	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	12,908	113,404	5	-	-	2	1,563	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	13,090	114,982	5	-	-	2	1,519	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	13,192	114,093	5	-	-	2	1,293	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	13,030	117,237	5	-	-	2	1,941	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	12,654	110,722	5	-	-	2	1,750	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	12,964	109,636	5	-	-	2	1,033	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	12,768	113,181	5	-	-	2	1,565	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	12,947	114,747	5	-	-	2	1,522	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	13,047	113,725	5	-	-	2	1,293	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	12,894	116,977	5	-	-	2	1,943	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,166	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,435	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,224	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,408	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,509	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	13,342	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,324	113,634	4	-	-	2	1,235	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,601	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,382	116,004	4	-	-	2	979	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,566	117,533	4	-	-	2	908	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,670	116,874	4	-	-	2	746	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	13,487	119,796	4	-	-	2	1,243	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	12,834	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	13,104	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	12,892	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	13,077	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	13,178	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	13,011	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	12,669	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	12,939	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	12,727	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	12,911	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	13,013	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	12,845	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,000	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,270	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,058	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,243	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,344	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	13,177	117,800	5	-	-	2	1,940	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,000	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,270	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,058	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,243	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,344	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	13,177	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,000	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,270	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,058	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,243	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,344	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	13,177	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,000	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,270	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,058	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,243	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,344	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	13,177	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,063	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,333	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,121	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,306	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,407	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	13,240	117,800	5	-	-	2	1,940	-	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,001	111,708	5	-	-	2	1,740	3	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,271	110,700	5	-	-	2	1,031	-	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,059	114,046	5	-	-	2	1,561	-	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,244	115,543	5	-	-	2	1,518	1	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,345	114,798	5	-	-	2	1,292	-	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	13,178	117,800	5	-	-	2	1,940	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

cenario	Forecast	Capital Cost	CO2 Price	Coal Price	Natural Gas Price	Wind Price	Solar Price	Market Price	Energy Efficiency	PVSC ($ Million)	CO2 Emissions (,000 tons)	Wind Units	Solar Units	CT Units	CC Units	Dump Energy (GWh)	Bridge PPA Units	Imports (GWh)	Exports (GWh)	Net Imports (GWh)
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 9	(1,758)	-	-	-	-	179	3	-	-	-
TEBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 184	(3,235)	-	-	-	-	(433)	-	-	-	-
TEBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 221	2,052	-	-	-	-	(67)	1	-	-	-
TLBG	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 396	1,541	-	1	-	-	(187)	-	-	-	-
TLBL	FCSH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 209	5,054	-	-	-	-	269	-	-	-	-
TEBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 37	(5,484)	-	(1)	(1)	1	(134)	2	-	-	-
TEBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 163	(3,085)	-	-	-	-	(423)	-	-	-	-
TEBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TLBE	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 195	(2,931)	-	1	(1)	1	148	2	-	-	-
TLBG	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 491	(3,765)	-	1	(1)	1	(293)	(1)	-	-	-
TLBL	FCSHH	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 279	(583)	-	1	(1)	1	186	(1)	-	-	-
TEBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-
TEBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 263	(2,072)	-	2	-	-	(512)	(3)	-	-	-
TEBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 73	1,265	-	2	-	-	234	(3)	-	-	-
TLBE	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 160	3,704	-	2	-	-	45	(3)	-	-	-
TLBG	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 277	1,878	-	3	-	-	6	(3)	-	-	-
TLBL	FCSL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 164	4,745	-	3	-	-	917	(3)	-	-	-
TEBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 32	(6,777)	-	(2)	-	-	(1,424)	1	-	-	-
TEBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 168	(8,322)	-	-	-	-	(1,389)	-	-	-	-
TEBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 3	(4,974)	-	-	-	-	(496)	-	-	-	-
TLBE	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 70	(2,824)	-	-	-	-	(461)	-	-	-	-
TLBG	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ 89	(3,343)	-	-	-	-	(825)	-	-	-	-
TLBL	FCSLL	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$ -	-	-	-	-	-	-	-	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	262	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	51	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	232	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	333	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPH	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	166	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	277	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	65	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	254	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	355	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPL	CO2M	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	187	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	263	(955)	-	-	-	-	(714)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	77	2,453	-	-	-	-	(184)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	274	4,031	-	-	-	-	(228)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	369	3,200	-	-	-	-	(455)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2H	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	225	6,278	-	-	-	-	193	(3)	-	-	-
TEBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	280	(1,268)	-	-	-	-	(709)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	41	2,005	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	214	3,464	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	322	2,805	-	-	-	-	(446)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2L	CLM	GASM	WNDM	SLRM	MKTM	EEHH	$	129	5,728	-	-	-	-	201	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	281	(943)	-	-	-	-	(710)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	87	2,464	-	-	-	-	(181)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	299	4,057	-	-	-	-	(224)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	399	3,201	-	-	-	-	(449)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLH	GASM	WNDM	SLRM	MKTM	EEHH	$	248	6,303	-	-	-	-	198	(3)	-	-	-

Department Attachment 13

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	260	(1,136)	-	-	-	-	(709)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	30	2,113	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	188	3,587	-	-	-	-	(221)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	290	2,944	-	-	-	-	(446)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLL	GASM	WNDM	SLRM	MKTM	EEHH	$	106	5,849	-	-	-	-	201	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	252	(1,179)	-	-	-	-	(709)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	33	2,139	-	-	-	-	(180)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	221	3,591	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	320	2,870	-	-	-	-	(446)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASH	WNDM	SLRM	MKTM	EEHH	$	147	5,843	-	-	-	-	202	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	234	(1,607)	-	-	-	-	(706)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	10	1,677	-	-	-	-	(177)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	202	2,930	-	-	-	-	(217)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	298	2,287	-	-	-	-	(441)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASHH	WNDM	SLRM	MKTM	EEHH	$	122	5,183	-	-	-	-	206	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	291	(954)	-	-	-	-	(714)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	86	2,486	-	-	-	-	(183)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	268	4,064	-	-	-	-	(227)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	370	3,175	-	-	-	-	(454)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASL	WNDM	SLRM	MKTM	EEHH	$	208	6,319	-	-	-	-	194	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	309	(1,086)	-	-	-	-	(717)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	114	2,458	-	-	-	-	(185)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	292	4,025	-	-	-	-	(228)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	393	3,003	-	-	-	-	(457)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASLL	WNDM	SLRM	MKTM	EEHH	$	239	6,255	-	-	-	-	193	(3)	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDH	SLRM	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	277	(2,934)	1	-	-	-	(203)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	58	2,370	-	-	-	-	(255)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	243	3,899	-	-	-	-	(326)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	346	3,239	-	-	-	-	(488)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDHH	SLRM	MKTM	EEHH	$	163	6,161	-	-	-	-	9	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDL	SLRM	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDLL	SLRM	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRH	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-

Market Off Modeling Approach, Energy Efficiency +30 GWh

TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRHH	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRL	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRLL	MKTM	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTH	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-
TEBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	-	-	-	-	-	-	-	-	-	-	-
TEBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	270	(1,008)	-	-	-	-	(708)	(3)	-	-	-
TEBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	58	2,338	-	-	-	-	(179)	(3)	-	-	-
TLBE	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	243	3,835	-	-	-	-	(222)	(2)	-	-	-
TLBG	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	344	3,090	-	-	-	-	(447)	(3)	-	-	-
TLBL	FCSM	CAPM	CO2M	CLM	GASM	WNDM	SLRM	MKTL	EEHH	$	177	6,092	-	-	-	-	200	(3)	-	-	-

MINNESOTA POWER'S PROJECTION OF CO2 EMISSIONS OVER PLANNING PERIOD

	ACTUAL	PROJECTED																			
Annual CO2 Emissions (tons)	2005	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
State GHG Goal Calculation	[TRADE SECRET EXCISED																				
CO2 Reduction from 2005 Levels																					TRADE SECRET EXCISED]

CERTIFICATE OF SERVICE

I, Linda Chavez, hereby certify that I have this day served copies of the following document on the attached list of persons by electronic filing, e-mail, or by depositing a true and correct copy thereof properly enveloped with postage paid in the United States Mail at St. Paul, Minnesota.

MINNESOTA DEPARTMENT OF COMMERCE – DER - COMMENTS

Docket Nos. **E015/RP-15-690**

Dated this **4th** day of **January, 2016**.

/s/Linda Chavez

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Christopher	Anderson	canderson@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022191	Electronic Service	Yes	OFF_SL_15-690_RP-15-690
Julia	Anderson	Julia.Anderson@ag.state.mn.us	Office of the Attorney General-DOC	1800 BRM Tower 445 Minnesota St St. Paul, MN 551012134	Electronic Service	Yes	OFF_SL_15-690_RP-15-690
William A.	Blazar	bblazar@mnchamber.com	Minnesota Chamber Of Commerce	Suite 1500 400 Robert Street North St. Paul, MN 55101	Electronic Service	No	OFF_SL_15-690_RP-15-690
Jon	Brekke	jbrekke@grenergy.com	Great River Energy	12300 Elm Creek Boulevard Maple Grove, MN 553694718	Electronic Service	No	OFF_SL_15-690_RP-15-690
Christina	Brusven	cbrusven@fredlaw.com	Fredrikson Byron	200 S 6th St Ste 4000 Minneapolis, MN 554021425	Electronic Service	No	OFF_SL_15-690_RP-15-690
Leigh	Currie	lcurrie@mncenter.org	Minnesota Center for Environmental Advocacy	26 E. Exchange St., Suite 206 St. Paul, Minnesota 55101	Electronic Service	No	OFF_SL_15-690_RP-15-690
Emma	Fazio	emma.fazio@stoel.com	Stoel Rives LLP	33 South Sixth Street Suite 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_15-690_RP-15-690
Sharon	Ferguson	sharon.ferguson@state.mn.us	Department of Commerce	85 7th Place E Ste 500 Saint Paul, MN 551012198	Electronic Service	No	OFF_SL_15-690_RP-15-690
Dave	Frederickson	Dave.Frederickson@state.mn.us	MN Department of Agriculture	625 North Robert Street St. Paul, MN 551552538	Electronic Service	No	OFF_SL_15-690_RP-15-690
Edward	Garvey	garveyed@aol.com	Residence	32 Lawton St Saint Paul, MN 55102	Electronic Service	No	OFF_SL_15-690_RP-15-690

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Barbara	Gervais	toftemn@boreal.org	Town of Tofte	P O Box 2293 7240 Tofte Park Road Tofte, MN 55615	Electronic Service	No	OFF_SL_15-690_RP-15-690
Janice	Hall	N/A	Cook County Board of Commissioners	411 W 2nd St Court House Grand Marais, MN 55604-2307	Paper Service	No	OFF_SL_15-690_RP-15-690
Lori	Hoyum	lhoyum@mnpower.com	Minnesota Power	30 West Superior Street Duluth, MN 55802	Electronic Service	Yes	OFF_SL_15-690_RP-15-690
Michael	Krikava	mkrikava@briggs.com	Briggs And Morgan, P.A.	2200 IDS Center 80 S 8th St Minneapolis, MN 55402	Electronic Service	No	OFF_SL_15-690_RP-15-690
John	Lindell	agorud.ecf@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012130	Electronic Service	Yes	OFF_SL_15-690_RP-15-690
Pam	Marshall	pam@energycents.org	Energy CENTS Coalition	823 7th St E St. Paul, MN 55106	Electronic Service	No	OFF_SL_15-690_RP-15-690
Daryl	Maxwell	dmaxwell@hydro.mb.ca	Manitoba Hydro	360 Portage Ave FL 16 PO Box 815, Station Main Winnipeg, Manitoba R3C 2P4 Canada	Electronic Service	No	OFF_SL_15-690_RP-15-690
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First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
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MINNESOTA'S SMARTER GRID

Pathways Toward a Clean, Reliable and Affordable Transportation and Energy System

VCE
VIBRANT CLEAN ENERGY

"This report shows that **Minnesota can achieve our 2050 greenhouse gas reduction goals** across the buildings, energy, and transportation sectors while providing reliable energy at affordable prices. Continuing our state's progress on **clean energy will not only allow us to tackle climate change**, but will significantly **reduce air pollution, increase human health, and boost our economy** by **tripling the number of energy sector jobs** by 2050."

- KATE WOLFORD
President of the McKnight Foundation

TABLE OF CONTENTS

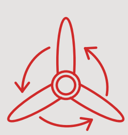
PREPARED BY:
Vibrant Clean Energy, LLC

PREPARED FOR:
McKnight Foundation & GridLab

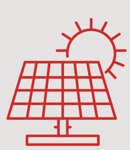
80% REDUCTION OF GAS EMISSIONS *by* 2050

THE NUMBERS

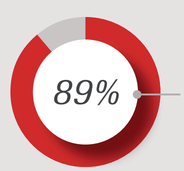
ENERGY SAVINGS PER HOUSEHOLD
$600 - $1200 per year

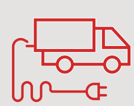


WIND JOBS
14,000



SOLAR JOBS
36,000





OF LIGHT-DUTY TRANSPORT
will be electric

30%

DECREASE IN PRICE PER KWH

ENERGY SECTOR
300%
increase in employment

Minnesota Gov. Tim Pawlenty signed the Next Generation Energy Act in 2007, bipartisan legislation designed to spur renewable energy deployment with the goal of decarbonizing the Minnesota economy 80% from 2005 levels by 2050. The *Minnesota's Smarter Grid* study modeled electric sector scenarios to determine optimal pathways that significantly decarbonize Minnesota's economy, in alignment with the Act's goals. The study was funded by the McKnight Foundation, managed by GridLab, and executed by Vibrant Clean Energy.

Vibrant Clean Energy used its WIS:dom energy model to project a future electric system of the entire Eastern United States grid out to 2050, with a focus on Minnesota. Initial economy-wide modeling suggests that in order to decarbonize 80% of the entire Minnesota economy by 2050, the electricity sector will need to decarbonize at 91% from 2005 levels, as it will be costly and difficult for other sectors to meet their 80% goals alone. The modeling includes significant electrification of heating and transportation, which allows for decarbonizing these sectors of the economy.

EXECUTIVE SUMMARY

KEY TAKEAWAYS

- Minnesota can have dramatically cleaner, more affordable, and more reliable electricity by significantly increasing renewable energy and clean transportation deployments. The state already benefits from home-grown clean energy production, and the scenarios detailed here will increase jobs, drive economic growth, reduce resident's electric bills, and deliver drastically improved air quality.
- To decarbonize the MN economy 80% by 2050 compared with 2005 levels, the electricity sector must decarbonize by 91% and serve new heating and transportation demands as those sectors electrify. Electrification includes a large expansion of residential and commercial water and space heat pumps, along with aggressive energy efficiency investments. We assume that by 2050, 89% of light-duty transport is electric vehicles.
- This deep decarbonized energy system will triple the number of jobs for Minnesota in the energy sector, creating an estimated 14,000 jobs in wind and 36,000 jobs in solar by 2050.
- Every major local and global air pollutant is reduced substantially.
- Residential electricity rates will remain stable or even fall.
- The cost of energy is reduced in all electrification and decarbonization scenarios. Households will save between $600 and $1200 a year on energy spending, amounting to cumulative economy-wide energy savings of up to $50 billion by 2050.
- In a business as usual scenario, natural gas is the dominant fuel, and emissions reductions cease by 2030. This natural gas future also exposes Minnesota to fuel price risk. In a decarbonized future, natural gas will play an important, but diminishing role in the reliable operation of Minnesota's grid. Flexible loads, interconnection to the wider MISO grid, and limited deployments of storage are a more cost-effective solution to address the variability of renewable generation.
- Minnesota can decarbonize without extending the current licenses of its two nuclear plants or building new nuclear. If the Eastern US decarbonizes along with Minnesota, new nuclear may be

deployed to provide carbon-free generation.

- While Minnesota can meet its decarbonization goals without expanding transmission, limiting new transmission investment will raise the overall cost of decarbonization. In addition, Minnesota could meet its goals with heavy reliance on distributed resources such as rooftop solar, but this pathway would require much more energy efficiency and additional costs.

OVERVIEW

The WIS:dom optimization model demonstrates numerous viable pathways to decarbonization through deployment of new in-state wind and solar generation, along with extensive energy efficiency, flexible loads, and electric storage. The model validates that Minnesota can effectively achieve a deep carbonization of the energy sector and meet its 2050 Next Generation Energy Act goals. The model further demonstrates that a high penetration of renewable energy and energy storage deployments *will not* threaten the reliability of the electric grid, while still providing service at prices less than current costs. Finally, these decarbonization pathways would deliver both jobs and increased revenue to Minnesota communities, provide enhanced air quality, and reduce overall greenhouse gas emissions.

GENERATING CAPACITY CHANGES

Currently, roughly a quarter of Minnesota's electricity comes from in-state coal fired generation, a fifth from Minnesota's two nuclear plants, a fifth from in-state wind, a quarter imported from outside Minnesota, and the final 10 percent from in-state natural gas fired generation.

By 2035, the model shows that wind and solar will make up 65% of Minnesota's generation, with the rest composed of imports (mostly renewable) from MISO and the Eastern Interconnection. Three percent of the generation will come from storage, which provides a key role in balancing supply and demand.

Nuclear energy provides low carbon electricity for the initial years, but MN can reach its decarbonization goals even with its two nuclear facilities retiring at the end of their current licenses. A scenario where the nuclear units stay online through 2050 increases electricity costs.

As the entire Minnesota economy electrifies, including the transportation, power, and heating sectors, the need for additional transmission upgrades declines as the load better matches the in-state generation. However, adequate transmission deployment is essential in keeping costs low during the decarbonization period. Minnesota will continue to exchange low-carbon electricity with MISO through decarbonization, but will become a net exporter of electricity by 2050 in the decarbonization scenario.

ELECTRICITY AND DEMAND

Increasing electric load over the next 30 years is due to electrification of heating and transportation, driven primarily by the latter and partially offset by increased energy efficiency. However, the deployment of these flexible loads, such as electric vehicle charging, are critical to economy-wide decarbonization, and result in significantly decreased energy costs over the scenario timelines. Importantly, increased electrification results in a higher nighttime winter load, increasing the value of "winter energy" and thus leading to higher wind deployments.

DECLINING COSTS AND INCREASED JOBS

Minnesotans currently pay an average of 10¢/kWh for electricity. In both the baseline and decarbonization scenarios, electricity costs fall considerably. Under the decarbonization scenario, electric prices are 3¢/kWh cheaper than today (around 7.2¢/kWh total), representing a decrease of approximately 30% by 2050. Employment in the electricity sector also jumps substantially. While coal and natural gas jobs, which currently encompass approximately one-half of the 20,000 jobs in the sector, drop precipitously, employment in the electricity sector overall almost triples, with the vast majority of jobs in wind and solar PV.

FINAL THOUGHTS

In order for the Minnesota economy to achieve an 80% reduction of greenhouse gas emissions by 2050, in line with its legislative goals, the electricity sector must decarbonize by at least 91%. Energy models indicate that a heavily decarbonized electric sector is possible at prices comparable to or lower than current electric costs, with a heavy focus on energy efficiency, along with the electrification of space heating, water heating, and transportation systems. A massive deployment of renewable energy will not disrupt the reliability of the electric grid, although increased transmission upgrades, as well as heavy transmission sharing and grid integration with neighboring states will be important to keep costs down as the sector decarbonizes. As natural gas and nuclear energy play a diminishing role in the states capacity mix, the flexible grid can efficiently support high penetrations of renewable energy as well as electrified heating and transportation systems. This flexible grid has the added bonus of improving air quality across all major human pollutants and reducing greenhouse gas emissions. The decarbonized trajectories will deliver both jobs and increased revenue to the state of Minnesota, with no sacrifice to system reliability or services.

I. BACKGROUND & SUMMARY

This study offers pathways and analysis of how Minnesota (MN) could transition from its current energy system to one that is decarbonized by 80% (from 2005 level) by 2050 [80x50]. The decarbonization would include the entire economy and is assumed to include energy efficiency measures, electrification, and generation changes. The study will model the entire United States (US) portion of the Eastern Interconnection along with electricity trade between the US, Mexico and Canada. The primary purpose of the study is to determine how Minnesota can meet the goals of 80x50 under various scenarios. These scenarios will be evaluated against a baseline scenario that assumes minimal electrification and no additional climate policies beyond those already enacted into law.

This study was commissioned by the McKnight Foundation in collaboration with GridLab and is an extension of two previous studies performed by Vibrant Clean Energy, LLC (VCE). The first previous study was commissioned by the Midcontinent Independent System Operator (MISO) to determine the effects of co-optimization for low-emission futures across the MISO footprint[1]. That study was primarily focused on assessing the impacts of high levels of renewables across MISO as emissions are reduced. The second previous study was commissioned by the University of Minnesota and VCE performed system modeling of MISO to determine how Minnesota might change with higher amounts of renewables and storage[2]. These two previous studies were developed around the electricity grid only, with minimal electrification of other sectors. They also only modeled the MISO footprint. The present study expands on those previous studies in several ways. First, the WIS:dom (Weather-Informed Systems: design, operation, markets) optimization model was expanded and enhanced. Secondly, the study is over the economy rather than just electricity. Thirdly, the demand-side is studied

1 https://www.misoenergy.org/_layouts/MISO/ECM/Redirect.aspx?ID=223249
2 http://energytransition.umn.edu/wp-content/uploads/2017/07/Workshop-Report-Final.pdf

in much greater detail. Fourthly, the WIS:dom optimization model solved for the entire US Eastern Interconnection footprint.

The study has shown that the economy in Minnesota can decarbonize by 80% (from 2005 levels) by 2050. All the decarbonization pathways involve deeper energy efficiency of existing electric demands (particularly in the industrial sector), heavy electrification of transportation, transitioning heating of space and water from natural gas and resistive heating to heat pumps, building new zero-emission generation technologies, and retiring fossil-fuel generation.

The electrification of other sectors provides the electricity sector with new demands, which have different load profiles to existing demands and have greater flexibility potential. These new loads provide increasing sales for the electricity sector to invest against. Further, the greater flexibility allows the electricity grid to incorporate more variable resources, which are low-cost and near-zero emissions. Further, the electrification provides net cost savings for consumers because the reduction in spending on other energy supplies (natural gas for heating and gasoline for transportation) outweighs the additional spending in the electricity sector for the electrified loads.

It was also demonstrated by the study that electrification and decarbonization at the same time can reduce the exposure to escalations of fuel prices (e.g. natural gas). These potential price increases would be unavoidable in a fossil-heavy future, while a future that is electrified and decarbonized can avoid such sensitivity. The study showed that if natural gas costs were higher, Minnesota could find itself spending a cumulative additional $16 billion on electricity by 2050. This compares with an estimated reduction in spending on energy in Minnesota of between $16 to $51 billion by 2050 if the economy electrifies and decarbonizes. This translates to a saving of between $600 to $1,200 per Minnesotan household per year.

The electrification and decarbonization of the Minnesotan economy could create more new jobs in the electricity sector than without these efforts. The study showed that on average decarbonized scenarios provided approximately 20,000 more full-time jobs than the baseline scenario (an additional 50%). These job increases are dependent on new generation assets being built to provide electricity for the growing new demand driven by the electrification of other sectors.

All the scenarios performed in the study showed declining cost per delivered unit of electricity for Minnesota through 2050. Part of the decline is due to growing demand and another portion is due to transitioning to generation assets with lower operating costs. These cost reductions, compared with average 2017 costs[3], could be less if more investment is required in the distribution grid or other spends were necessary within the system. The recent trend in electricity costs has been lower generation costs in exchange for higher costs in delivery of the electricity (e.g. transmission and distribution upgrades, interconnections costs, and reserves). The WIS:dom optimization model does not capture all the delivery costs explicitly (such as distribution costs), but does capture explicitly transmission costs, generation costs, demand-side management (DSM) / demand response (DR) costs, and implicitly distribution costs. The modeling showed continued downward pressure on the cost of generation, with overturn of older/uneconomic existing generation to new near-zero operating cost clean technologies. It further showed that the increased spending on transmission and sub-transmission (along with implicit distribution costs) was strongly outweighed by the decreased generation costs.

The modeling performed was designed to have a pathways component. This enabled comparisons between scenarios at different times. Overall, the total emissions for all the scenario pathways appear relatively similar until approximately 2030. The transition to natural gas from coal, from an emissions perspective, can look similar to a lower-emission driven target. However, once along a pathway that

3 Average retail cost of electricity in Minnesota for 2017 was 9.9¢/kWh.

invests heavily for natural gas, emission reductions cease and even climb in the longer term. This occurs because along those pathways with natural gas infrastructure there are sunk costs that must be recuperated; which slows investment in new lower cost generation. Essentially, decisions made earlier in the infrastructure buildout may lead to similar results in the short term, but has the potential to limit future emission reductions many years in the future.

One scenario was dedicated to the whole Eastern Interconnection electrifying and decarbonizing along with Minnesota. If Minnesota were to decarbonize its economy by 80% by 2050, the impact on emissions from the whole Eastern Interconnection would be small (not considering the leadership role that Minnesota would impart on the other states in the Eastern Interconnection). When the whole Eastern Interconnection decarbonizes with Minnesota there was a different pathway. Changes in the rest of the Eastern Interconnect creates feedback with decisions in Minnesota, which results in altering deployment of technologies to strengthen the progress across the whole Eastern Interconnection. A counter-intuitive result was that transmission needs decreased with electrification and decarbonization for the whole Eastern Interconnection. This was driven by changing local resource correlation to demand profiles and the higher flexibility available across the Eastern Interconnection to use variable resources efficiently.

Finally, the scenarios were dispatched at 5-minute intervals with 3-km weather data for an entire year for each investment period across the entire Eastern Interconnection. The highly detailed dispatch allowed the modeling to determine the benefits and disadvantages of each resource (generation, demand, storage, and transmission) and formulate an efficient way to reliably provide power. In fact, for all scenarios performed, the WIS:dom model was successful at providing the necessary balance between supply and demand for every 5-minutes throughout the footprint, without fail.

II. SCENARIOS PERFORMED

The McKnight Foundation, GridLab, VCE, and participant stakeholders identified a total of eight main scenarios to deploy the WIS:dom optimization model on for this study. Within some of the scenarios there was up to two branches that altered a single parameter to investigate the impact of that single change. Therefore, in total there was thirteen scenarios created and analyzed.

Every scenario was conducted over the entire US portion of the Eastern Interconnection for generator siting, transmission expansion, storage capacity expansion, demand-side resource deployment, transmission power flow, economic dispatch, and metric tracking. The time horizon for all the scenarios was 2050. The WIS:dom optimization model output for the investment periods 2017, 2020, 2025, 2030, 2040 and 2050. For each investment period, economic dispatch, power flow, and load balancing was performed for a single year with 5-minute intervals and 3-km weather data.

The scenarios performed for the study are listed below. The list includes the major features of each scenario that are assumed within the WIS:dom optimization model. The detailed results section will refer back to this list to identify the scenarios discussed.

A. ***Baseline:*** Current enacted policies and regulations. No carbon goals. WIS:dom makes economic choices to build new generation or retire old generation. All nuclear power plants in Minnesota stay online through their current licenses, which are 2030 (Monticello) and 2033/34 (Prairie Island). Load growth projections assumed to not include electrification of other sectors, and flexibility remains low. Cost projections are provided by the National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB) 2017 dataset[4]. Locational multipliers for capital and fuel costs are provided by VCE. The initialization (seeding) of the WIS:dom optimization model is based upon

4 https://atb.nrel.gov/electricity/2017/index.html

data for the end of 2016. VCE combined publicly available datasets for generation[5] and internally produced (reduced form) datasets for transmission. The baseline scenario has two branches;

1. ***Allowing interstate transmission expansion (Baseline w/ Tx);*** WIS:dom can build new transmission based on co-optimization to allow sharing of resources across state boundaries more efficiently; market friction elevates transmission costs between RTO boundaries.
2. ***Blocking interstate transmission expansion (Baseline w/o Tx);*** WIS:dom cannot build new transmission between states beyond estimated 2017 capacities; transmission for the integration of renewables within states to load centers/substations is applicable.

B. ***MN deep decarbonization:*** A carbon emission reduction target for Minnesota is set such that by 2050 the entire economy can only emit 20% of the carbon dioxide compared with 2005 emission levels[6]. As discussed in Section III, to achieve the 80% economy-wide reductions, the electricity sector must decarbonize by 91%. Substantial electrification and energy efficiency are assumed and are explained in detail in Section III. The electrification enables flexibility in the demand resources. The rest of the Eastern Interconnection and model assumptions are as in Baseline.

1. ***Allowing interstate transmission expansion (Decarb w/ Tx);*** see ***Baseline*** description around transmission modeling.
2. ***Blocking interstate transmission expansion (Decarb w/o Tx);*** see ***Baseline*** description around transmission modeling.

C. ***High natural gas (NG) costs:*** Use the AEO[7] high natural gas price forecast to determine the impacts on the baseline and decarbonization scenarios. The rest of the Eastern Interconnection are as in Baseline.

1. ***Baseline with high natural gas costs (Baseline + High Gas);*** Apply high natural gas prices to the ***Baseline w/ Tx*** scenario.
2. ***Decarbonization with high natural gas costs (Decarb + High Gas);*** Apply high natural gas prices to the ***Decarb w/ Tx*** scenario.

D. ***Zero emission decarbonization MN:*** Minnesota electricity must be completely decarbonized by 2050 (including imported power). All other assumptions identical to the ***MN deep decarbonization*** scenario.

1. ***Allowing interstate transmission expansion (100% w/ Tx);*** see ***Baseline*** description around transmission modeling.
2. ***Blocking interstate transmission expansion (100% w/o Tx);*** see ***Baseline*** description around transmission modeling.

E. ***Eastern Interconnection decarbonization with MN:*** The entire Eastern Interconnection electrifies and decarbonizes the economy to 80% (of 2005 emissions) by 2050. All other assumptions identical to the ***MN deep decarbonization*** scenario.

1. ***Allowing interstate transmission expansion (EI w/ Tx);*** see **Baseline** description around transmission modeling.

F. ***MN deep decarbonization with dominant distributed energy resources (DERs):*** Minnesota decarbonizes while giving preference to localized resources such as electric vehicles (EVs), DSM,

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5 https://www.eia.gov/electricity/data/detail-data.html

6 The total carbon dioxide emissions allowed by 2050 for Minnesota is 22.4 million metric tons (20% of 111.9 million metric tons in 2005). Electrification of other economic sectors results in the rest of the economy emitting 17.9 metric tons by 2050 (the residual emissions from the extremely hard to decarbonize sectors). Thus, the electric sector in Minnesota must provide electricity while emitting at most 4.5 million metric tons by 2050 to achieve the 80% target. Import/export emissions are included in the computations of emissions.

7 United States Energy Information Administration (EIA) Annual Energy Outlook (AEO) that provides forecasts for energy metrics.

DERs, and additional energy efficiency (EE). All other assumptions identical to the ***MN deep decarbonization*** scenario.

1. ***Allowing interstate transmission expansion (Local Decarb);*** see **Baseline** description around transmission modeling.

G. ***MN deep decarbonization with less flexibility:*** Minnesota decarbonizes through electrification, but the electrification does not provide as much flexibility potential. All other assumptions identical to the ***MN deep decarbonization*** scenario.

1. ***Allowing interstate transmission expansion (Low-Flex Decarb);*** see ***Baseline*** description around transmission modeling.

H. ***MN deep decarbonization nuclear sensitivity:*** Minnesota decarbonizes, but the treatment of nuclear power plants is changed for two different sensitivities. All other assumptions identical to the ***MN deep decarbonization*** scenario.

1. ***Nuclear power plants can retire when economic (Nuclear Retirements);*** Allow the nuclear power plant to retire based on economics for the ***Decarb w/ Tx scenario***.
2. ***Nuclear power plants must relicense through 2050 (Nuclear Relicenses);*** Enforce nuclear power plant relicenses through 2050 for the ***Decarb w/ Tx*** scenario.

Scenarios Completed

ID		Scenario	Transmission Expansion	Emission Target	Electrification	MN Flexibility Level	EI Flexibility Level	NG Cost	Nuclear Retirement	DERs
A	1	*Background*	Interstate & Intrastate Allowed	Current Policies	EI Minimal	0% to 2.1% by 2050	0% to 2.1% by 2050	NREL ATB - Low	Follow License Schedule	No Lower Limit
	2		Intrastate Allowed Only							
B	1	*MN Deep Decarbonization*	Interstate & Intrastate Allowed	**MN 80% Economy Reduction**	**MN Extensive**	**0% to 20.8% by 2050**	0% to 2.1% by 2050	NREL ATB - Low	Follow License Schedule	No Lower Limit
	2		Intrastate Allowed Only							
C	1	*High NG Cost*	Interstate & Intrastate Allowed	Current Policies	EI Minimal	0% to 2.1% by 2050	0% to 2.1% by 2050	**AEO 2018 - High**	Follow License Schedule	No Lower Limit
	2			**MN 80% Economy Reduction**	**MN Extensive**	**0% to 20.8% by 2050**				
D	1	*Zero Emission Electricity MN*	Interstate & Intrastate Allowed	**MN 84% Economy Reduction**	**MN Extensive**	**0% to 20.8% by 2050**	0% to 2.1% by 2050	NREL ATB - Low	Follow License Schedule	No Lower Limit
	2		Intrastate Allowed Only							
E	1	*EI Decarbonizes with MN*	Interstate & Intrastate Allowed	**EI 80% Economy Reduction**	**EI Extensive**	**0% to 20.8% by 2050**	**0% to 20.8% by 2050**	NREL ATB - Low	Follow License Schedule	No Lower Limit
F	1	*MN Deep Decarb. with Dominant DERs*	Interstate & Intrastate Allowed	**MN 80% Economy Reduction**	**MN Extensive**	**0% to 32.3% by 2050**	0% to 2.1% by 2050	NREL ATB - Low	Follow License Schedule	**50% from DERs**
G	1	*MN Deep Decarb.with less Flexibility*	Interstate & Intrastate Allowed	**MN 80% Economy Reduction**	**MN Extensive**	**0% to 5.2% by 2050**	0% to 2.1% by 2050	NREL ATB - Low	Follow License Schedule	No Lower Limit
H	1	*MN Deep Decarb. Nuclear Sensitivity*	Interstate & Intrastate Allowed	**MN 80% Economy Reduction**	**MN Extensive**	**0% to 20.8% by 2050**	0% to 2.1% by 2050	NREL ATB - Low	**Allow Early Retirement**	No Lower Limit
	2								**Keep Online Through 2050**	
			External Decision On Transmission Expansion	*Reductions is taken from the 2005 emission record*	*Electrification of Sectors*	*Percentage of Demand*				*Percentage of Demand*

Summary of the thirteen (13) scenarios performed for the present study. The table highlights the major components and assumptions that differentiates each scenario. The purpose of the scenarios was to explore possible futures that might occur for Minnesota as it attempts to decarbonize its economy. These scenarios provided the necessary insight to comment on the major hurdles that different futures might impose on the pathway possibilities.

III. ELECTRIFICATION POTENTIAL & ASSUMPTIONS

For any study carried out there are input assumptions that influence the overall conclusions. For this study, the most significant assumptions are how much energy is transferred from other sectors to electricity due to electrification, the geographic and temporal profiles of the electrified loads and the flexibility of these new energy (electricity) demands. The WIS:dom optimization model primarily considers electrical (and some thermal) energy. Therefore, input demands are required for the model to optimize upon. A detailed description of the WIS:dom optimization model, its internal assumptions, logical equations, and input data is provided in Section V of this report. The present section is dedicated to assumptions specific for this study related to the electrification component.

For the purposes of this study the energy demand is disaggregated into four categories: Residential, Commercial, Industrial, and Transportation. The main changes that occur during electrification are as follows:

I. Transportation electrification,

II. Space heating in the residential sector transitioned to heat pumps,
III. Space heating in the commercial sector transitioned to heat pumps,
IV. Water heating in the residential sector transitioned to heat pump water heaters,
V. Water heating in the commercial sector transitioned to heat pump water heaters,
VI. Energy efficiency programs applied to residential, commercial, and industrial sectors.

The combination of changes I-VI above enables sufficient electrification and reduction in emissions outside the electricity sector for Minnesota to meet its goal of 80x50 (80% reduction in emissions by 2050). The annual energy needs for Minnesota were provided by Synapse Energy Economics (Synapse) along with the remaining emissions outside of the electricity sector. These energy and emission numbers provided boundary conditions for the WIS:dom optimization model to solve for.

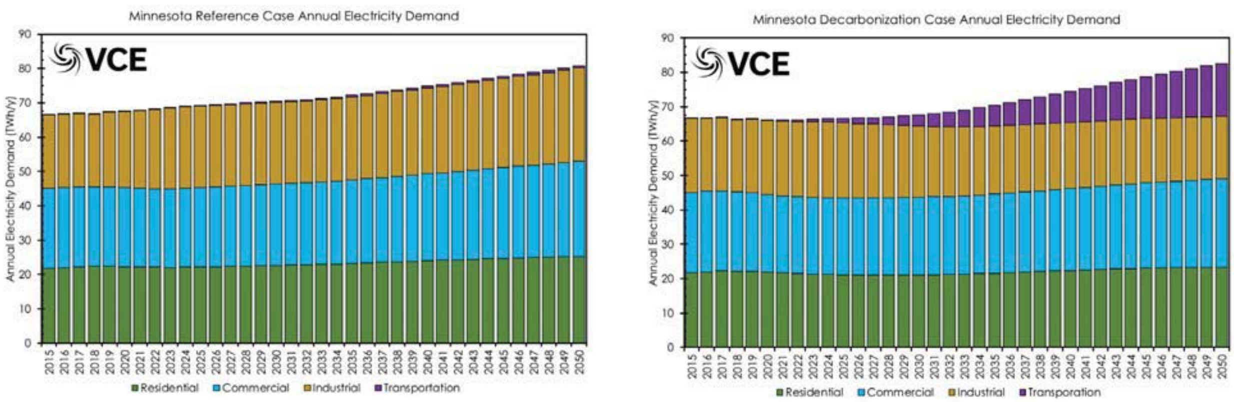


FIGURE 1: *Synpase provided electricity demand for each sector for the Baseline case (left) and the Decarbonization case (right). The electricity sector must undergo dramatic change between 2015 and 2050. There is strong energy efficiency, and new loads appearing in the demand.*

Due to the new demands being added to the electricity profile and the reduction in traditional demands through energy efficiency, the total amount of electricity required by 2050 is only slightly higher for Decarbonization than for the Baseline. Figure 1 displays the total annual electrical energy demand for each year between 2015 and 2050 for the two cases. The figure illustrates the changing composition of the demand, but masks many of the changes within each sector. The increase in electricity demand by 2050 for the decarbonization case over the baseline case is 1,690 GWh (2.1%).

As there is such a small increase in the overall electrical energy required to achieve deep electrification and decarbonization, more explanation is required to the composition of the sectors. The largest assumption is the use of energy efficiency. There are deep reductions in traditional demands projected using these programs. Figure 2 displays the cumulative impact of energy efficiency assumed in the demand data. The figure shows that it is assumed that end-use electricity demand is reduced by 19,600 GWh by 2050 through the energy efficiency programs. The reductions are reported against the Baseline case.

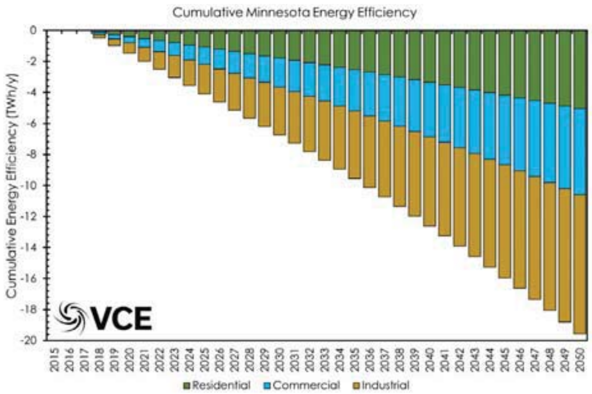


FIGURE 2: *The cumulative adjustment to Minnesota traditional electricity demands from energy efficiency. The programs combine to reduce the end-use electricity demand by 19,600 GWh by 2050. These energy efficiency savings are reductions compared to the Baseline case.*

With energy efficiency there is a reduction in the demand; however, Figure 1 shows an overall increase in demand for the decarbonization case. The increase comes from three areas. The first is the electrification of space heating. There are two components to this electrification; a decrease in demand by transitioning electric resistive heating to heat pumps and an increase in demand by transitioning natural gas furnaces to heat pumps. These changes are assumed to occur in the residential and commercial sectors. The second area of increased demand is transitioning water heating to heat pump water heaters. Similar to the space heating, some of the transition involves moving from electric resistive water heaters to heat pump water heaters and some comes from natural gas water heaters to heat pump water heaters. Figure 3 shows the cumulative fraction of space and water heating that become heat pumps by year. The figure estimates growth in the adoption of heat pumps more rapidly for residential than commercial sectors; with 2050 fractions approaching 60 to 75% of all space and water heated by heat pumps across Minnesota.

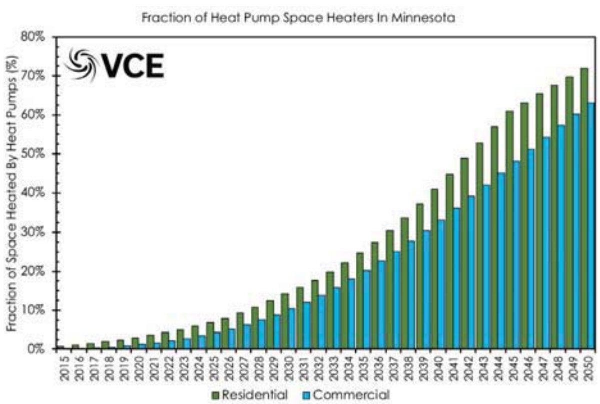


FIGURE 3: *The cumulative fraction of space (left) and water (right) heating provided by heat pumps by year. There are separate fractions for residential and commercial sectors. It is assumed that the adoption in the residential sector is faster than in the commercial sector. By 2050, 72% of residential and 63% of commercial spaces in Minnesota are heated by heat pumps. For water heating, the numbers are slightly higher, 75% and 69% of water heating occurs by heat pumps in the residential and commercial sectors, respectively.*

The third, and most substantial, increase in demand comes from electrification of transportation. It is assumed that light-, medium-, and heavy-duty transportation to some degree can be electrified. The most readily available sub-sector to electrify is light-duty vehicles, while medium- and heavy-duty are assumed to take a slower adoption curve. It is assumed that 89% of all light-duty vehicle miles travel are electrified by 2050, which is displayed in Figure 4. Overall, the electrification of transportation covers 22% of all ton-miles by 2050. The electrification of transportation is one of the biggest areas of emission reduction for Minnesota, if the electricity sector can be decarbonized alongside the electrification.

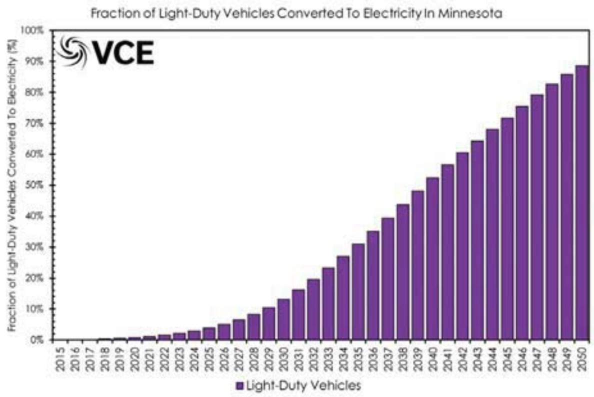


FIGURE 4: *The cumulative adoption curves for light-duty vehicles (left, in fraction of vehicle miles traveled) and all transportation (right, in fraction of ton-miles). The assumption is low adoption to 2020, rapid growth through 2030 and approximately linear growth from 2030 to 2050. The growth in electrification of transportation increase demand substantially in Minnesota.*

The additional demands from space and water heating along with transportation are somewhat compensated for with the additional energy efficiency assumed in each sector. Below, in Figure 5, it is shown how transportation is the largest net growth in demand, while the other three sectors have net reductions in demand. Both residential and commercial fall by smaller amounts compared with industry because of the added demands from electrified heating (space and water). Once the energy demand changes are summed, the resulting electrical energy needs for decarbonization by 2050 is approximately the same as in the baseline case.

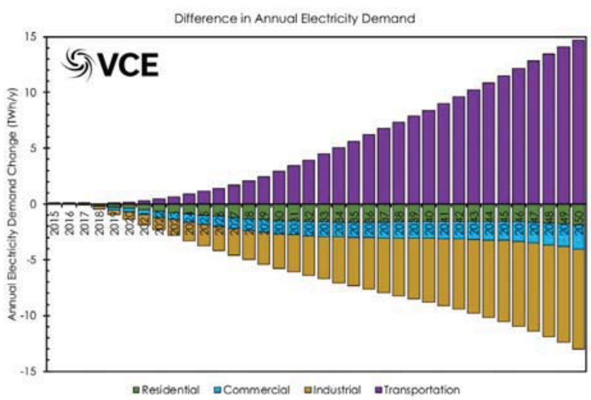
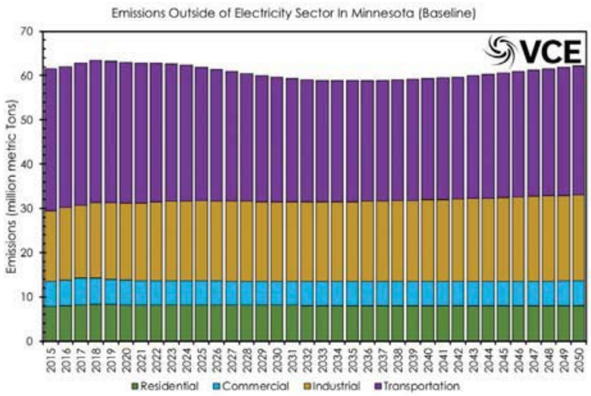


FIGURE 5: *Net electrical energy requirements by sector. Transportation creates strong demand increases, while industry (through energy efficiency) creates strong demand decreases. The electrification of space and water heating does not outpace assumed energy efficiency for residential and commercial sectors; however, it does limit the decrease in demand substantially.*

The purpose of electrification of other sectors is to remove greenhouse gas (GHG) emissions from sources outside the electric sector and then have the electric sector decarbonize, since the types of clean energy for the electricity sector are low-cost. Figure 6 displays the baseline and decarbonization GHG emissions for those sectors outside of electricity. The reduction in GHG emissions by electrification is 44 million metric tons by 2050. That represents 71% of all GHG emissions coming from sources outside the electricity sector in 2017. It also accounts from more emissions than the entire Minnesota electricity sector emitted in 2017. This illustrates one of the most important features of electrification. Decarbonizing the electricity sector alone will not reduce GHG emissions enough to reach the 80% reduction by 2050.



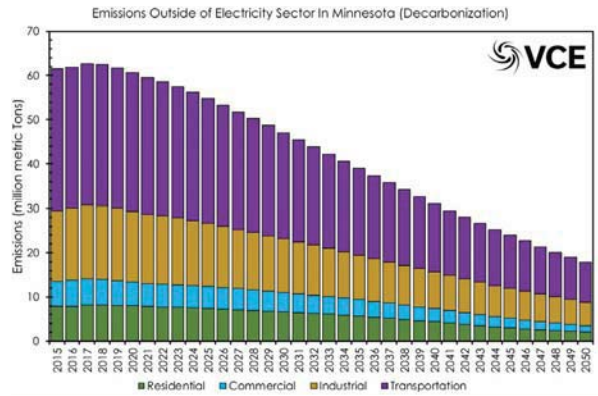


FIGURE 6: *The GHG emissions from sources outside the electricity sector under the baseline case (left) and the decarbonization case (right). The GHG emissions from all four sectors are decrease substantially by 2050 in the decarbonization case compared to the baseline case. The largest decreases occur within the transportation and industrial sectors. By electrifying energy needs, the GHG emissions from sources outside the electricity sector falls by 44 million metric tons (71%). That reduction is more than the entire electricity sector emitted in 2017.*

The GHG emissions still present by 2050 from sources outside electricity total 17.9 million metric tons. Therefore, to meet the 80% reduction (from 2005 levels) in GHG emissions from the Minnesota economy by 2050, the electricity sector can only emit a maximum of 4.5 million metric tons. This emission number was calculated by taking the 2005 emission level, 111.9 million metric tons, and reducing it by 80%, leaving a total of 22.4 million metric tons. The emission reduction for the electricity sector is equivalent to 91% decarbonization (while providing more electricity) from 2005 levels.

The components of electrification are important. Even though Figure 1 displays relatively little change in end use annual electricity needs, it does show that the composition of the demand has changed significantly. The different electrified demands have new profiles that are not represented in the electricity profiles that exist today. To compute the new additional demand profiles at hourly (and 5-minutely) resolution VCE built algorithms that used weather data, human social patterns, and the properties of the new technologies. These profiles then formed the basis for the demand-side flexibility as well as the input load profiles for the WIS:dom optimization model.

For electric vehicles, first the historical total amount of gasoline purchased per month and vehicle miles traveled were compiled[8,9]. These numbers provided the necessary analogue for the driving patterns for each month, as well as the additional energy use for heating and cooling the vehicles in each season. Driving patterns and energy use were also correlated to the weather throughout those months. Secondly, the temperature impacts on the electric batteries was considered. It is well known that batteries are strongly influenced by temperature. Outside of their normal operating temperature (~20ºC / 68ºF) the efficiency of the battery is reduced[10]. Colder temperatures have a greater impact than higher temperatures. Colder temperatures can increase energy consumption per unit distance traveled by up to 30%. Battery thermal management (BTM) devices can reduce this impact. However, overall a combination of the additional heating required for the cabin in winter months along with reduced efficiency of the battery pack increases the electricity energy requirements by 40% compared with summer months, even when including the fact that people tend to travel more miles in summer months. Combining these factors with charging pattern behaviors, it is determined that peak charging

8 Gasoline Sales: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=a103600001&f=m
9 Vehicle Miles Traveled: https://www.fhwa.dot.gov/policyinformation/travel_monitoring/historicvmt.cfm
10 https://www.sciencedirect.com/science/article/pii/S0378775316308941

would occur in the winter months overnight[11]. These charging patterns are inputs to the WIS:dom optimization model. These patterns can be altered by the model if it is cost effective to do so (paying customers to not charge, and do so at a later date). Figure 7 shows the average input profiles for daily electricity needs and the diurnal cycling of charging.

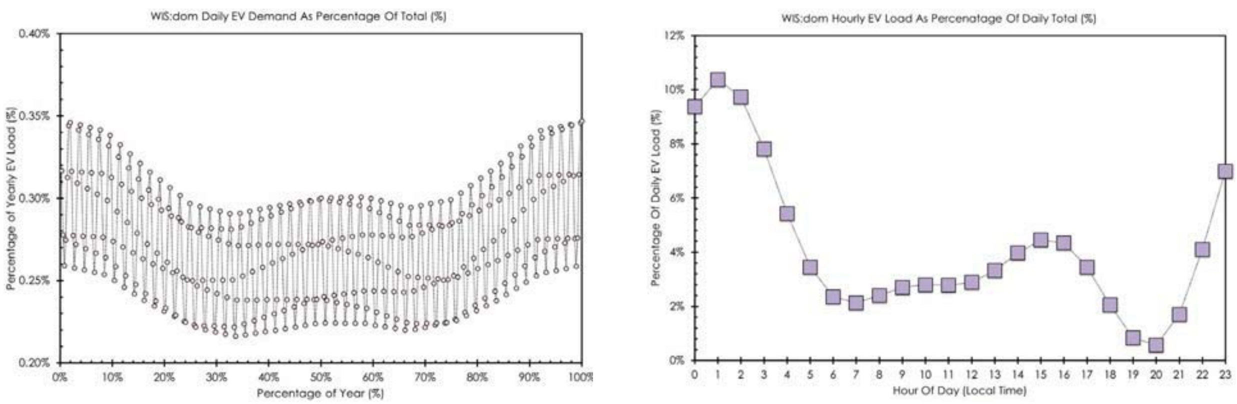


FIGURE 7: *The daily electricity requirements as a percentage of annual transportation energy that is electrified (left) along with the diurnal profile based upon social patterns (right). The electricity needs are higher in winter than summer, and the charging profile is higher overnight than during the day. These inputs can be adjusted by the WIS:dom model (for a cost) to shift the charging around supply, if it is economical to do so.*

For heating there are two main components, space and water. Space heating is very strongly correlated with the ambient air temperature. Water heating is also correlated to ambient air temperature, but to a much smaller extent (most customers want hot water available all day, every day). The temperature from the weather data was used to compute the temperature-heating demand correlation profiles. The amount of end-use energy was computed for each month based upon natural gas sales[12]. With the correlation calculated the electrical energy required for each day was computed. From the diurnal cycle of temperature, it was possible to compute when the electricity was required throughout the day. Commercial and residential space and water heating combine to produce Figure 8. The electrical energy requirements for heating in winter is 6- to 7-fold greater than in summer. There is still some electricity required for heating in the summer months for water heating and build stock that is kept at a relatively constant temperature, regardless of season. There is a clear weekly cycle for the heating, due to the coincident electrical needs of the residential and commercial heating. The diurnal cycle is an average requirement that is dependent on the diurnal temperature changes that occur in Minnesota. As with the EVs the highest demands occur in the winter months in the evening and night-time hours.

11 https://www.energy.gov/sites/prod/files/2014/12/f19/SGIG-EvaluatingEVcharging-Dec2014.pdf
12 https://www.eia.gov/dnav/ng/ng_cons_sum_a_EPG0_vgt_mmcf_m.htm

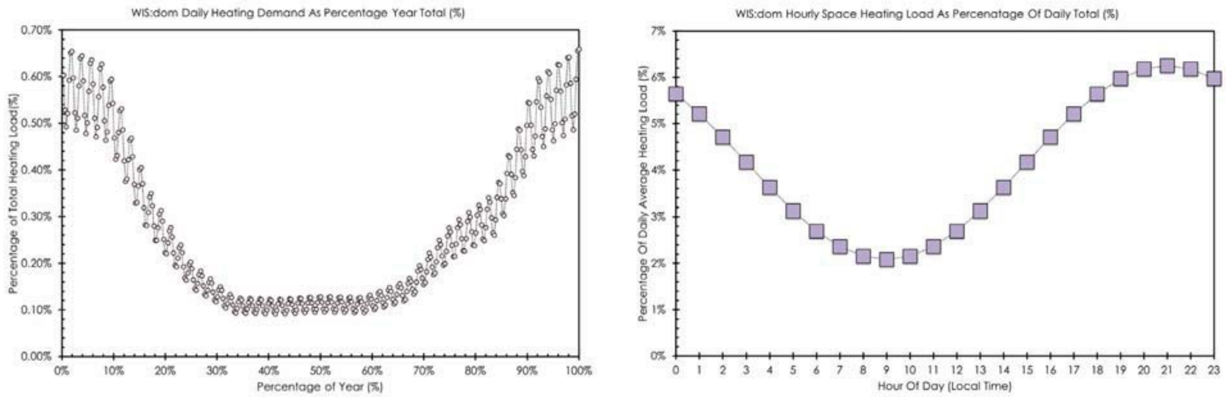


FIGURE 8: *The daily requirements of electricity for heating (left) and the diurnal cycle for heating (right). The panels show the aggregated requirements for space and water heating for both residential and commercial buildings. There is still heating needs in summer for water heating and for some building stock that is kept at a constant temperature. The electrical energy needs in winter is 6- to 7-fold greater than that in summer for Minnesota. The weekly cycles are more apparent in winter compared with summer due to the commercial and residential coincident requirements.*

The new demands for electricity are additions to the traditional load profiles. The traditional loads are exposed to energy efficiency, which reduces the total amount of electricity required. It was assumed that energy efficiency applies as a percentage reduction for every 5-minute demand interval. Therefore, the more electricity required in that time interval, the larger the energy efficiency reduction. The culmination of all these demand changes is a very different time series of the load for each investment period as more loads are electrified.

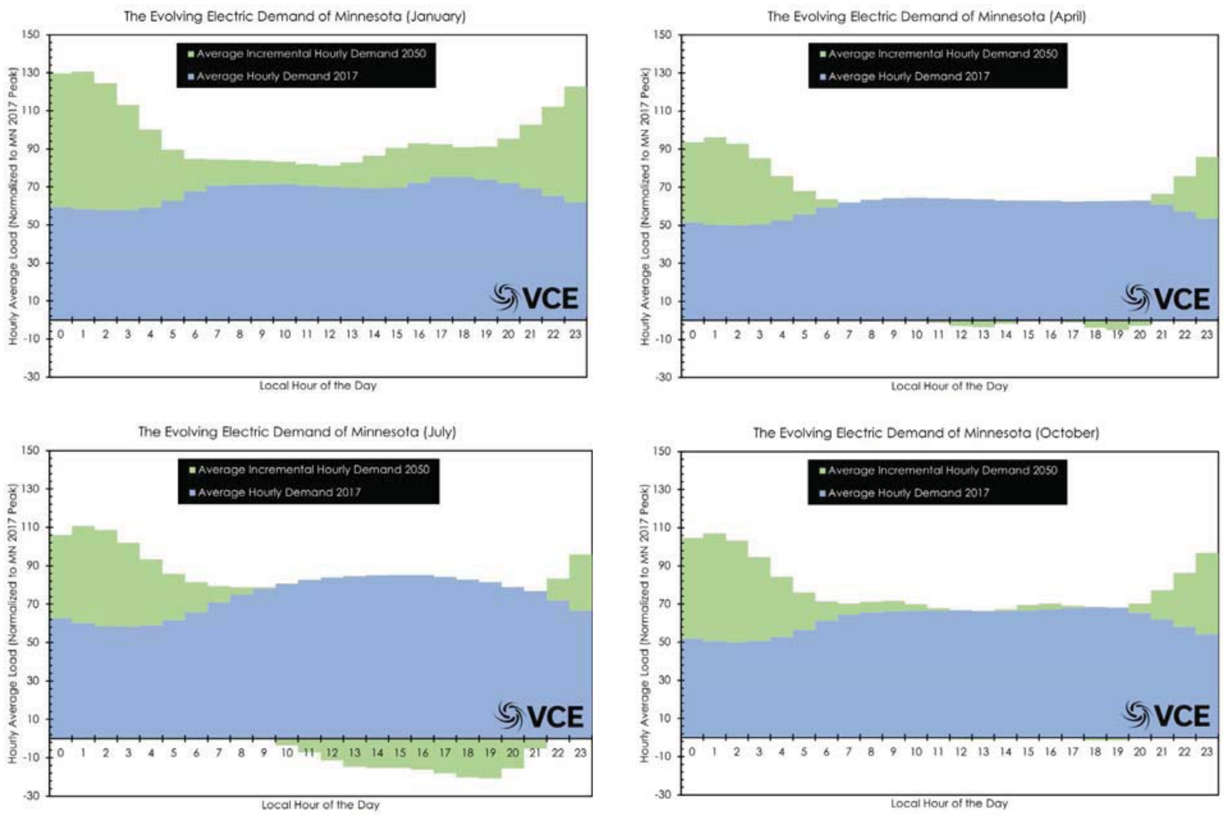


FIGURE 9: *The average hourly demand profiles for four months: January (top-left), April (top-right), July (bottom-left), and October (bottom-right). Blue shows the 2017 normalized load (100 = 2017 peak hourly demand) and green shows the incremental demand by 2050. In colder months there is a substantial increase in electricity demand, while in the hotter months the increase is smaller, or even negative in day-time hours.*

Figure 9 shows the average hourly daily cycle for four months (January, April, July, and October) to represent each season. The WIS:dom optimization model executes over each 5-minute interval for a year, but for display purposes that is cumbersome. This Figure illustrates the general changes in demand profiles between 2017 and 2050. The changes in demand result in a reduction in day-time electricity requirements in warmer months, but an increase (substantial) in electricity needs for the night-time hours in the colder months. Figure 9 shows average hourly profiles over four months. Figure 10 shows the average hourly electricity requirements for 2017 and 2050, normalized to the peak of 2017 (=100). The figure shows that Minnesota transitions from a summer to a winter peaking state. This is due to energy efficiency of traditional loads in combination with new loads in heating and EVs, which are highest in colder conditions.

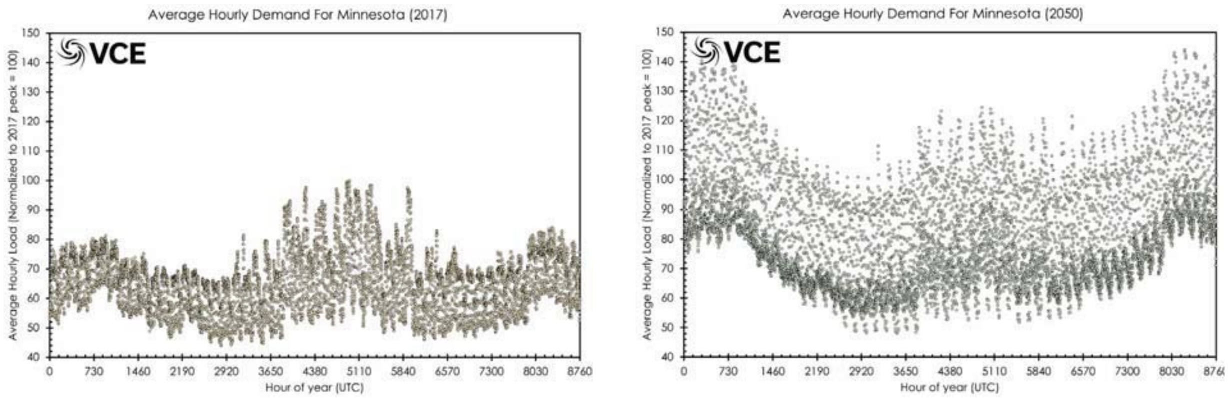


FIGURE 10: *The average hourly demand profile for Minnesota for 2017 (left) and an electrified and decarbonized 2050 (right). The values are normalized to the peak demand in 2017 (=100). The panels show that the demand has become more oscillatory diurnally. Additionally, it can be seen that Minnesota has become a winter peaking state. The growth in electricity needs is highest in the colder months.*

In Figure 11, the ratio of the hourly demand between 2050 and 2017 is shown. It demonstrates the higher increase in demand for the winter months compared with the summer months. This property is important for flexibility. It is assumed that these new loads are more capable of flexibility and for the colder time periods there is a higher percentage of these demands comprising the total demand. Therefore, there is more available flexibility for those time periods.

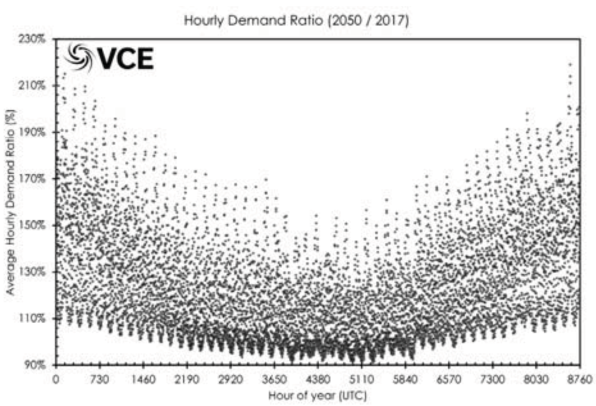


FIGURE 11: *The ratio of the 2050 hourly loads to the 2017 ones. The plot illustrates the impact of these new demands (including EE). Essentially, the summer month minimums in 2050 are lower than in 2017 and the maximums in winter are up to twice those in 2017.*

The input demand profiles are for each of the investment periods and the profiles change depending on the amount of each sector electrified (and the energy efficiency applied). In addition, the fraction of each 5-minute interval for each demand type is stored for WIS:dom to determine the amount of demand-side flexibility that is available. These demand-side resources are dispatched by WIS:dom if it determines the cost of doing so is lower than additional supply resources. The demand-side resources must balance with user-defined reductions allowed (for Demand Response) or be a net-zero for demand-side management (DSM). Essentially, WIS:dom is informed of the demand-side in the absence of cost signals or changing social behaviors. WIS:dom can then alter those demand resources based on price signals to shift the use of electricity. These resources are separate to storage, which in an abstract sense performs the same function.

In the decarbonization cases, it is assumed that 50% of the EV fleet can be has a flexible charging schedule. No vehicle-to-grid is allowed. If there is demand present, WIS:dom must pay a charge to shift the demand to another time period. The demand for EVs must be balanced within a five-day time period. It is further assumed that 25% of heating demands can be used for flexibility, which must be in balance within a four hour-time period. Again, WIS:dom must pay a charge per MWh shifted to dispatch the DSM resources. A minimum charge of $21 / MWh is charged to dispatch DSM resources, with that charge escalating to $60 / MWh up to the limit of the flexibility. The blocks of DSM are in 5-minute intervals. Thus, they can contribute to resource adequacy within WIS:dom. The model could decide to not use the DSM resources, in which case the input demand profile must be met by supply-side resources.

The present section has explained a new formulation for demand-side shifts that could occur due to electrification. These assumptions and computations result in a future demand resource mix very different to the one that exists today. For Minnesota, that means an evolution that moves the peak demand from summer day-time to winter night-time. Further, it provides the Minnesota grid with various new sources of flexibility that could be low-cost. Indeed, there is more flexibility available at (the new) peak times than at other times.

The general assumption around DSM is predicated on the demand-side participating in the market; providing and receiving signals that can utilize the flexibility that could arrive from electrification. The increased electricity needs along with its new flexibility provides more room for variable resources to operate and a combination of these resources to provide robust power supply. Finally, the demand-side changes involve many more modular components (individual EVs, heat pumps, water heaters, etc.) and as such enable finer adjustments along with the statistical knowledge of fewer large impact events of units disappearing (e.g. a large coal-fired power plant tripping offline). Therefore, the demand-side becomes an integral area for the planning of the system and, as will be discussed in later sections, can be utilized to accommodate more low-cost, low-emission variable resources.

In WIS:dom, for the present study, rooftop solar PV is considered a generation resource. As such, it is determined via siting within the core of WIS:dom codes. A reduction of demand within the region for thermal heat gain on the rooves is calculated; and a computation is made for the carrying capacity of the existing distribution grid. Implicitly, additional spend is allocated if the rooftop solar is installed above that carrying capacity. Essentially, rooftop PV does not "mask load" and does participates in the markets. Rooftop solar PV does not have a transmission cost associated with it, and the losses are assumed to be the average of the distribution grid (unless power flows out to the transmission grid).

No costs associated with the build out of infrastructure of the electrification is considered by WIS:dom. It is assumed that those costs are a burden on other sectors and not the electricity sector. All costs for new electricity capacity and fuel come from the NREL ATB 2017 dataset[13]. Two exceptions exist, AEO 2017 high gas price[14] for one sensitivity and storage costs are taken from a previous study performed by VCE[15].

IV. DETAILED OVERALL FINDINGS

In this section, the major metrics from all the scenarios are compared, discussed and analyzed for general conclusions. All the outputs from the WIS:dom optimization model and spreadsheets for each scenario (that are used to produce the present section) are provided for use by McKnight Foundation and GridLab to use as required. In the next section, each scenario will be discussed in more detail with respects to the WIS:dom outputs and scenario specifics.

The first major metric is the cost per unit of electricity provided to customers. The WIS:dom optimization model explicitly computes the fixed and operating costs for each generator to provide service. It also calculates the cost of transmission, wheeling charges, and ramping costs for generators. In addition, WIS:dom considers the cost to the system to provide demand-side resources. Finally, the model (implicitly) provides the cost of distribution upgrades by increasing the cost of electricity

13 https://atb.nrel.gov/electricity/2017/index.html
14 https://www.eia.gov/outlooks/aeo/
15 http://energytransition.umn.edu/wp-content/uploads/2017/07/Workshop-Report-Final.pdf

generation, transmission, storage and DSM by $22.43 / MWh[16]. This allocated $59.2 billion for distribution spending in 2017 across the Eastern Interconnection[17]. The adjustment is based on the need for WIS:dom to increase the infrastructure within the distribution grid (which is not explicitly modeled) for rooftop solar PV, residential DSM programs and other investment needs.

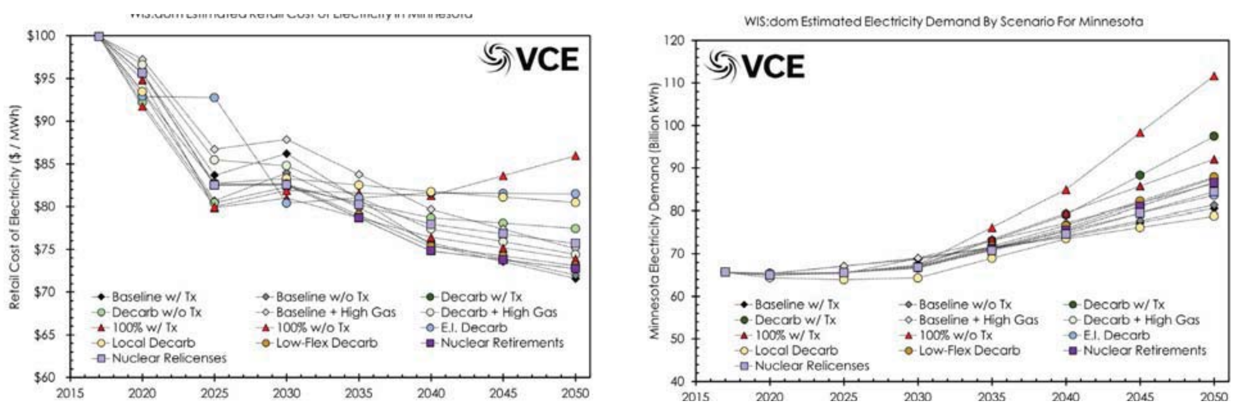


FIGURE 12: *The estimated average cost per unit of electricity (left) and the total final electricity demand (right) by investment period. The cost per MWh on the left panel shows downward pressure, even with the static $22.43 / MWh for investment in the distribution system. The cost of electricity does include payment of sunk costs for retiring power plants that may not have cleared their capital debt. The right panel illustrates that electricity demand is rising through time. The differences are created by different amounts of storage and DSM that will increase the total electricity necessary for the system.*

In Figure 12, the average cost per unit of electricity and total electricity demand is shown for all the scenarios over the investment periods. The cost of electricity per MWh reduces over time (even with the static $22.43 / MWh for distribution costs). The reduction in cost per unit of electricity is primarily driven by two factors: transitioning to low-cost variable resources that are sited efficiently to reduce the burden to the system (as well as retiring older less efficient plants with newer ones) and the increase in total electricity requirements for the system. The right panel of Figure 12 shows that the final electricity requirements are different for each scenario. The reason behind this is varying amounts of storage and rooftop solar PV. More rooftop solar PV reduces the demand for cooling due to thermal heat gain calculations, while storage drives additional demand through its charge-discharge cycle. The impact of additional storage can be substantial for very high penetration levels. DSM can also alter the total amount of electricity required as this will alter the amount of storage required and its cycling. These numbers are consumed electricity and do not count transmission or distribution losses, which must be accounted for by the generation requirements.

The lowest-cost (per unit cost of electricity) scenarios are the baseline cases. This is to be expected because the baseline cases have the lowest amount of demand and there are no additional constraints on the system in terms of decarbonization (or electrification). The majority of the electrification and decarbonization scenarios are less than $5 / MWh (0.5¢ / kWh) more expensive than the baseline scenarios. These scenarios achieve an 80% reduction in economy-wide emissions across Minnesota

16 In 2017, the cost share for electricity can be broken down to approximately 59% for generation, 13% for transmission and 28% for distribution (https://www.eia.gov/energyexplained/index.php?page=electricity_factors_affecting_prices). It is assumed that the cost for distribution remains the same, in real terms, throughout the optimization. Therefore, to inflate the WIS:dom output costs to represent retail costs, the generation and transmission share (for 2017) is multiplied by 139%. This results in $22.43 / MWh additional spend for distribution costs. This is a generous addition, since the generation and transmission costs in WIS:dom include all the DSM costs, additional upgrade costs for increasing distribution carrying capacity, rooftop solar PV buildout, and market clearing prices. This approach is limited by a couple of factors. 1) The installation on rooftop solar, where capital investments are made by WIS:dom, but transmission may not be necessary. 2) The spend for distribution, in real terms, might need to increase with additional smart buildings and higher EV penetrations. Note, however, that the addition is per MWh, so the more electricity that is produced, the larger total amount spent on distribution.

17 https://www.eia.gov/todayinenergy/detail.php?id=36675

for a very small increase in the per-unit cost of electricity provided. Outlier scenarios, which are more expensive, include the local decarbonization scenario (another $5 / MWh more expensive), the Eastern Interconnection decarbonization (another $6/MWh above the other 80% decarbonization scenarios), and the 100% decarbonization scenario without transmission expansion (another $10 / MWh more expensive). Therefore, the additional cost per unit of electricity to decarbonize Minnesota economy could be as low as 0.1¢ / kWh or as high as 1.2¢ / kWh, depending on the assumptions and constraints applicable to Minnesota. Later in this section of the report, it is shown that the cost of energy, as a whole, is reduced under the electrification and decarbonization scenarios, since there will be less spending in other sectors that have transitioned to electricity.

To get a better understanding of the changing costs for electricity, the total cost of electricity provided is needed, and is shown in Figure 13. The plot demonstrates that the total cost of electricity is reduced through 2025 then increases afterwards at different rates depending on the electrification, decarbonization, and other constraints imposed on the scenarios

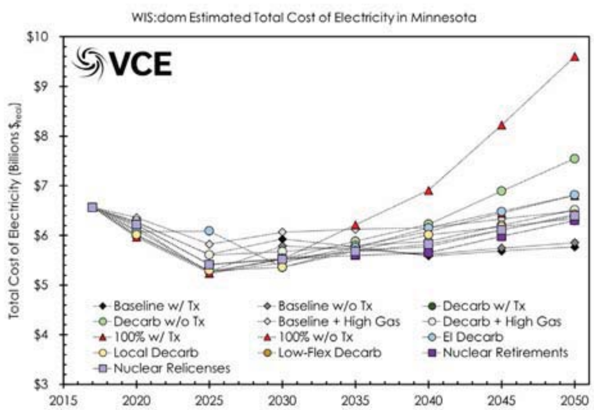


FIGURE 13: *The estimated total cost of electricity by investment period for all scenarios. The total spending (in real dollars) declines for all scenarios from 2017 to 2025 and then increases beyond that timeframe out to 2050. The increase in spending is driven by higher demand, which outpaces the reduction in cost per unit of electricity. There are groupings of scenarios by 2050 that can be observed in the plot.*

Figure 13 illustrates a number of different conclusions. First, that transmission expansion between Minnesota and other states (into MISO) can reduce the cost of decarbonization. In fact, it even reduces the cost without decarbonization. The annual saving by 2050 in the baseline scenario is $86 million when interstate transmission expansion is allowed compared with not expanding the transmission capacity. For the decarbonization cases, this saving is dramatically increased. For the 80% economy-wide electrification and decarbonization, the annual savings by 2050 for Minnesota due to transmission expansion being allowed is $1,249 million ($1.25 billion), while the savings are even deeper if Minnesota completely decarbonizes the electricity grid (while electrifying) up to $2,797 million ($2.8 billion). These savings are compared with the same scenarios, but with transmission expansion between states being limited to 2017 levels. Secondly, the graph shows that the main scenarios for decarbonization are relatively tightly bunched in terms of total cost by 2050. This implies that Minnesota has numerous pathways to achieve the target of 80% by 2050 and even though the composition of each pathway may be very different, if planned properly the resulting costs and emissions can be very similar. Thirdly, spending in the electricity sector does not need to rise dramatically above 2017 spending to electrify and decarbonize; driven by the increasingly low-cost of variable renewables and the addition of new flexible demands.

A tantalizing prospect arises from Figure 13, if the total spending on electricity is not dramatically increased in many of the scenarios studied, then the cost to the customers for all energy must be reduced. This is because, in the decarbonization scenarios electrification is taking place, thus spending for those electrified sectors must be curtailed. In Figure 14, the total cumulative savings are displayed alongside the average annual saving per household in Minnesota.

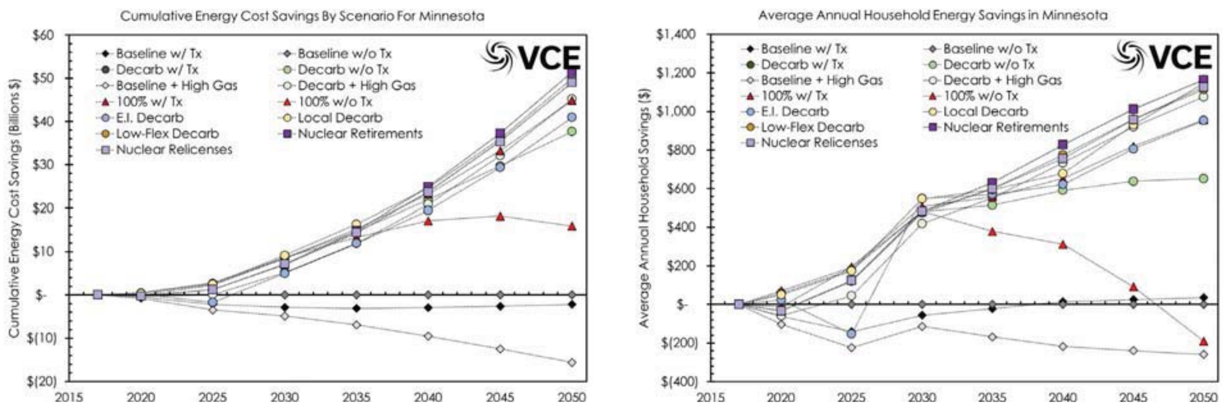


FIGURE 14: *The cumulative energy cost savings (left) and average annual household energy savings (right) for Minnesota under each of the scenarios carried out in this study. The savings are created when compared with the baseline scenario with no transmission expansion allowed. Under two scenarios there is no cumulative savings by 2050. These are the baseline with transmission expansion and the baseline with high natural gas prices. The baseline with transmission expansion is closing the gap, in another 10 years the difference would be zero (time to pay back the transmission investments). For the high natural prices, the cost increases continue to grow with time. All the other scenarios result in large amounts of cumulative savings, up to $51 billion by 2050. The annual household savings show a similar characteristic, with generally increasing savings as time progresses.*

Figure 14 demonstrates the extent of the savings possible with electrification and decarbonization. For all the decarbonization scenarios there are cumulative savings of between $15.9 and $51.4 billion. These savings are based on a comparison with the baseline scenario that does not allow interstate transmission expansion. The savings are computed using the input assumptions around what fraction of each sector is electrified and the spending that has transitioned away from the other sectors (primarily natural gas and gasoline). With higher natural gas prices in the baseline scenario there are additional costs to the Minnesota economy amounting to $15.6 billion by 2050 than with lower natural gas prices. This highlights another benefit of electrification and decarbonization: reduced exposure across the economy to higher fuel prices. The right panel of Figure 14 shows the same data, but represented as annual household savings. It shows that electrification and decarbonization provides a net positive for households in Minnesota. For the 100% without transmission expansion, the annual savings becomes annual costs due to the additional burden of removing the last 9% of emissions from the electricity sector. Notwithstanding the outlier of the 100% with no transmission expansion, the electrification and decarbonization scenarios could save Minnesotans an estimated yearly household spend on energy of between $653 and $1,165. Therefore, the 80% reduction of Minnesota economy-wide emissions by 2050 could be a net positive for the economy in Minnesota, since spending on energy could be reduced, freeing up capital to be invested elsewhere.

The next critical metric considered is the economy-wide greenhouse gas (GHG) emissions for Minnesota. In Figure 15, the GHG emissions for the entire Minnesotan economy and the emission rate for electricity generation are shown. The panels show that baseline scenarios do not create low enough emissions to achieve the 80% by 2050 goal. In fact, since baseline scenarios do not electrify other sectors, the emission reductions are limited to 30%. All scenarios reduce the carbon intensity of electricity; however, the electrification and decarbonization scenarios reduce the carbon intensity to below 50g / kWh. They achieve this, while also electrifying (and removing emissions from) other sectors. Figure 15 provides more evidence that electrification is beneficial in achieving the goal of economy-wide decarbonization. Under the baseline scenarios, the electricity grid reduces its carbon intensity by a factor of three. This reduction is based on economics alone. Therefore, electrifying sectors would provide a pathway to lower-emission power for those sectors. The process of electrification, in turn, provides additional demand for the electricity sector to invest capital against and, since the new loads could be more flexible, higher variable generation amounts can be added.

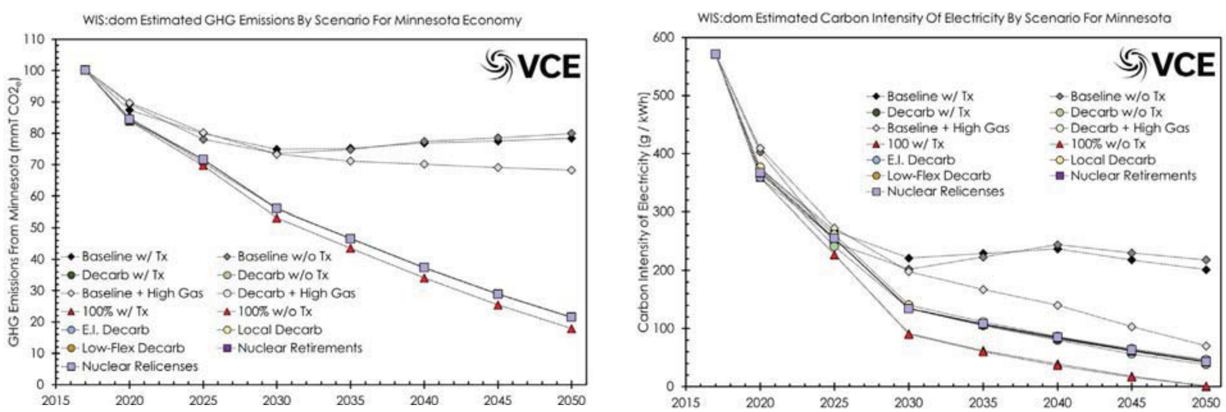


FIGURE 15: *Economy-wide GHG emissions (left) and carbon intensity of electricity generation (right). It can be seen that the electrification and decarbonization scenarios produce much lower GHG emissions than the baseline scenarios. It demonstrates the potential of electrification because the electricity sector, in the baseline scenarios, lowers its carbon intensity by a factor of three by 2050, yet emissions for the whole economy only drop by ~20%. Further, under the high gas price scenario the decarbonization of the electricity sector is even more pronounced; however, that only results in 10% fewer economy-wide emissions. The electrification and decarbonization scenarios have a carbon intensity of 50g / kWh or lower for electricity.*

Eight of the scenarios (the 80% by 2050 for Minnesota economy) follow almost exactly the same emissions trajectory, but their compositions in terms of deployed assets are very different. This is because WIS:dom has been set the same GHG emissions target to meet for those scenarios. As noted earlier, the costs and emissions from the majority of the decarbonization scenarios are relatively similar, therefore, there are numerous pathways to achieve the same overarching goal: a low-emission future at a low cost.

The decarbonization of the electricity sector (with and without electrification) happens with a transition away from coal-fired power plants, some dependence on natural gas, a large-scale build out of wind and solar generation, supplemented with storage, demand-side resources, and transmission. Nuclear power plants can contribute to zero-emission generation; however, cost is a constraint that manifests in nuclear losing installed capacity under most scenarios. The WIS:dom optimization model considers scheduled relicense dates and estimates the cost to relicense the nuclear plants for an operations extension of 20 years. Natural gas (or coal) with carbon capture and sequestration (CCS) is another technology option to lower emissions, but the costs and efficacy of this technology were not optimal (or selected by WIS:dom) in the decarbonization scenarios performed[18]. The CCS technology may be selected by WIS:dom if emission reduction targets were more aggressive, or the cost of CCS was lower than assumed.

Under all scenarios there is an increase in the installed capacity in Minnesota, as shown in Figure 16. The figure also displays the full-time jobs for each investment period to 2050. Since there is an increase in the total installed capacity (and the majority of the capacity comes from variable resources) there is a

18 The CCS was modeled with a cost of $1,098 / kW-installed incrementally added to natural gas combined cycle power plants. There was a fixed cost of $23 / kW-year and additional variable cost of $4 / MWh for the operation of the CCS component of the plant. Finally, the heat rate of the natural gas combined cycle plant was increase by 1,060 Btu / kWh if CCS were implemented. The CCS was assumed to have a negative CO2 emission profile per MWh produced from the natural gas power plant that reduces the CO2 emissions from burning the natural gas by 80%. It is assumed that other pollutants are reduced by 65% due to process of capturing the carbon.

marked increase in the number of jobs. The difference in capacity build out is due to emission targets, transmission availability, and restrictions on flexibility / resource availability. The full-time job numbers are an output of WIS:dom, which uses the NREL Jobs and Economic Development Impact (JEDI) models as an input for many of the technologies[19]. There are some missing data for jobs, and VCE created input numbers for solar PV and rooftop solar PV jobs from publicly available data. Currently, these numbers do not include employment figures for energy efficiency, demand-side resources, or storage. These numbers would increase the employment rates seen in Figure 16 for all scenarios. Additionally, the full-time job numbers are only for direct and indirect jobs, and do not include any induced job numbers. Again, these induced jobs would increase the full-time job numbers further. These numbers were not included due to several factors: 1) Lack of reliable data for that industry; 2) WIS:dom was not explicitly computing the deployment, so could not track those values; or 3) too many variables would need to be considered to provide accurate input numbers for WIS:dom to calculate output values.

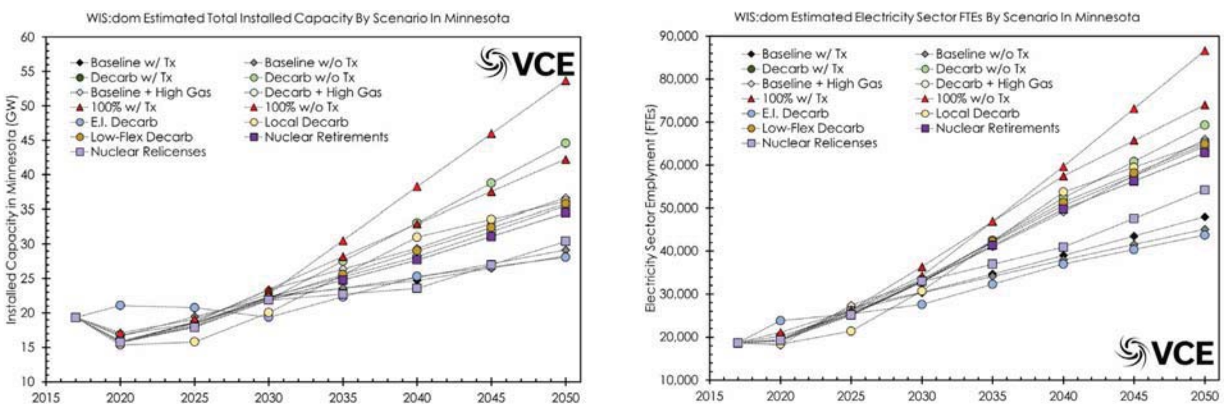


FIGURE 16: *The total installed capacity (left) and full-time jobs within the electricity sector (right) for Minnesota. These jobs numbers include direct and indirect jobs for generation technologies. It does not include jobs for energy efficiency, demand-side resources, or storage (due to lack of reliable data points from within the industry). The job numbers are an output of the WIS:dom optimization model, which computes these from inputs provided by the NREL JEDI model for each state. Missing data is provided by VCE calculations (such as solar PV, and rooftop solar PV).*

In summary, Figure 16 suggests that all pathways require increased installed capacity in Minnesota over the next three decades. The choice of technology mix will substantially alter the GHG emission reductions for the electricity sector and, in combination with electrification, alter the ability of Minnesota to meet its climate goals. In general, the electrification and decarbonization pathways creates more jobs and increases the installed capacity more than under the baseline cases. These new projects would increase tax revenue for Minnesota, which could be used to support the infrastructure spending required to accelerate the electrification of other sectors.

19 https://www.nrel.gov/analysis/jedi/models.html

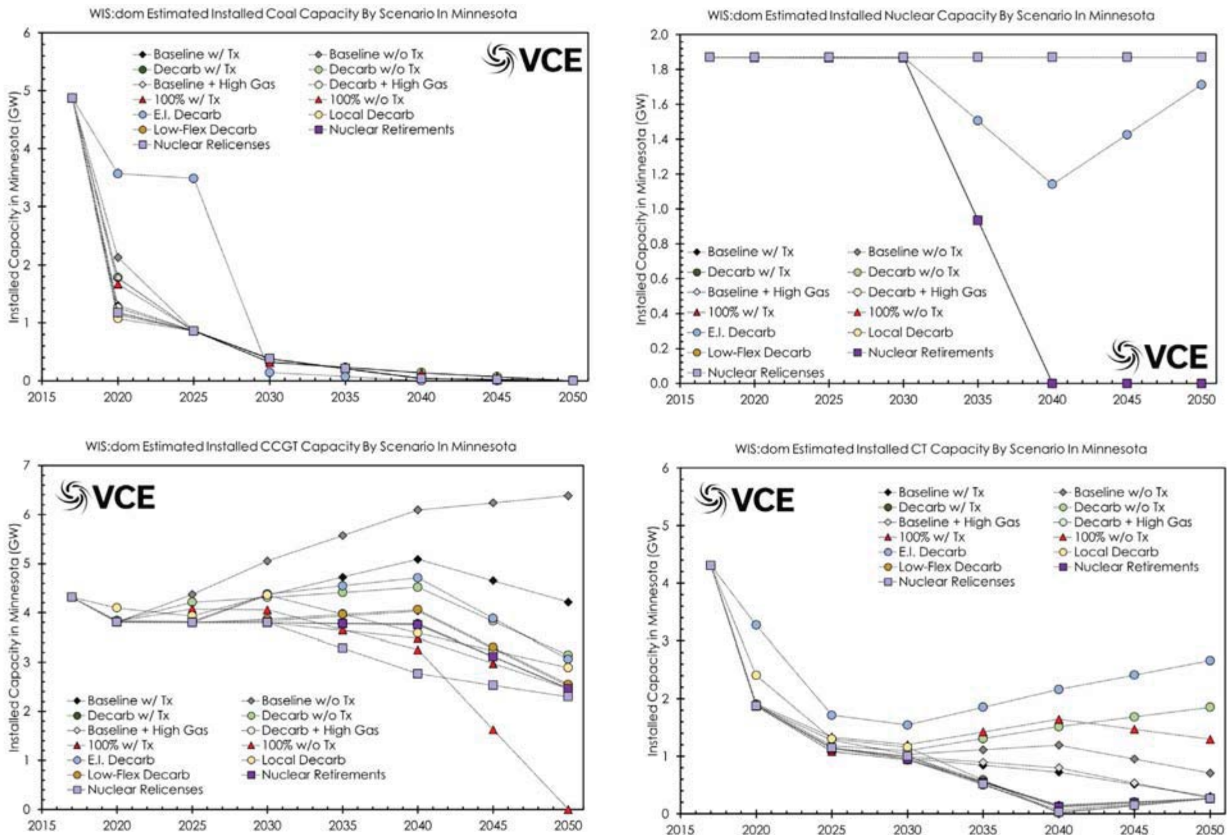


FIGURE 17: *The thermal generation fleet in Minnesota for each investment period. Top-left shows that coal is retired almost completely in all scenarios by 2030. The top-right panel shows that for the majority of the scenarios it is assumed that nuclear power plants will retire with the relicense schedule. Only two scenarios are different. When the EI decarbonizes with Minnesota, new nuclear is built to replace retired generation. The other scenario has nuclear forced to relicense in WIS:dom. The Bottom panels display the changes in combined cycle (left) and combustion turbines (right). Combined cycle has varied capacity depending on scenario, with most seeing a reduction in capacity. For combustion turbines, there is a reduction in capacity for all scenarios, with tight grouping to 2030, but vary more heavily as time moves forward. The CTs and CCGT plants complement the variable resources, but still emit GHGs.*

Figure 17 shows the thermal generation fleet for Minnesota for each scenario pathway through 2050. Coal-fired power plants are almost entirely retired by 2030, regardless of scenario. Nuclear power plants are retired with relicense schedule for most scenarios (constraint within WIS:dom). New nuclear is only built in the scenario where the Eastern Interconnection electrifies and decarbonizes along with Minnesota. Another scenario has WIS:dom enforce nuclear relicense through 2050.

Under baseline scenarios, new natural gas (combined cycle) power plants are built in Minnesota to cover demand growth. Under all other scenarios natural gas plant capacity falls. In fact, most scenarios group around 2,000 - 3,000 MW of natural gas combined cycle by 2050, compared with 4,000 - 6,000 MW in the baseline scenarios. It should be noted that WIS:dom is optimizing across the entire Eastern Interconnection, so some of the capacity within Minnesota can be shared with outside regions (and compete in the MISO market). The capacity of natural gas combustion turbines is reduced in every scenario from 2017 levels. This is partly driven by WIS:dom having detailed knowledge of the weather-patterns for every 5-minutes for an entire year for each investment period and partly from its ability to site new generation more appropriately to reduce the burden on the entire system[20]. Since WIS:dom is considering all generation simultaneously (co-optimized) and is computing the dispatch, it can more accurately reflect the capacity needs of the system and how the new generators might contribute to that resource adequacy. The capacity of combustion turbines (CT) are similar for all scenarios to 2030. For the decarbonization scenario that allows transmission expansion reduces the capacity of the CTs further towards zero. When the Eastern Interconnection decarbonizes with Minnesota, the capacity of CTs increases to support much higher wind and solar buildout over the MISO (and SPP) footprint. In 2050, the installed capacity of CTs is non-zero for all scenarios (at least 200 MW). This is because WIS:dom recognizes the need for planning reserve margins and CTs can provide inexpensive capacity that could be dispatched in extreme conditions to ensure reliability.

In Minnesota, there is approximately 220 MW of hydroelectricity power plants. The WIS:dom optimization model has the ability to expand hydroelectricity plants up to twice their current capacity (assuming upgrades to turbines and other efficiency gains); however, WIS:dom is limited by the run-off water conditions provided by the detailed weather data inputs. WIS:dom can dispatch hydroelectricity with market signals, but must not exceed its installed capacity. If WIS:dom decides not to dispatch the hydro plant for any reason, it must release the water downstream that it would have done under normal operation. This constraint ensures that other uses for the water are not impacted by hydro plant ramping. The ramping of hydropower can be used by WIS:dom to accommodate more variable resources. Nevertheless, under all, but one, of the scenarios hydro remains unchanged throughout the optimization period. For the localized decarbonization scenario, the capacity of hydropower is increased to 440 MW to provide local generation of clean power. WIS:dom finds it more economical to use hydropower as a baseload generation source as much as it can.

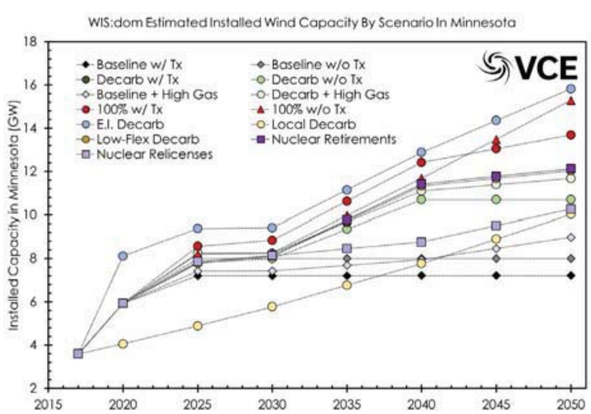


FIGURE 18: *The installed capacity of wind turbines in Minnesota for each scenario. All scenarios increase the installed capacity of wind to at least 7,200 MW. Slower adoption occurs for the local decarbonization scenario, while the fastest adoption occurs when the EI decarbonizes with Minnesota. The lowest installed capacity occurs for the baseline scenarios, while the electrification and decarbonization scenarios have an installed capacity of between 10,000 MW and 15,800 MW by 2050. The WIS:dom optimization model includes the expiration schedule of the PTC (and ITC). The installed capacity is almost fixed between 2025 and 2030, but afterwards capacity climbs. This is driven by the electrification of new loads that are more correlated with wind power generation.*

In Figure 18, the installed capacity of wind power is displayed for all the scenarios. It suggests that a minimum of 7,200 MW of wind is economic in Minnesota regardless of carbon emission goals and expiration of the production tax credit (PTC). To proceed above that level, electrification comes into play. The electrification of the new demands has a temporal component that is more correlated with wind than traditional demands. For example, space heating demands are highest when temperatures are lower, which occur more frequently in winter and overnight hours. These correlate well with wind power production, which is greatest in the colder seasons and in evening hours. In addition, the

20 This is very different to siting new generation at the lowest LCOE [levelized cost of electricity] locations. WIS:dom determines the placement of all generation but, in particular, variable generation that minimizes the system costs. Therefore, it may be more cost effective to construct a, for example, wind farm at a slightly more expensive site (in terms of LCOE), because when it competes in markets it might generate more revenue due to its power production patterns, there could be less requirement to provide supporting infrastructure for that wind farm, and the additional transmission capacity necessary for the new plant could be utilized by other assets on the system. These effects can combine to reduce the overall cost of the system more than if a new wind plant was sited at the least-cost LCOE wind site.

decarbonization drives more investment into the low-emission technologies, which further increases the capacity of wind power. For the electrified and decarbonized scenarios, the installed capacity of wind by 2050 ranges from 10,000 MW and 15,800 MW for Minnesota.

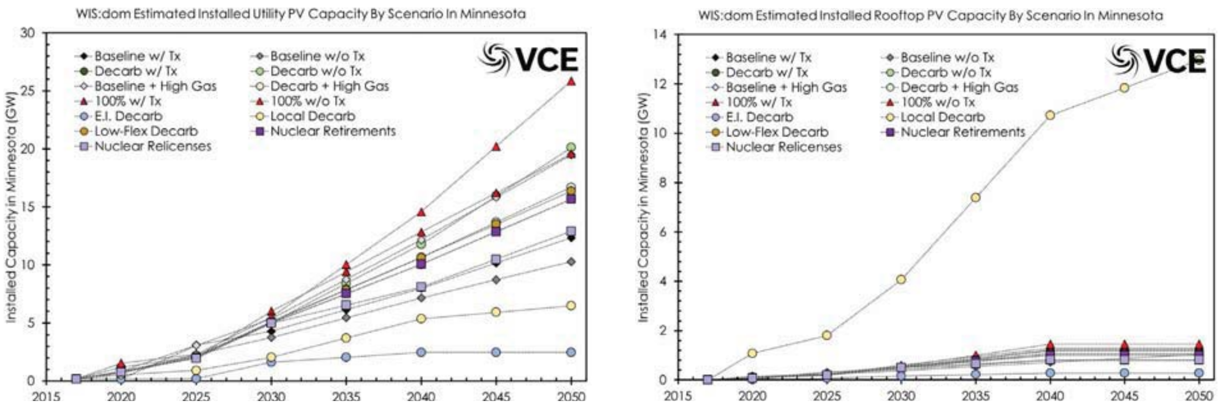


FIGURE 19: *The installed capacity of utility-scale solar PV (left) and rooftop solar PV (right). All scenarios have increased capacity of solar PV. The baseline scenarios have a higher installed capacity for utility-scale PV than two decarbonization scenarios, both EI and localized decarbonization. The EI decarbonization reasoning is based around more wind on the system and solar PV installed in other parts of the EI. For the local decarbonization, the capacity is transferred to the rooftop solar PV sector. By 2050, the combined solar installed ranges between 2,700 MW and 27,300 MW. The highest capacity occurs when Minnesota requires 100% decarbonization of the electricity sector, and the lowest is when the EI decarbonizes with Minnesota.*

The installed capacity of solar PV is categorized into two subgroups. The first is utility-scale PV and the second is rooftop solar PV. The two categories are treated separately within WIS:dom. Rooftop solar PV has an impact on local load due to positioning of the panels, while utility-scale PV can be fixed, 1-axis, and 2-axis tracking panels (depending on the economics of each resource site). Under all scenarios solar PV installed capacity for Minnesota increases (as shown in Figure 19). Figure 19 shows that the baseline scenarios have more utility-scale solar capacity than two decarbonization scenarios. This is due to very different reasons. The baseline scenario utility-scale solar PV installed capacity is higher than in the EI decarbonization scenario because Minnesota has access to more wind power generation that can be shared across MISO (and the EI). The baseline scenario utility-scale solar PV installed capacity is higher than in the localized decarbonized scenario because the installed capacity is transferred to rooftop solar PV. For the majority of scenarios approximately 1,200 MW of rooftop solar PV is installed in Minnesota. The pathways are more varied for utility-scale solar PV, but at least 2,700 MW are installed by 2050. This installed capacity could reach as much as 27,300 MW in the 100% decarbonized electricity sector scenario. Most scenarios cluster between 10,000 MW and 20,000 MW. The range of values for the installed capacities demonstrates the various combinations of generation that could supply the required electricity for decarbonization of the Minnesotan economy by 2050.

In addition to generation, the WIS:dom optimization model can deploy energy storage technologies. These technologies are characterized as assets that change from being demands to generators. When the storage is charging it is recognized as a demand in WIS:dom, and when it is discharging it is recognized as a generator. The storage assets are deployed only when doing so reduces the cost of electricity or provides services that are required to meet constraints at a lower cost than alternatives. There are two components of the storage that are important for WIS:dom to track and optimize: the power input/output (kWs) required and the amount of energy stored (kWhs). Therefore, WIS:dom does not predefine the storage duration (e.g. 4-hours storage), rather WIS:dom computes the peak charge and discharge rates that are required along with the capacity of energy storage necessary to provide reliable power without fail, at a cost that is lower than other alternatives. For example, WIS:dom could choose to dispatch demand-side resources over building more energy storage capacity (or vise-versa). For the scenarios conducted for this study it was found that storage is beneficial regardless of pathway. As can be seen in Figure 20, the power and energy needs are different for each scenario.

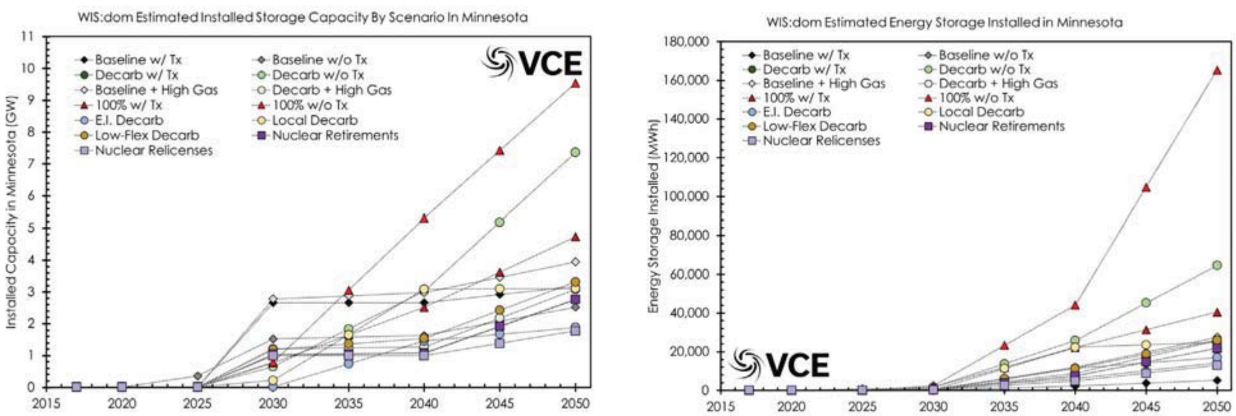


FIGURE 20: *The installed capacity of storage, separated into peak power capacity (left) and energy storage capacity (right). By 2035, all scenarios have some energy storage installed. In fact, all but one scenario has energy storage deployed by 2030. More storage is required when there is no additional interstate transmission allowed and when emission reductions are deeper. The amount of energy storage capacity (kWh) is drastically increased when 100% decarbonization (w/o Tx) or local decarbonization is considered. The maximum amount of deployed storage was 9,500 MW with 17.5 hours at max output. The majority of decarbonization scenarios require approximately 2,000 – 3,000 MW with 450- – 550-minute (7.5- – 9.2-hour) duration of energy storage.*

In Figure 20, it can be seen that energy storage becomes an important component of the electricity system for all scenarios by 2035. The amount of storage required for different scenarios varies, but in general more storage is utilized when there are deeper emission reductions and transmission is restricted. This applies to both power and energy storage values. In the extreme, with complete decarbonization of the electric sector, electrification, and limited transmission expansion, WIS:dom installs 9,500 MW of energy storage with 17.5-hour duration. For the vast majority of the electrification and decarbonization scenarios, 2,000 to 3,000 MW with 7.5- to 9.2-hour duration storage adequately provides the necessary services to provide power for each 5-minute interval for an entire year by 2050. The storage technologies increase the overall demand on the system while reducing (or eliminating) negative costs because they can alleviate transmission congestion, absorb over-production of power and dispatch to cover lower generation periods. The WIS:dom optimization model prefers to assign storage to be a system-wide asset, rather than a competing generation asset. The reasoning is two-fold: 1) The whole electricity system can benefit from storage being available and when a certain amount of storage exists on the grid the arbitrage that a generation asset would survive on would be largely removed, thus sharing the costs over the whole system keeps the asset available for all customers and generators, while keeping system costs down; 2) If the asset were considered more akin to a transmission asset it could be deployed by the RTOs or balancing authorities to assist with events that might not otherwise be compensated for. For example, storage could provide capacity to a system, but only if it has stored energy; however, it may receive market signals to dispatch at a specific time, and if it does so it might not be available at a later time when the system requires more services. Thus, under a generation asset paradigm the storage would not be able to assist; but, in a transmission asset paradigm, the storage could hold reserve amounts of electricity for extreme events, help with faults on the system or absorb electricity generation / demand spikes. Regardless of the paradigm required for storage to be valuable, the scenarios show that more of the technology on the system is helpful in lowering overall costs and reducing emissions.

Another asset that is considered by WIS:dom for all the scenarios for deployment is transmission. There are two forms of transmission considered by WIS:dom, interstate and intrastate transmission. Using existing transmission topology, a reduced form model is produced that computes the interstate and intrastate transmission. The interstate transmission must carry electricity across state borders, while intrastate remains entirely within the state. For all the scenarios performed the intrastate transmission is increased by the installation of new generation capacity and providing power reliably at 5-minute intervals of dispatch. For interstate transmission, there are more restrictions. While intrastate transmission must be paid for, it is allowed to be constructed if required for supporting generation; the same is not true for interstate transmission. For interstate transmission, it is sometimes forbidden to be constructed. Further, it is included in the capital expenditure limits within WIS:dom (which defines the total amount of investment that can happen in the electricity sector). The interstate transmission, when allowed to expand, increases its capacity between Minnesota and surrounding regions by 1,500 – 3,000 MW of export capacity and 8,000 MW import capacity. WIS:dom computes the need for capacity expansion of transmission based upon economics and reduced form transmission topology with neighboring regions. The power flow along transmission lines is tracked by WIS:dom and electric losses are computed for each 5-minute interval along each of the corridors, which is a function of temperature, wind speed (and direction), line loading, and the composite conductance and susceptance properties of the lines.

V. SCENARIO SPECIFIC RESULTS

In this section, emphasis will be placed on the differences between scenarios. If a topic is discussed in an earlier scenario, but not in a later one, then the scenarios have been deemed to have similar characteristics (in a broad sense) as the earlier scenario. The summary spreadsheets with the most important metrics (and accompanying images) will be available at the time of release of this report.

Every scenario has exactly the same outputs from WIS:dom, and so each spreadsheet and image set for every scenario contains the same data and information, with the values changing between scenario results. Thus, for each image shown in the current section, there is a counterpart for all the other scenarios for comparison.

A. BASELINE

The baseline scenario is based on economics. There are no carbon taxes assumed. As with all the scenarios WIS:dom is solving over the entire US portion of the Eastern Interconnection. There are two branches to the baseline scenario, one with interstate transmission expansion allowed and one where it is not. Figure 21 displays the installed capacity for both branches for all the investment periods.

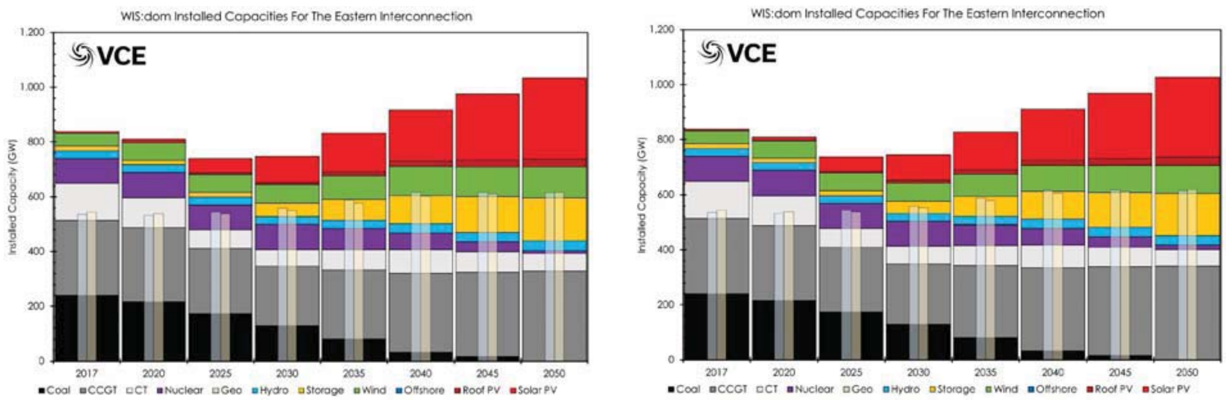


FIGURE 21: *The installed capacity across the US portion of the Eastern Interconnection for the two branches of the Baseline scenario. The left panel is for the branch that allows interstate transmission capacity expansion (w/ Tx), while the right is for the branch that does not allow interstate transmission capacity expansion (w/o Tx). In the w/ Tx branch, there is more variable (and less thermal) generation present by 2050. The transparent bars within the columns (blue and yellow) represent the peak average hourly demand for that investment period. The blue is the input demand peak, while the yellow is for the WIS:dom determine demand peak. Note that by 2030 the peak demand is above the synchronous generation, because WIS:dom can deploy portfolios of asynchronous generation, storage, DSM, and transmission to provide robust balance between supply and demand for each 5-minute interval.*

Figure 21 illustrates the evolution of the electricity grid in the Eastern Interconnection from 2017 to 2050 under economics (and current policies, with their expiration schedule). The overall trend is a diminishment of baseload generation sources (coal and nuclear), with an increasing dependency on natural gas power plants in conjunction with wind and solar generation (supplemented with storage). The electricity system becomes more flexible due to faster ramping technologies (storage and natural gas) and zero-marginal-cost variable generation. These trends are supported by recent history in the electricity grid transformation[21]. The cost projections for natural gas fuel remain low throughout the optimization horizon, while reductions in wind and solar costs drive further investment in those technologies as time progresses (even with the expiration of PTC and ITC). The baseline transition estimated by WIS:dom reduces GHG emission and other pollution from the Eastern Interconnection electricity system by around 40% compared to 2017 levels (Figure 22). The methane (CH_4) emissions reduce until 2030 then level off at a reduction of 20%. This is due to the transition from coal to natural gas, which results in more of this powerful GHG being emitted compared with carbon dioxide trends. Other dangerous localized pollutants are considerably reduced by removing coal-fired power plants from the electricity system. Direct PM2.5 and PM10 are almost entirely extinguished by 2050.

21 https://www.eia.gov/todayinenergy/detail.php?id=36092

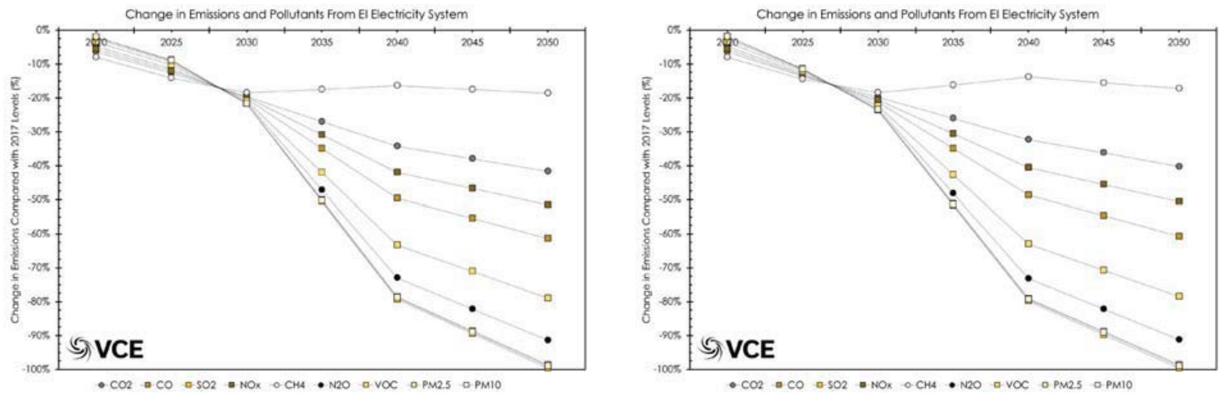


FIGURE 22: *The GHG emissions and other pollution from the Eastern Interconnection (left, w/ Tx; right, w/o Tx). The evolution of the electricity system results in a 40% drop in carbon dioxide emissions by 2050 (from 2017 levels). Most pollution trace the carbon dioxide emission reductions, but noticeably CH4, methane, emission reductions level off at 20% reduction by 2030. This is because coal has been replaced, in large part, by natural gas and incomplete combustion results in more emissions from this powerful GHG.*

In Figure 23, the state-level installed capacities are shown for the six investment periods for the w/ Tx branch of the Baseline scenario. The figure illustrates the spatial heterogeneity of the Eastern Interconnection electricity system. Each state within the Eastern Interconnection is represented and has a unique load profile, existing generation mix, and potential resource. The figure also depicts a future pathway with baseload generation being replaced with near-zero-emission variable resources complemented with natural gas. Some states are more reliant on natural gas under the baseline scenario, such as the South-East states. Most states have storage technologies deployed by 2050. To retire power plants from the system, WIS:dom must do so in a way that reduces the cost of the system. Therefore, if there is capital outstanding on a power plant, the model must repay this. If the power plant has repaid all its capital investments, to remove the power plant, WIS:dom must find a portfolio of alternatives that are lower in cost than the fixed and variable operational costs of the old plant. Thus, WIS:dom is making investment decisions that reduce the cost of electricity the most during each investment time period.

Figure 24 shows the electricity generation share by technology for each investment period. It shows that the generation mix is transitioning away from baseload generation to flexible natural gas and variable generation. Due to the assumed depressed natural gas prices throughout the optimization, it dominates the generation share by 2050 as it absorbs the reduced shares of coal and nuclear. Of course, wind and solar generation also consume some of the generation share left by coal and nuclear, but their share is lower than that of natural gas. Figure 25 also demonstrates the exposure that the electricity system could have to fluctuating natural gas prices. With such a large share of the generation mix by 2050, the entire electricity sector would be extremely sensitive to any increase in the price of natural gas fuel.

Figure 25 displays the winter dispatch of the Eastern Interconnection, while Figure 26 shows the dispatch for the summer of each of the investment periods out to 2050. The dispatch is average hourly numbers from the 5-minute dispatch performed by WIS:dom. The images aggregate all the generation of each type for that hour. In addition, the plots show how the demand-side is altered by the WIS:dom optimization model. The alterations come from storage demand and the demand-side resources available to WIS:dom. At each 5-minute interval, WIS:dom must balance generation, transmission losses, load-following reserves, storage charging/discharging with its associated losses, demand-side resource dispatch, market prices, and fuel consumption / limitations. It is clear from Figures 25 & 26 that the Eastern Interconnection electricity system is estimated to be completely different by 2050 compared with the one that existed in 2017.

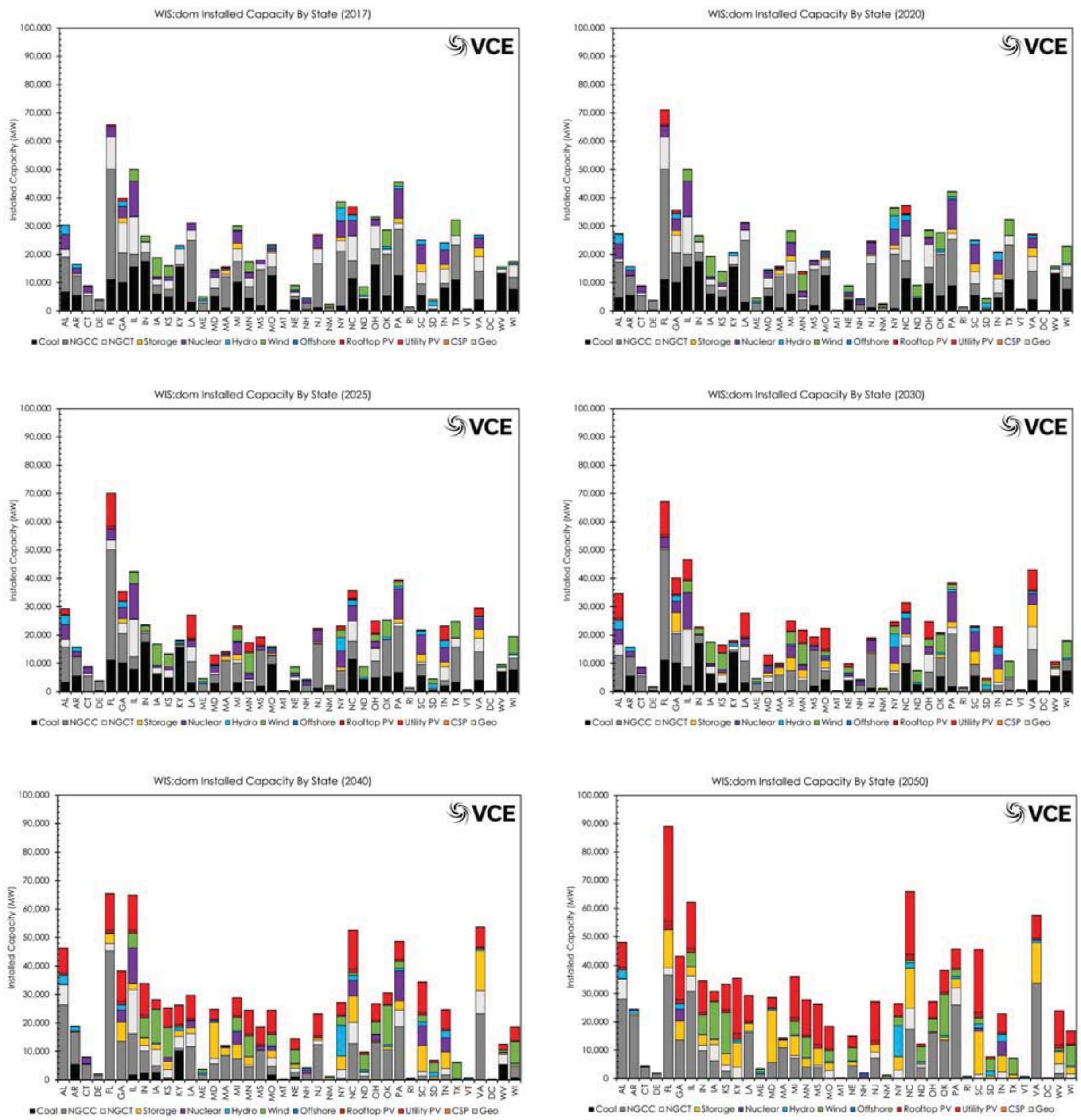


FIGURE 23: *The installed capacity for each state in the Eastern Interconnection for each investment period optimized by the WIS:dom model. The evolution of the electricity grid can be followed from the top-left (2017) to the bottom-right (2050). The system in 2050 is dominated by natural gas, solar, wind and storage. That system is completely different to the coal and natural gas dominated system in 2017. As the generation capacity mix changes, the WIS:dom optimization model must adapt and find a way to have all the resources work in a way that provides reliable power for each 5-minute interval for a full year.*

The general feature of Figures 25 & 26 is the flexibility of natural gas and storage to provide the necessary ramping capabilities for solar PV to provide electricity while the sun is shining. Indeed, storage shifts the traditional peak to when solar peaks (shifting it earlier in time) as it charges, in anticipation of the net peak that occurs at sunset. The flexibility of these resources absorbs the longer-duration cycles in wind power. The reduction in nuclear power (as a clean electricity source) is noticeable throughout the dispatch stacks to 2050. Some of the power is replaced with variable resources, but some is absorbed by natural gas power.

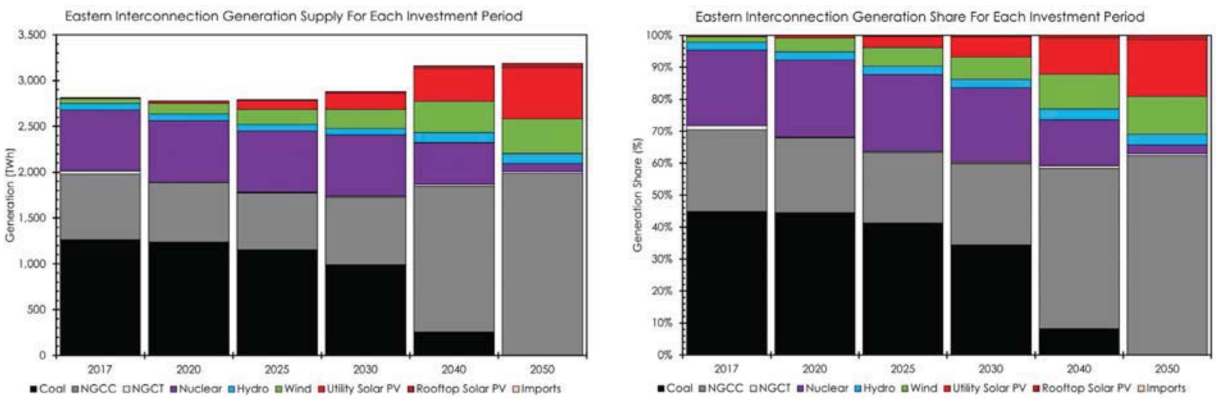
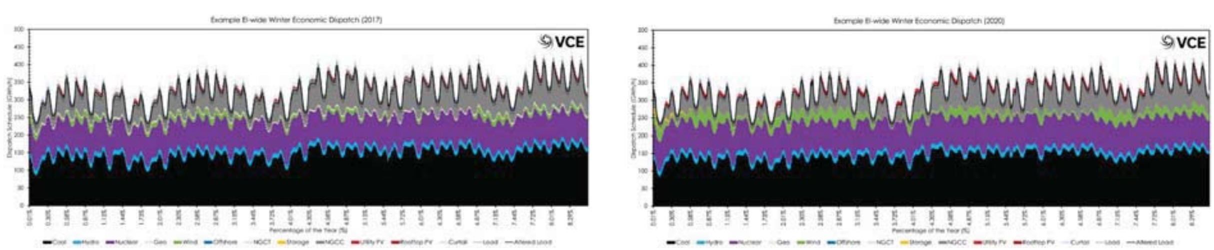


FIGURE 24: *The estimated generation mix for each investment period in the Eastern Interconnection. The left panel shows the total electricity production in TWh, and the right panel shows the percentage of generation by technology. The system in 2050 is dominated by natural gas generation. The remaining share is primarily from wind and solar. With such a skewed generation mix, the system is exposed to high risks of fuel cost changes.*

Another important illustration from Figures 25 & 26 is that baseload generation is clearly not necessary as a concept. The WIS:dom optimization model finds resource mixes that can provide reliable generation at 5-minute intervals without fail. Further, the model does this while providing over 7% of load-following reserves at all times (through spinning reserves in the natural gas power plants, down-dispatched wind and solar power, and storage). The WIS:dom optimization model also maintains the NERC planning reserve margins[22] across the whole footprint.



22 https://www.nerc.com/pa/RAPA/ri/Pages/PlanningReserveMargin.aspx

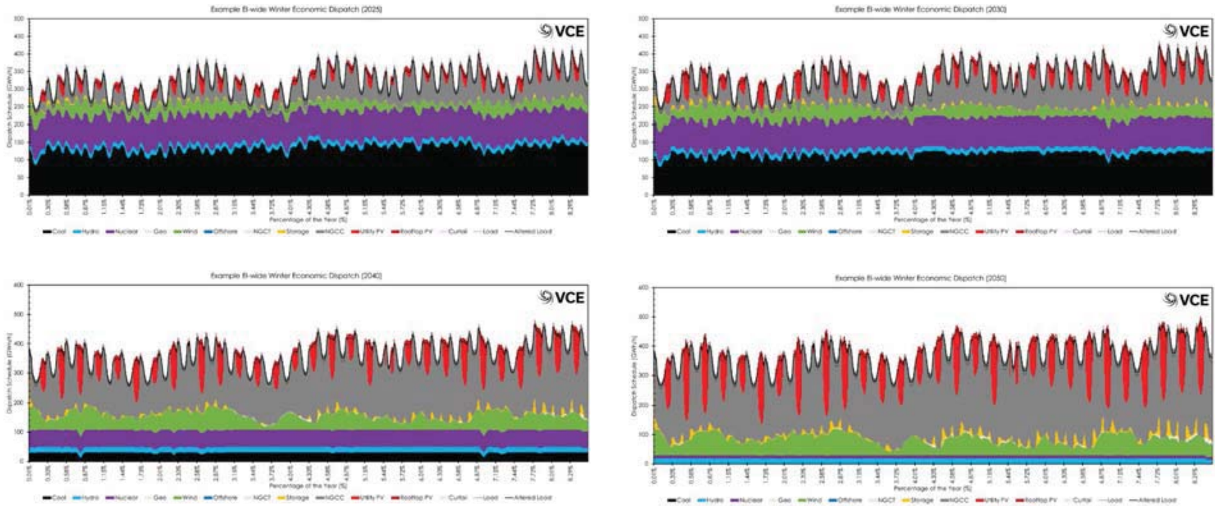


FIGURE 25: *The economic dispatch stack for January for each investment period in the Eastern Interconnection. The evolution of the electricity grid can be followed from the top-left (2017) to the bottom-right (2050). The cycling of storage and natural gas is clear by 2050, when solar squeezes out other generation when it appears. Notice the altered load that is enabled by storage and demand-side resources.*

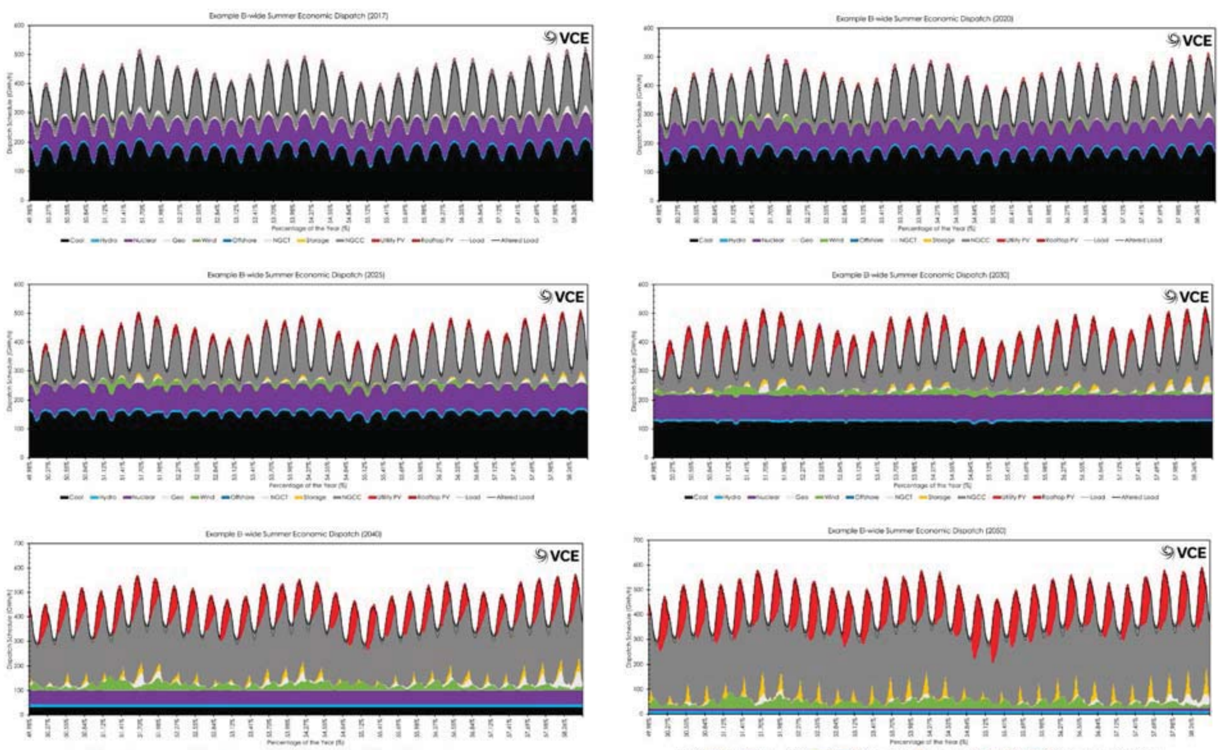


FIGURE 26: *The economic dispatch stack for July for each investment period in the Eastern Interconnection. The evolution of the electricity grid can be followed from the top-left (2017) to the bottom-right (2050). In the summer months the dispatch is centered around the solar being used as peaking for the traditional load peak, and then natural gas and storage dispatching to fill the new net peak that appears at sunset. Also, the altered load enables charging of the storage to coincide with the solar peak.*

An additional benefit that comes from the transition to more variable generation and flexible generation is the modularity of the system. Weather-driven generation varies more predictably and slowly than large-scale baseload generation (if they go offline). This benefit is reduced in this baseline scenario because there are large-scale natural gas power plants constructed, but as newer plants are built these will be more flexible and have higher availability.

One benefit of using WIS:dom is its ability to co-optimize different resources and time-horizons to reduce the overall system costs, while ensuring demand and supply balance over every 5-minute interval. For the Baseline there are two branches that treat interstate transmission differently. Figure 27 displays the aggregate interstate transmission capacity in terms of import and export capacity for each state in the Eastern Interconnection.

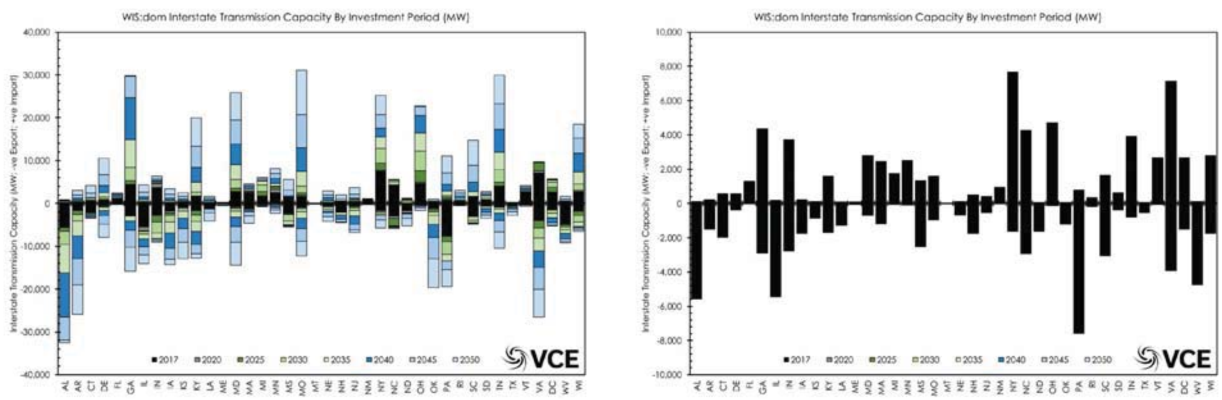


FIGURE 27: *The import (positive) and export (negative) capacity for each state within the Eastern Interconnection. The left panel is for the w/ Tx branch and the right is for the w/o Tx. The right panel shows that WIS:dom fixed the import/export capacity for each state to the value estimated for 2017 for the w/o Tx branch. The interstate transmission buildout is substantial in the left panel. The new transmission enables more resource sharing and cooperation between regions. It reduces curtailments and provides access to lower-cost resources. Note that the majority of the transmission capacity expansion occurs in the 2040 to 2050 timeframe, which is due to construction times and variable generation being built.*

In Figure 27, the biggest construction in transmission is completed in the 2040 to 2050 timeframe. This is driven by construction time, variable generation coming online, and the retirement of plants enabling a shifting of resource locations and higher levels of resource sharing. The right panel in Figure 27 is the estimated 2017 interstate transmission capacity, which is fixed for the w/o Tx branch. Referring back to Figure 21, the difference in transmission does not dramatically alter the installed capacities; however, it alters its dispatch and the ability for WIS:dom to invest in different siting that is more robust over time.

While computing the capacity expansion and economic dispatch of the electricity system, WIS:dom must determine the spatial siting of each power plant. This is performed at a 3-km resolution. In general, each power plant generator unit of similar type within a 3-km grid cell is aggregated together with average characteristics of all the units within that grid cell. For focus regions (such as Minnesota), each individual power plant is described. Limitations to the construction of generators and transmission are provided to WIS:dom as exogenous variables. Therefore, WIS:dom can compute the best locations to build new generation (and transmission) to supply the electricity grid. Each 3-km grid cell has characteristics with respect to cost of interconnection, existing transmission and substations, and transmission loss functions to supply local and distant demands.

Figure 28 demonstrates the ability of WIS:dom to consider the geographic siting of generation, storage and transmission. The siting of generation, particularly wind and solar, provides WIS:dom with new temporal evolutions of power production. These new time-series are used by WIS:dom to determine if the new siting provides a net benefit to the electricity grid. If not, WIS:dom will not select the site. Essentially, WIS:dom can automatically determine the benefits of spatial diversity across electricity grids. In addition, the 5-minute intervals for the generation profile provide detailed descriptions of the potential electricity resource available. WIS:dom can recognize patterns in the correlation shapes for variable generation and exploit those correlations, while avoiding their possible disadvantages.

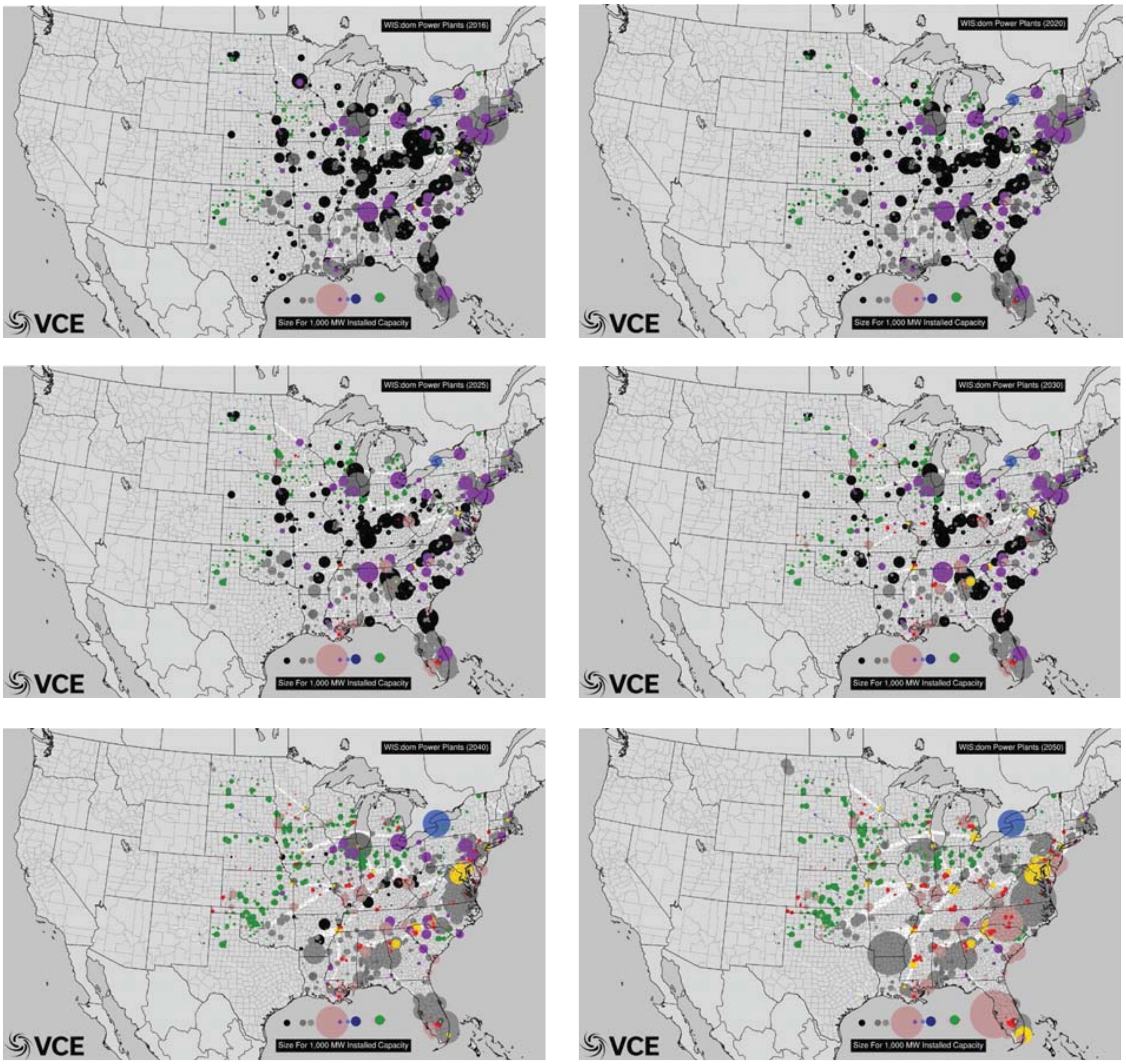
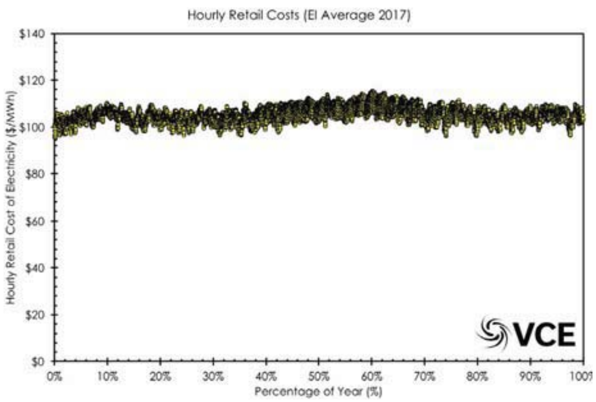
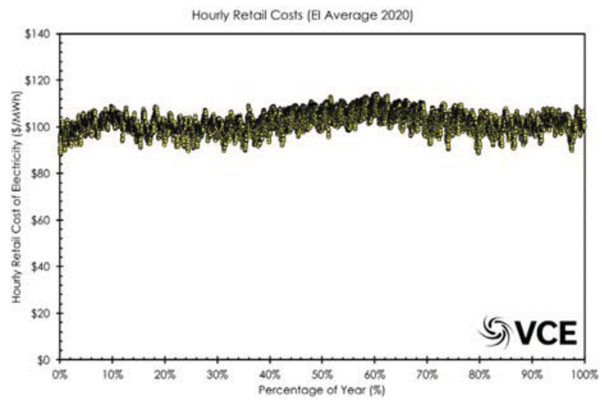
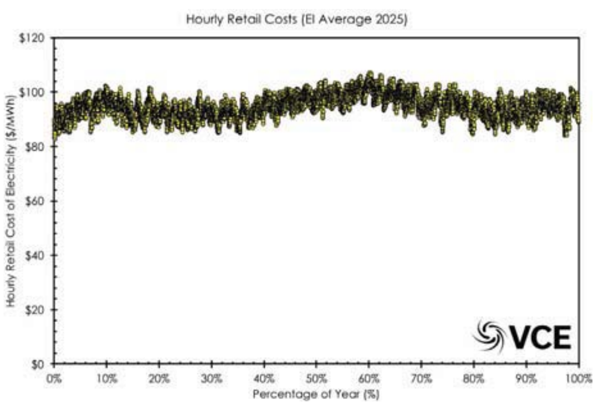


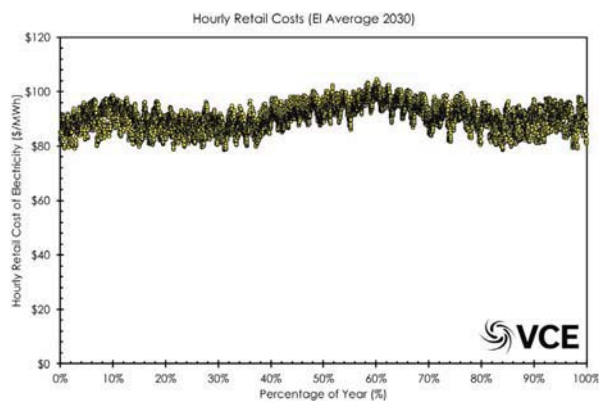
FIGURE 28: *The geographic siting of generation created by WIS:dom for the Baseline w/ Tx scenario branch. The investment periods can be followed from 2017 in the top-left panel to 2050 in the bottom-right panel. The white lines represent the interstate transmission capacity. The thicker the lines the greater the capacity. The colors are (in order shown at bottom): black = coal, yellow = storage, dark grey = NGCC, light grey = NGCT, rose red = rooftop solar PV, purple = nuclear, light blue = hydroelectric, dark blue = offshore wind, pink = geothermal, green = onshore wind, red = solar PV.*

Interestingly, Figure 28 depicts a transition in the electricity sector comprising two, seemingly apposed paradigms: more remote, utility-scale, variable generation; and more localized distributed generation with demand-side resources. The storage tends to gravitate to high demand centers. The portfolio of utility-scale variable generation, distributed generation, transmission, storage and large-scale natural gas is the economical pathway for the Eastern Interconnection, absent any climate mitigating policies. It appears that across the entire Eastern Interconnection footprint coal-fired power plants retire in order of their economics and regions that they can sell the most power to, i.e. more isolated (vertically integrated markets) coal-fired power plants retire the fastest, while plants in regions surrounded by large, integrated markets remain for longer.









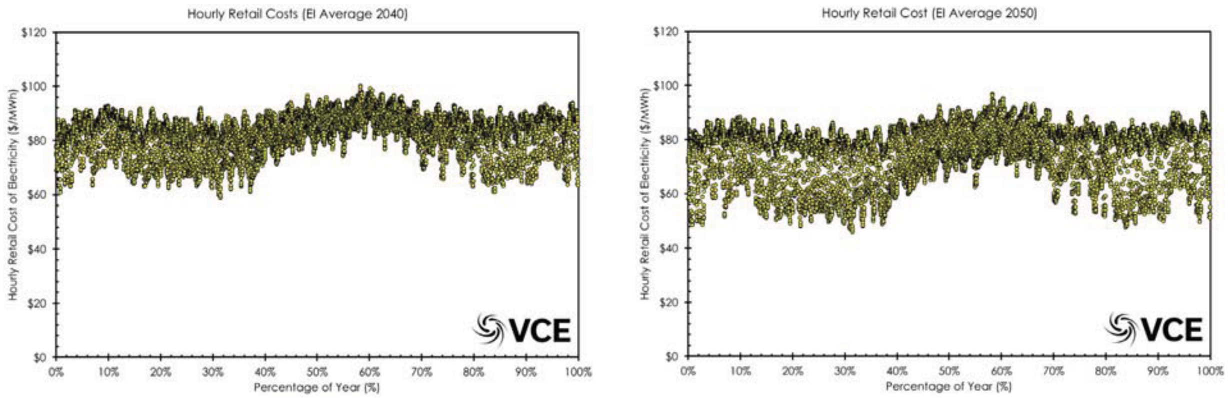


FIGURE 29: *The average retail cost of electricity for each hourly interval across the Eastern Interconnection. The retail cost represents the average cost to provide electricity to all the customers across the entire footprint. It does not represent the rate structure that a customer is charged. It is the equivalent of a real-time Time of Use (TOU) rate structure. With each investment period the cost of electricity is experiencing downward pressure due to the low-cost variable generation and cheap, abundant natural gas fuel.*

Figure 29 depicts the average hourly retail cost of electricity. The "cost" represents the average cost to deliver electricity to all customers over the Eastern Interconnection over twelve, 5-minute intervals. It illustrates the downward pressure on real-time costs for electricity; when demand is lower, and variable generation more abundant, the cost of electricity falls. From the perspective of WIS:dom, if costs are low enough, more resources could be deployed (storage, transmission, or demand-side resources) to increase demand at some time periods (increasing prices) and then dispatch the system differently at high-price constrained time periods. Due to this process, the negative price signals do not emerge. By definition, WIS:dom must charge for electricity over a year such that all generators make a profit. Further, WIS:dom must pay for all transmission construction, storage capacity, and any demand-side resources dispatched.

The present study is focused on Minnesota, and while the influence from outside the state must be analyzed, the evolution of the Minnesotan electricity grid is the primary metric considered. In Figure 30, the installed capacity and full-time jobs for Minnesota are shown for both Baseline scenario branches.

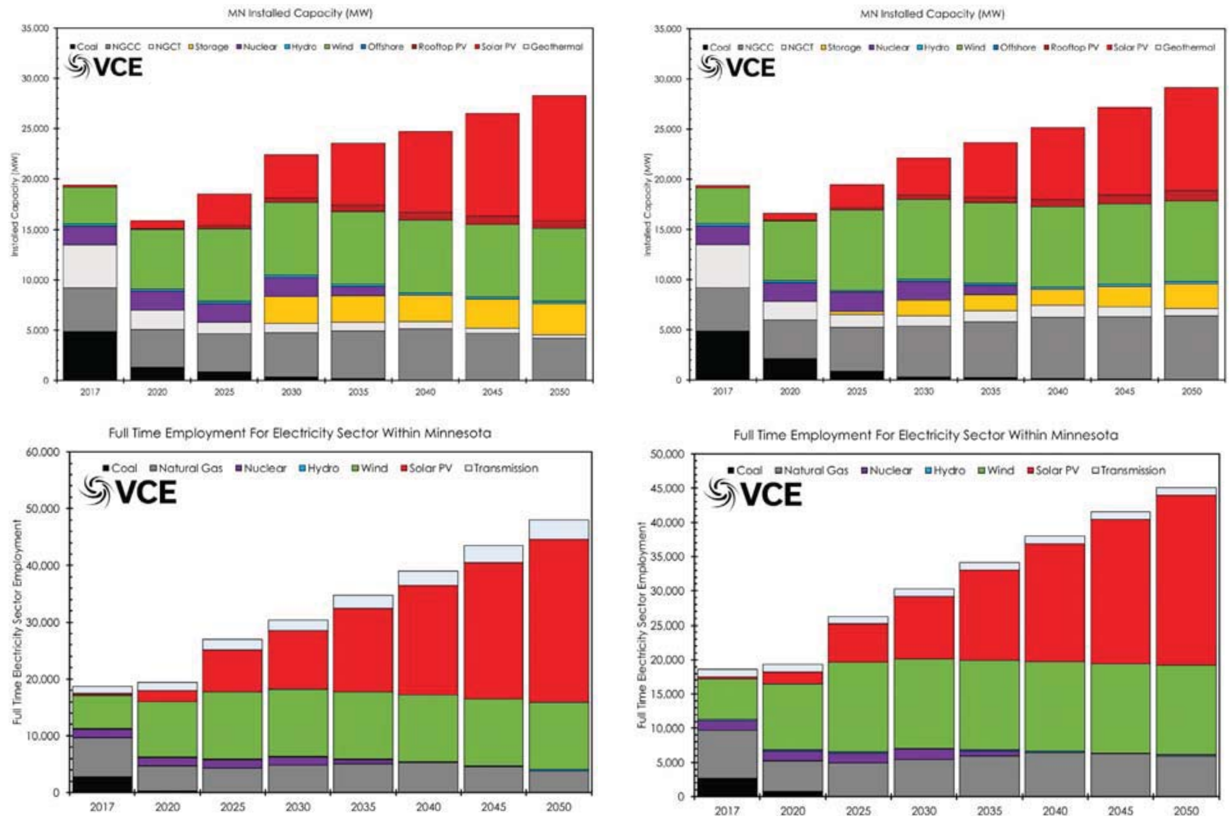


FIGURE 30: *The installed capacities (top) and full-time jobs (bottom) for the Minnesotan electricity sector. The left panels are for the w/ Tx branch, while the right panels are for the w/o Tx branch. More natural gas and wind is deployed when interstate transmission is constrained. When transmission expansion is allowed, more storage and solar PV is brought online reducing the need for natural gas combined cycle and combustion turbines. More jobs are created when transmission expansion is allowed, and solar connects to the grid, at larger capacities, earlier.*

Figure 30 suggests that allowing transmission, even in a baseline scenario, increases the amount of variable generation installed. Further, the transmission enables more storage to come online, more solar PV construction, and a marked reduction in natural gas dependency. The transmission enables Minnesota to interact more with the surrounding regions (particularly MISO), which allows WIS:dom to combine resources in a cost-effective manner and reduce the need for natural gas power plants. This implies that considering more than just the focus region (Minnesota) multiplies the pathways available for resource combinations and can automatically reduce the dependency on fossil-fuel generation. If a considered planning region is smaller, there are less resources available to consider.

With the higher share of variable generation constructed in Minnesota, Figure 30 shows that the number of jobs also increases. The higher numbers of jobs are simultaneous with lower-cost electricity and a cleaner grid.

Figure 31 displays the generation share for Minnesota for each investment period for the Baseline w/ Tx branch. The dispatch stack includes imports from out of state that provide power to the Minnesotan consumers. The import and exports are monitored by WIS:dom, so that GHG emissions can be attributed to the purchasers of electricity that was generated with fossil-fuels. Local pollution is attributed to the generation site, but since GHG emissions are global it is important to determine when the electricity is consumed and apply those emissions to the demand site. Figure 31 shows that Minnesota can transform from a fossil-dominated grid to one dominated by variable generation.

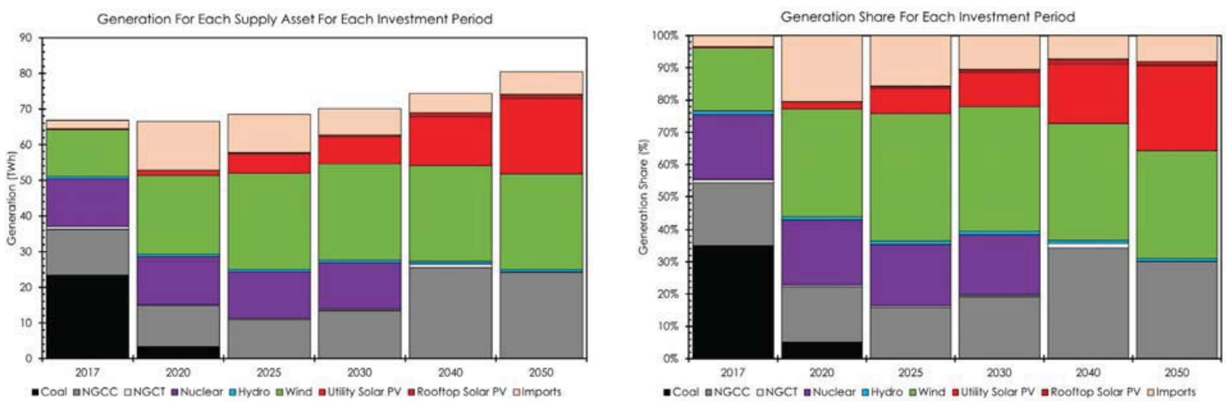


FIGURE 31: *The generation share by investment period for Minnesota for the Baseline w/ Tx scenario. The left panel displays the total generation in billions of kWhs, or TWh, and the right panel shows the percentages. The generation share transitions from fossil-dominated to variable generation dominated. Further, imports are removed from Minnesota in the longer-term and replaced with exports into MISO; producing economic benefits for Minnesota.*

Figures 32 and 33 display example dispatch stacks output from WIS:dom for Minnesota for the month of January and July for each investment period. The panels show how WIS:dom coordinates the dispatch of variable generation through seasons at high-temporal frequency.

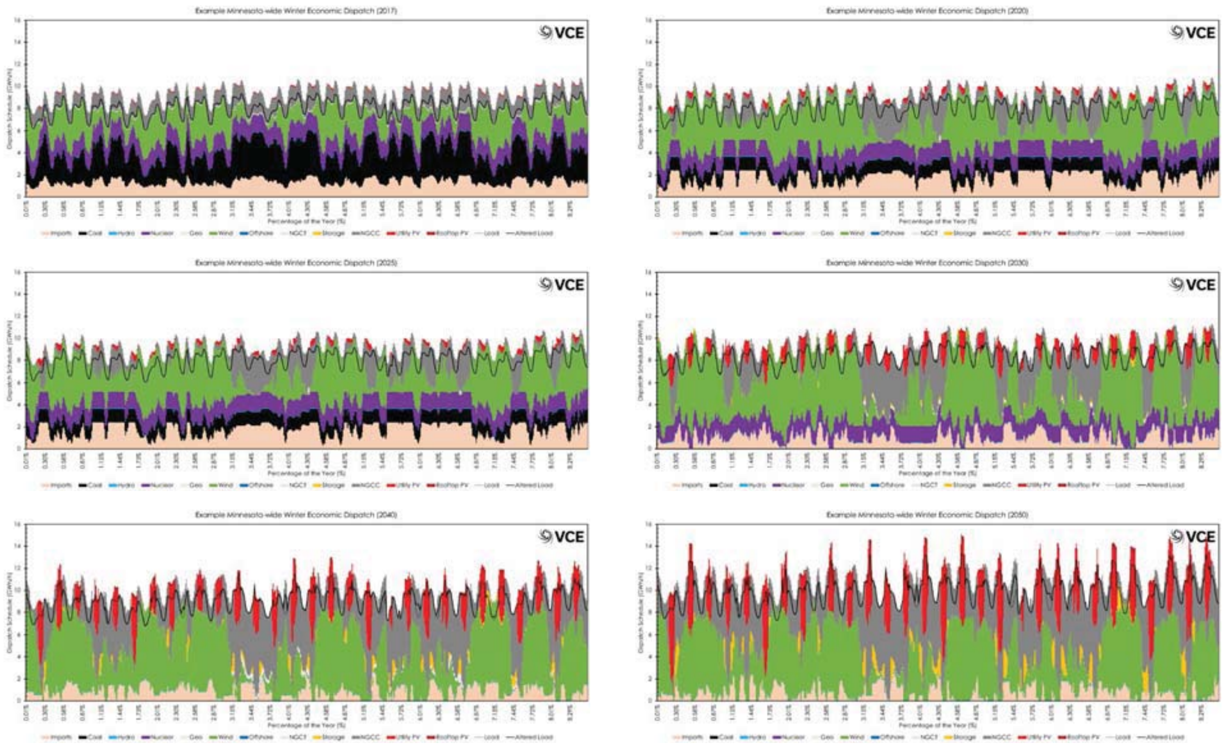


FIGURE 32: *The economic dispatch over the month of January for Minnesota for each of the investment period. WIS:dom finds combinations of generation and demand-side resources for each 5-minute interval for all of Minnesota to keep electricity flowing throughout each investment period.*

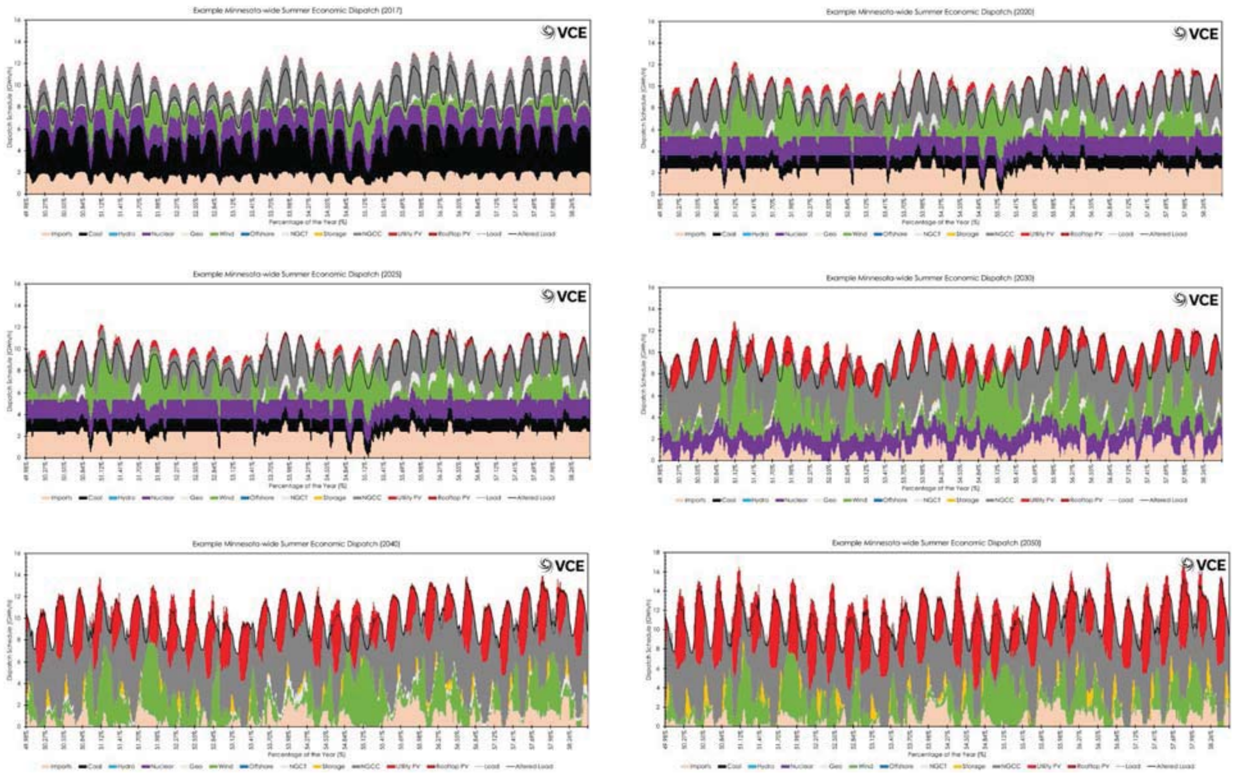


FIGURE 33: *The economic dispatch over the month of July for Minnesota for each of the investment period. WIS:dom finds combinations of generation and demand-side resources for each 5-minute interval for all of Minnesota to keep electricity flowing throughout each investment period.*

The dispatch stacks in Figures 32 and 33 demonstrate that power can be reliably provided by a portfolio of technologies working in coordination. They also illustrate the seasonality of wind and solar with varying penetration levels. In summer (July), solar provides much more power and energy than in winter, while the inverse is true for wind; it provides more power and energy in winter (January). This weather-driven anti-correlation helps wind and solar reinforce each other (if siting can be carried out efficiently).

It is clear from Figure 31 that the electricity mix is not 100% variable generation for any investment period, yet during the time-series represented in the dispatch stacks there are numerous occasions where the instantaneous level of variable generation is 100% and above. These instances occur in all seasons. This demonstrates that achieving 100% instantaneous variable generation occurs well before a 100% variable generation mix is achieved.

One more metric that is tracked by WIS:dom is carbon dioxide emissions for each state. As noted before, the consumer of the electricity is responsible for emitting the GHGs. In Figure 32, the cumulative carbon dioxide emissions for each state is shown. It illustrates the emission characteristics of the Eastern Interconnection electricity grid and shows the relative contribution to the total emissions from each state. For Minnesota, it suggests that under the baseline scenarios cumulative carbon dioxide emissions by 2050 (from 2017) could be 700 million metric tons. Figure 32 also illustrates that Minnesota is a part of a larger system that influences and impacts the role that Minnesota and its targets can have on total emissions. There are two avenues for progress that Minnesota can impart:

1) Being a leader and demonstrating the viable pathways to low-emission futures for the state itself; and 2) initiate an evolving paradigm where planning is performed considering other areas and how they may have to evolve around states that are taking action to reduce emissions; which may end up altering their grid performance in terms of revenue and competitiveness, if they themselves do not also adapt.

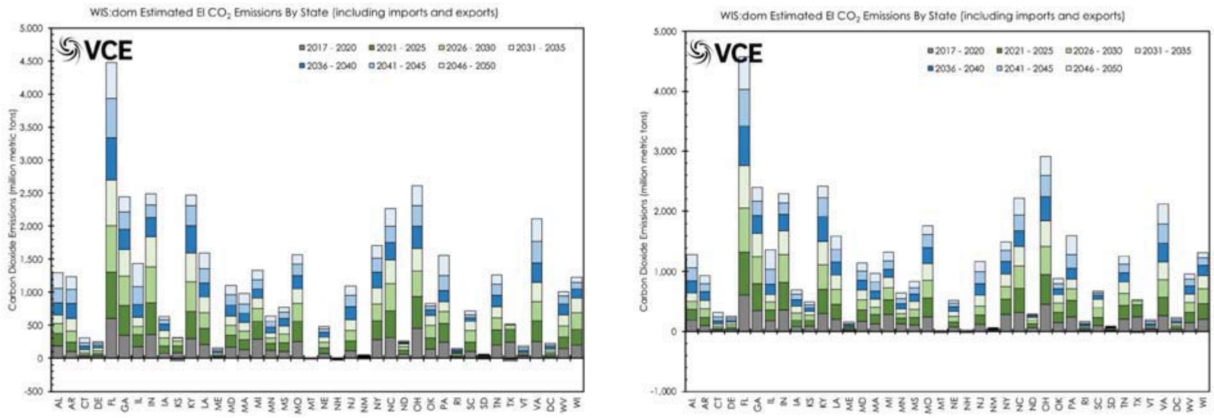


FIGURE 32: *The cumulative carbon dioxide emissions for each state within the Eastern Interconnection. The left panel is for the Baseline w/ Tx branch and the right is for the w/o branch. The colors represent the emissions during each investment period from 2017 to 2050. When emissions are negative, it means that the state is exporting enough electricity that has carbon dioxide emissions attributed it that the state has a net deficit of emissions. Those negative emissions will appear on the importing state's inventory of emissions. Therefore, the net contribution is zero (i.e. WIS:dom is avoiding double counting GHG emissions).*

The Baseline scenario is the pathway against which all other pathways in this study will be compared. The reasoning behind this is that the future is uncertain and the Baseline scenario gives a pathway of a possible future where WIS:dom makes all decisions based upon economics only, while the other scenarios will have additional constraints imposed upon them. Since different pathways are compared within a single modeling framework (WIS:dom) the differences can be evaluated in a rigorous, uniform, manner. For example, if WIS:dom is deficient in a particular area, all model scenarios will be deficient in the same area, and so its impact will be the same across all pathways.

The following scenarios will only have the metrics and features that substantially change compared with the baseline discussed and analyzed.

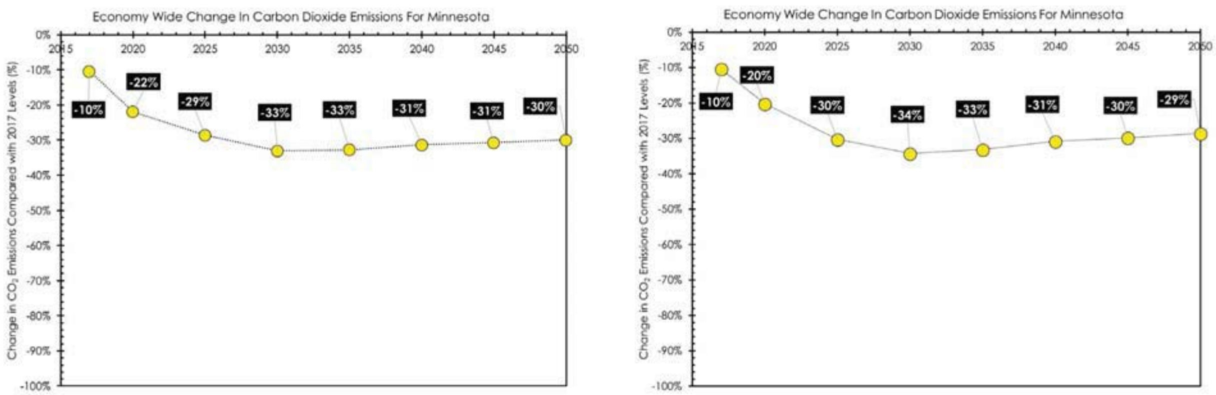


FIGURE 33: *The carbon dioxide emission reductions for the entire Minnesotan economy. It shows that by 2017 the reduction from 2005 has reached 10%. By 2050, both branches reduce emissions by another 20%. With emission reductions essentially ceasing by 2030.*

B. MINNESOTA DEEP DECARBONIZATION

The Minnesota deep decarbonization scenario had two branches: one that allowed interstate transmission capacity expansion (w/ Tx), and one that did not (w/o Tx). In this scenario, the rest of the Eastern Interconnect evolved along the Baseline scenario pathways, while Minnesota electrified and decarbonized its economy to achieve 80% reductions, from 2005 levels, in GHG emissions by 2050. The scenario pathway suggests that Minnesotans could save a cumulative $37.6 billion or $51.4 billion if electrification and decarbonization were carried out. The lower value is for the branch that does not allow interstate transmission and the higher amount is for more interconnection with neighbors. In other words, the cumulative value of transmission expansion by 2050 under the MN deep decarbonization scenario is $13.8 billion. These saving are calculated in comparison with the Baseline without transmission capacity expansion scenario branch. These cumulative values translate to an average annual saving for each household of between $653 and $1,165 by 2050. Figure 34 displays the investment period cumulative savings along with the average annual household savings.

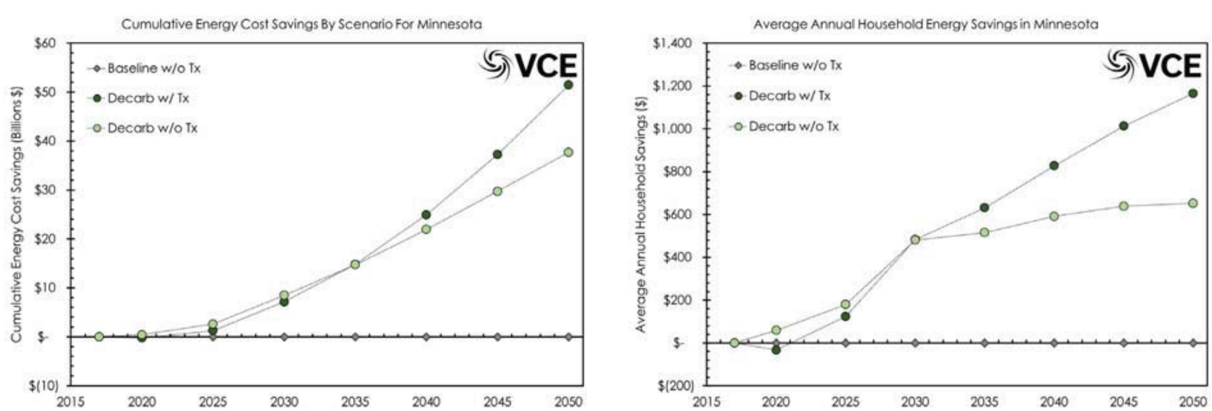


FIGURE 34: *The cumulative energy savings (left) and the average annual household savings (right) for the MN deep decarbonization scenario. The expansion of interstate transmission costs slightly more by 2020, but by 2030 the cost savings overtake the non-transmission-expansion branch, resulting in almost $14 billion more in energy savings.*

The MN deep decarbonization scenario requires the reduction of economy-wide emissions to below 80% of those in 2005. Figure 34 shows that this electrification and decarbonization generates energy cost savings. The carbon dioxide emission reductions for the electricity sector (for all states) and the entire economy is shown in Figure 35.

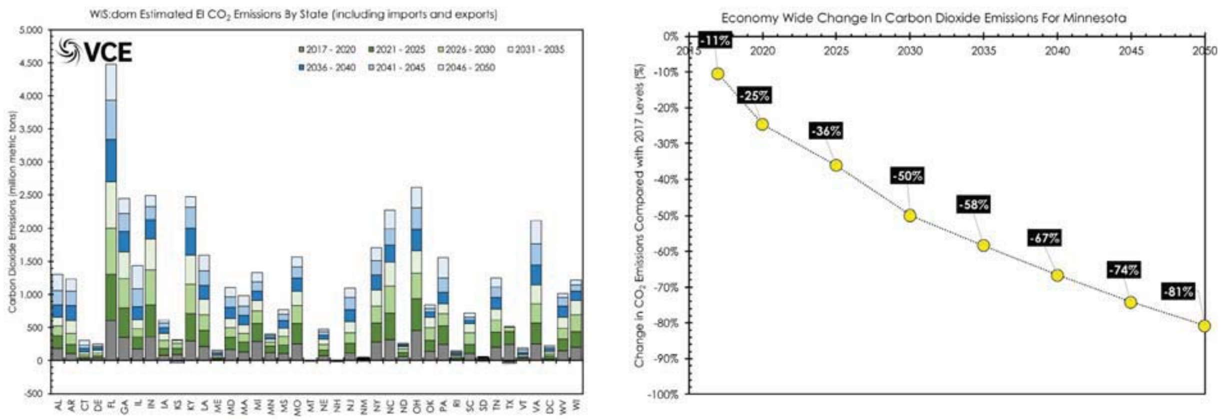


FIGURE 35: *The electricity sector emissions for all states in the Eastern Interconnection (left) and the Minnesota economy-wide emissions reductions from 2005 levels (right). Comparing the left panel with Figure 32, it can be seen that the emissions from the electricity sector are substantially reduced. While comparing the right panel to Figure 33, it can be seen the economy-wide emissions are reduced by a further 50% beyond the baseline scenario. These panels are for the w/ Tx branch.*

Figure 35 demonstrates the potential of electrification and decarbonization working together. The left panel shows Minnesota electricity is becoming cleaner (compared with Figure 32), while also removing 50% more emissions from the entire economy (compare right panel of Figure 35 with Figure 33). Note that the remaining states in the Eastern Interconnect are not impacted unduly by the electrification and decarbonization of Minnesota.

Minnesota is altered through electrifying and decarbonizing the generation mix. Figure 36 shows the installed capacity and full-time jobs for the w/ Tx branch. The figure shows that total installed capacity is approximately 6,000 MW more than in the Baseline scenario. Additionally, there are about 15,000 more full-time jobs created. The primary changes are higher wind and solar PV installations with fewer natural gas power plants.

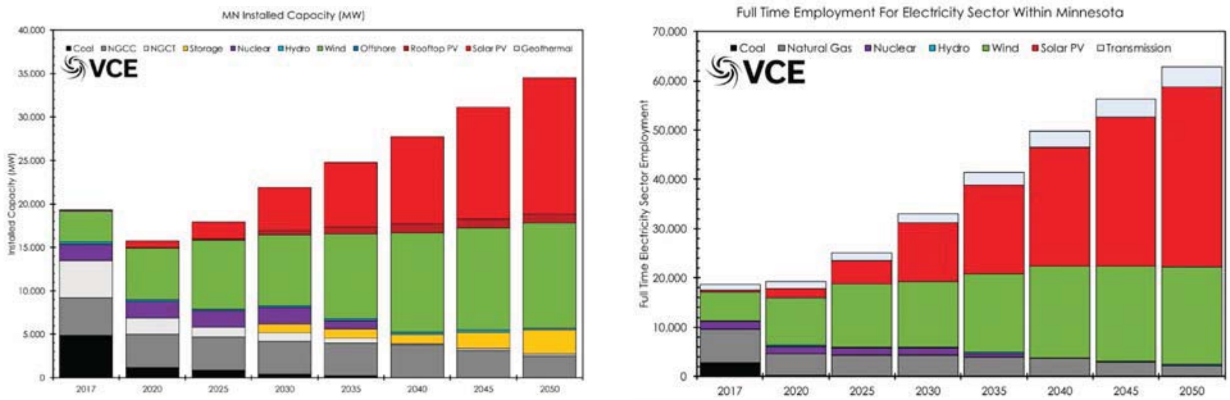


FIGURE 36: *The installed capacity (left) and full-time jobs (right) for Minnesota. Comparing these panels with those in Figure 30, it can be seen that total installed capacity has increased by approximately 6,000 MW. Additionally, over 15,000 more full-time jobs have been created. There is a marked increase in wind and solar PV installations, with accompanying reductions in natural gas power plants.*

The amount of storage for this scenario, as seen in Figure 36, was at the same level as in the Baseline scenario. When interstate transmission capacity is limited, the amount of storage increased three-fold. The storage installations come in-lieu of the spatial advantage that the transmission infrastructure provides. Alongside additional storage, higher capacities in wind and solar PV are deployed to charge the storage for use at a later time. This explains the large difference in cumulative energy cost savings between the w/ Tx and w/o Tx branches.

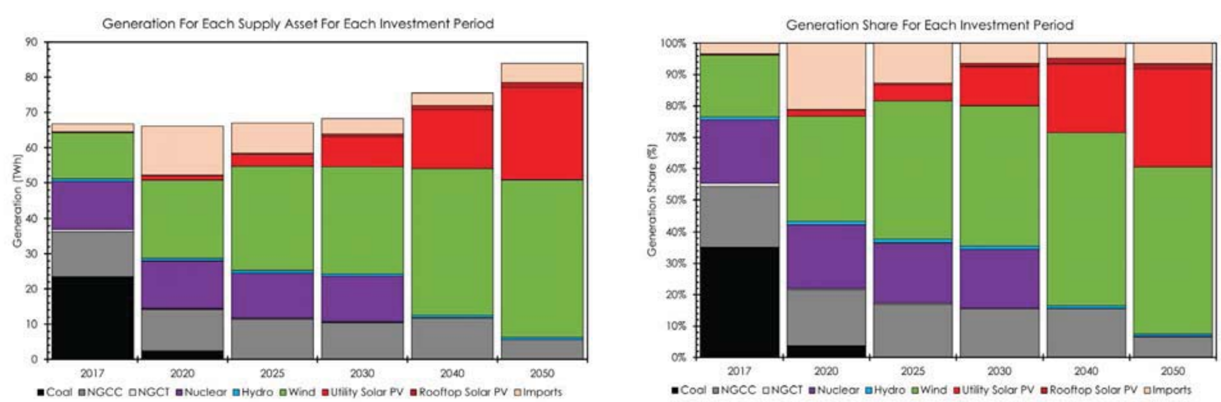


FIGURE 37: *The electricity generation share by investment period in TWh (left) and percentage (right) for Minnesota. Comparing these panels to those in Figure 31 illustrates the differences in the share of electricity generated in Minnesota. By 2050, in this scenario, over 50% of the electricity comes from wind, while 30% comes from solar PV. This is 23% more generation from wind and solar compared with the Baseline scenario. Only 6% comes from natural gas, compared with 38% in the Baseline scenario. The electricity generated covers more sector demands than in the Baseline scenario.*

In Figure 37 the Minnesota electricity generation shares for each investment period are shown. The figure demonstrates that decarbonization moves generation away from fossil-fuels to variable generation (wind and solar PV). Further, the electrification alters the demand requirements, which further supports variable generations; since the new load profiles are more flexible. There was 23% more variable generation in this scenario compared with the Baseline. Storage is dispatched more frequently in this scenario and imports are larger than in the Baseline (for the w/ Tx branch).

The process of electrification altered the input demand profiles for Minnesota. These are processed within WIS:dom and it can decide to utilize the flexibility of these new loads; but must pay a cost to do so. Figures 38 and 39 display January and July dispatch stacks for Minnesota. They show how Minnesota could electrify and decarbonize on a high-temporal frequency. It becomes clear that the system shown in Figures 38 and 39 are fundamentally different to the one shown in Figures 32 and 33.

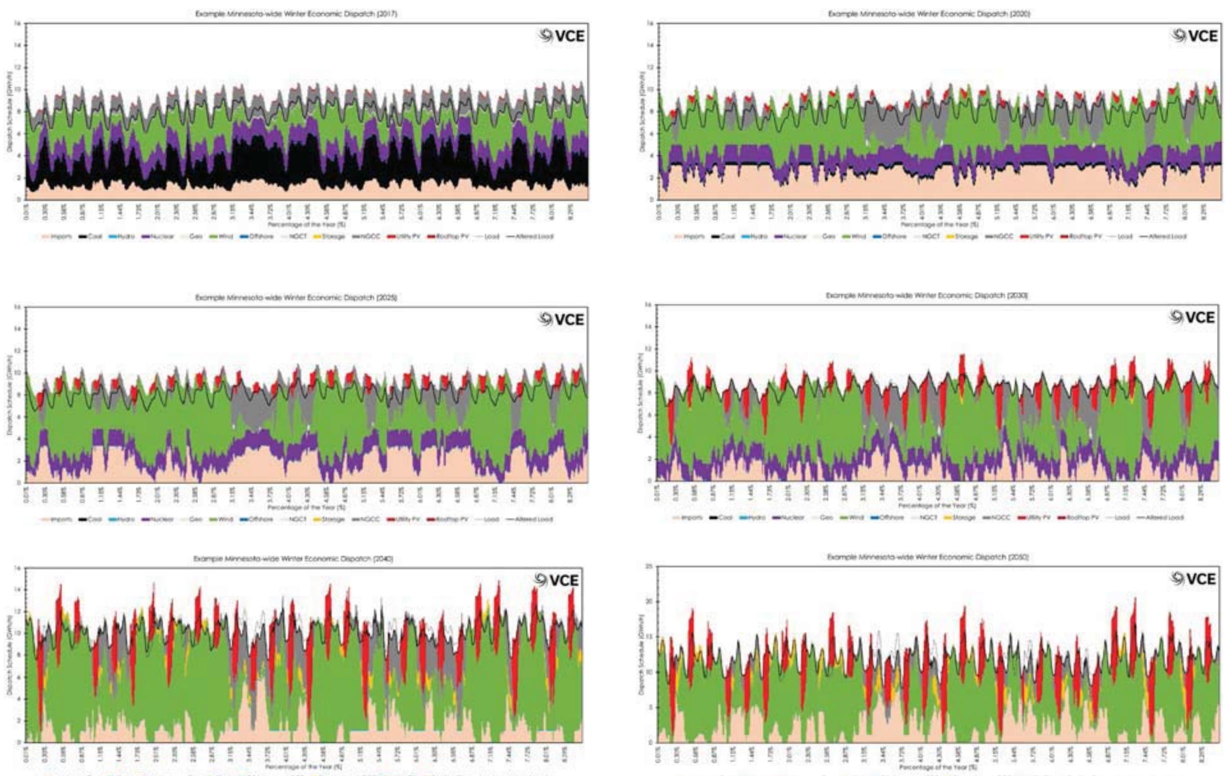


FIGURE 38: *The economic dispatch over the month of January for Minnesota for each of the investment period. WIS:dom finds combinations of generation and demand-side resources for each 5-minute interval for all of Minnesota to keep electricity flowing throughout each investment period. There is more time-periods with flexibility being dispatched by WIS:dom, along with storage, variable generation and imports.*

Attachment B to CEOs' Petition for Reconsideration

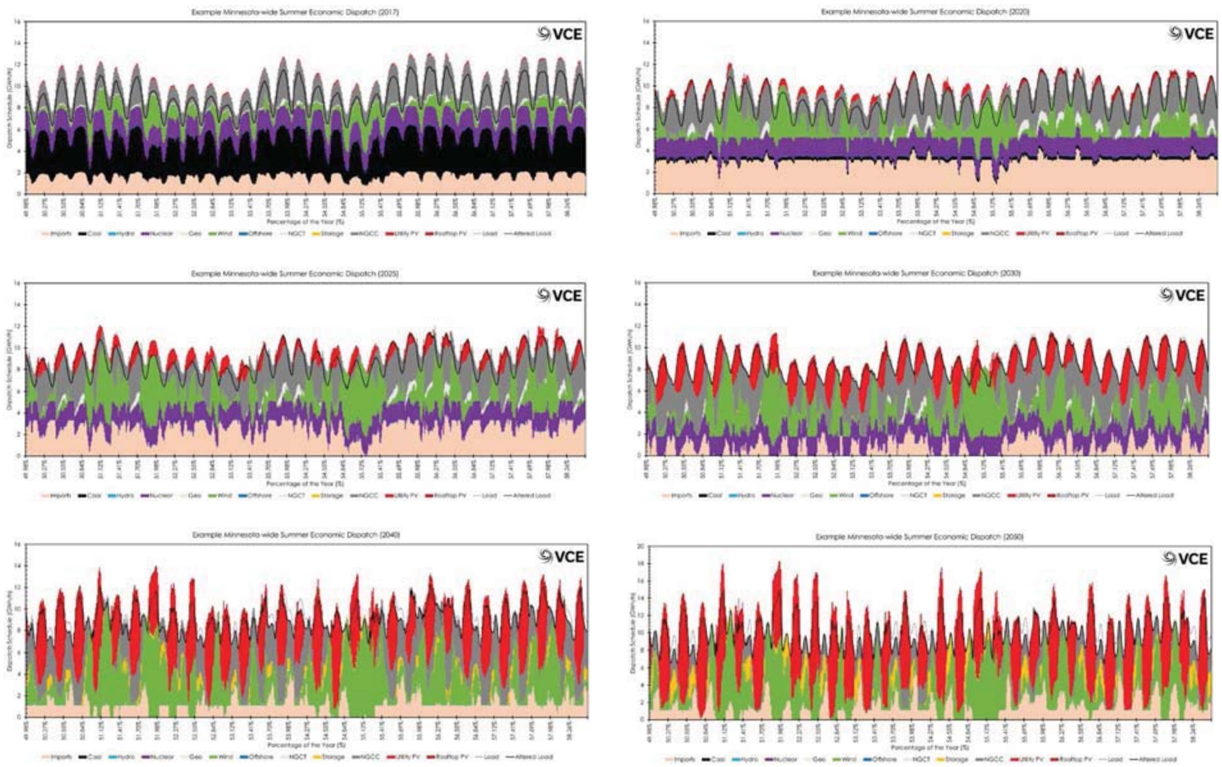


FIGURE 39: *The economic dispatch over the month of July for Minnesota for each of the investment period. WIS:dom finds combinations of generation and demand-side resources for each 5-minute interval for all of Minnesota to keep electricity flowing throughout each investment period. The summer months by 2050 have lower peak demand than winter for Minnesota.*

Figures 38 and 39 demonstrate that WIS:dom can combine generation, transmission and demand-side resources to provide electricity at high-temporal resolution for Minnesota without fail. There are time periods where it is clear that WIS:dom is dispatching demand-side resources. Compare the solid-black line with the dash-black line. These allow the demand to be more flexible to the changing variable generation. It can be observed that there are many instances of 100% variable generation contributing to the power of the grid. Some of that electricity is stored or transmitted to other regions. The combination of storage and transmission accommodates much higher volumes of variable generation. Inspecting Figures 38 and 39, it can be seen solar PV installations increase along with storage capacity increases.

The addition of demand-side resources enables further accommodation and reduces the burden of the system to seek out more generation sources. Some sources of demand-side flexibility are simple; such as EV charging, which is already available in the mass-markets. The WIS:dom optimization model must pay for the charging to be more flexible. Therefore, there are incentives for customers to act. Note that for EVs, the flexibility is only supplied by delaying or bringing forward the charging time, it is not supplied by vehicle-to-grid discharge of EV batteries. Thus, customers could benefit from payment (or credit to utility bill) for moving their charging, which might be a lower-cost time period. Therefore, customers could "save" twice.

In general, the Minnesota deep decarbonization scenario was more readily feasible to solve than the Baseline scenario. There were more components to the electricity system that could work together and were (anti-)correlated with weather that provides the majority of the fuel for the electricity generation. The dispatch portion involved less computation as the model included more variable generation, since there are fewer unit commitment issues and less competition for fuel. Superimposed on these easier aspects was the ability of the demand to provide dispatch that could avoid extreme periods at lower-cost and complexity than additional generation / transmission resources would have been.

The Minnesota deep decarbonization would require a fundamentally different electricity system in Minnesota than existed in 2017. These changes might prove difficult, but there are high amounts of monetary savings to be exploited if the changes are implemented for Minnesotans. The changes would also reduce the exposure to higher gasoline and natural gas prices in the future.

C. HIGH NATURAL GAS COSTS

The high natural gas scenario is designed to evaluate the impact of higher natural gas prices on the Baseline and MN deep decarbonization pathways. The Annual Energy Outlook (AEO) high natural gas price is used as the new input. With the higher natural gas price, WIS:dom must determine the least-cost pathways to meet the goals set in the Baseline and MN deep decarbonization scenarios.

The higher natural gas prices have relatively low impact on the MN deep decarbonization scenario. In fact, the transition follows a relatively similar pathway. It does denude, slightly, the energy savings for Minnesota. In Figure 40, the cumulative savings by 2050 reach $45.2 billion ($1,076 average annual household saving), a reduction from the MN deep decarbonization scenario of $6.2 billion ($89 reduction in the average annual household saving). For the higher natural gas cost baseline scenario, the exposure to the higher natural gas prices is much higher than in the MN deep decarbonization scenario. In fact, it increases the cumulative costs for energy by 2050 by $15.6 billion (or $294 annually per household). The additional spending comes from higher fuel costs and more capacity of generation, which results in emissions falling by a further 9% compared with the Baseline by 2050.

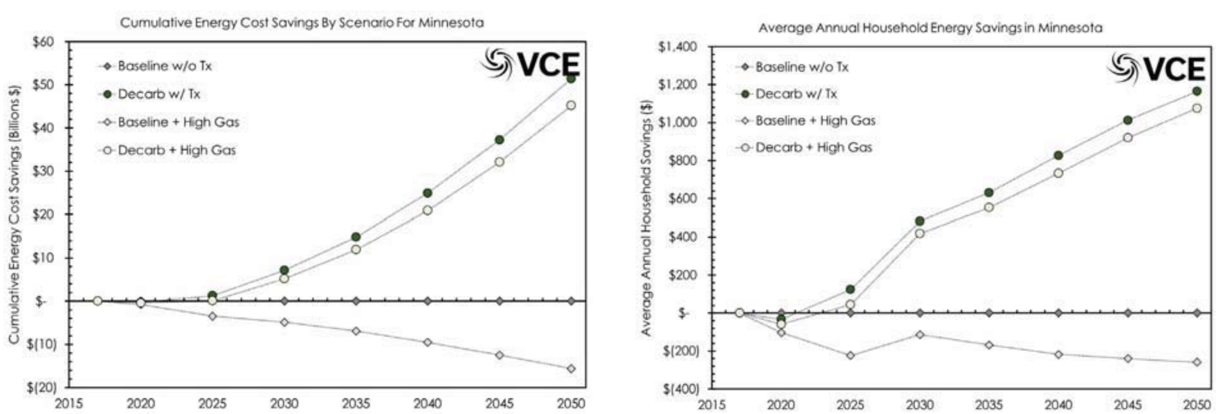


FIGURE 40: *The cumulative (left) and average annual household energy (right) savings or increases for the higher natural gas price scenario. The exposure to increased natural gas prices is much higher for the Baseline than in the MN deep decarbonization scenario. The higher natural gas prices did drive more investment into wind and solar PV power, which reduces emissions by a further 9% in the Baseline scenario.*

The higher natural gas price scenario has illustrated that under the electrification and decarbonization pathway there is less exposure to the volatility of natural gas fuel costs. The lower exposure comes from two areas: 1) less natural gas needed for heating; and 2) less natural gas required within the electricity sector to produce power. Another feature of the higher natural gas price scenario within the

Attachment B to CEOs' Petition for Reconsideration

Baseline scenario was that WIS:dom constructed more wind and solar compared with the lower natural gas price. This suggests that building more natural gas power plants could come with unnecessary risks of fuel prices exceeding forecasts; while, in contrast, variable generation is not exposed to that risk. In fact, as shown in Figure 41, the natural gas power plant capacity in Minnesota is halved in the high natural gas scenario compared with the Baseline (see Figure 30). With the change in capacity comes more full-time employment, which is another positive attribute to the variable generation installations.

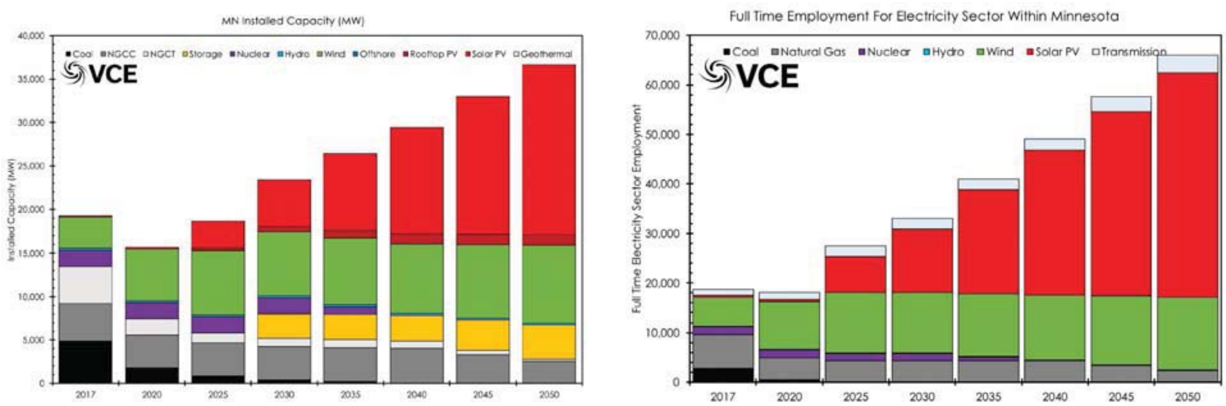


FIGURE 41: *The installed capacity (left) and full-time jobs (right) for the high natural gas baseline branch. With higher natural gas prices, the baseline scenario installs half the amount of natural gas and replaces it with wind and solar PV power. With the additional capacity comes more full-time employment. Compare these panels to those in Figure 30.*

D. ZERO EMISSION DECARBONIZATION FOR MINNESOTA

This scenario is similar to the MN deep decarbonization scenario, but with the additional constraint of completely removing emissions from the electricity sector by 2050 (rather than the 91% reduction from 2005 levels). The scenario has two branches that address the differences created by allowing or restricting interstate transmission capacity expansion.

The impact of aiming for 100% reduction in emissions for the electricity sector is a reduction in energy cost savings. These reductions in savings are amplified if interstate transmission expansion is restricted. The cumulative savings for this scenario, w/ Tx, is $44.9 billion ($6.9 lower than the MN deep decarbonization scenario); however, the cumulative savings are reduced by $35.5 billion to $15.9 billion when interstate transmission is restricted. The dramatic reduction is caused by the lack of geographic diversity when interstate transmission cannot be expanded. It even causes the household savings to become additional annual costs by 2050 amounting to $191 per household. Figure 42 shows these values for each investment period.

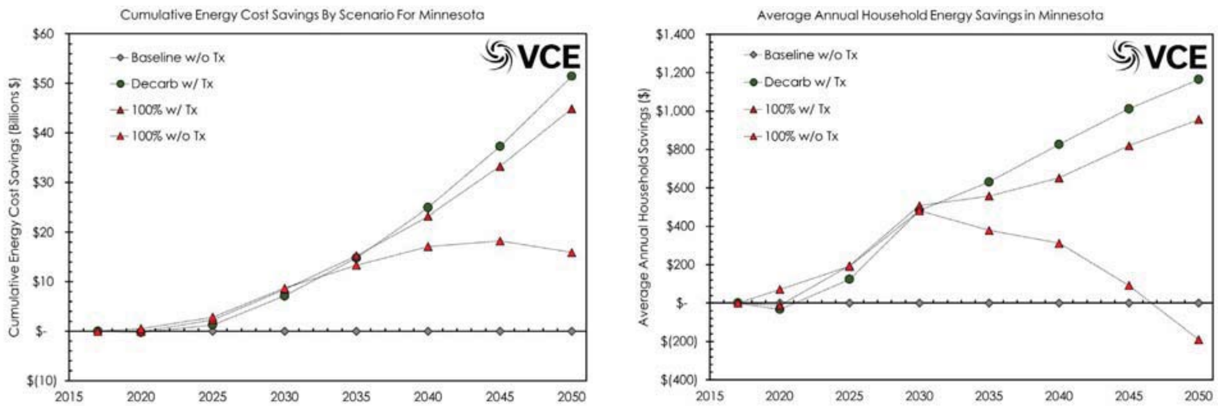


FIGURE 42: *The cumulative savings compared to the Baseline scenario (left) and average annual household saving (right) for the zero-emission electricity grid scenario. Unit 2030 the branches look incredibly similar, but after that time the costs to provide reliable power diverge.*

The difference in cost is quite remarkable. The increase between the branches is primarily due to the geographic diversity in Minnesota being saturated and without increased transmission to other regions, more storage and capacity is required. Figure 43 shows the installed capacities in Minnesota for the two branches. It highlights the need for storage in a transmission constrained situation and how smaller regions can be impacted by weather variability.

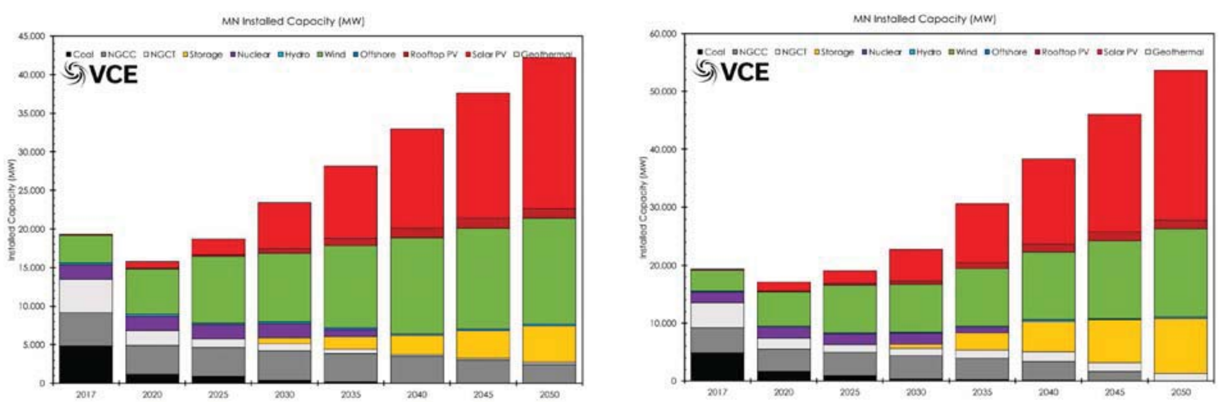


FIGURE 43: *The installed capacity for the w/ Tx branch (left) and w/o Tx branch (right). Minnesota can still have natural gas generation for the w/ Tx because it provides electricity to other parts of MISO, when it is short of power, in exchange for zero-emission electricity at other times when Minnesota is short of power. For the w/o Tx branch, the Minnesotan electricity grid must balance everything on its own. To do this WIS:dom deploys much more storage along with wind and solar PV. The total capacity is 15,000 MW higher in the w/o Tx branch compared with w/ Tx branch.*

Along with higher power capacity of storage, there is a substantial increase in the energy storage capabilities in Minnesota to cover the variability of the weather over its footprint. Figure 20 highlights the scale at which the 100% w/o Tx branch is in terms of storage capacity. There is over 165,000 MWh of energy storage capacity deployed. That provides over seventeen hours of storage discharge at full power (~9,500 MW). The full discharge capability covers over half of the peak demand for Minnesota.

The WIS:dom optimization model can still dispatch the system without fail for all 5-minute intervals for each of the investment periods when there are no emissions from the electricity grid allowed within Minnesota. In Figure 43, natural gas combustion turbines are still present, which provide capacity to ensure that if there are extreme, unexpected, events dispatch capabilities are present. The natural gas combustion turbines are not used for any 5-minute period in 2050, but rather provide capacity, just in case. Figure 44 shows the dispatch of the Minnesota footprint for the 100% w/o Tx branch in 2050. It depicts a future where more flexibility is used, more storage is deployed, and high capacities of wind and solar provide all the electricity requirements. There are imports and exports along existing interstate transmission corridors.

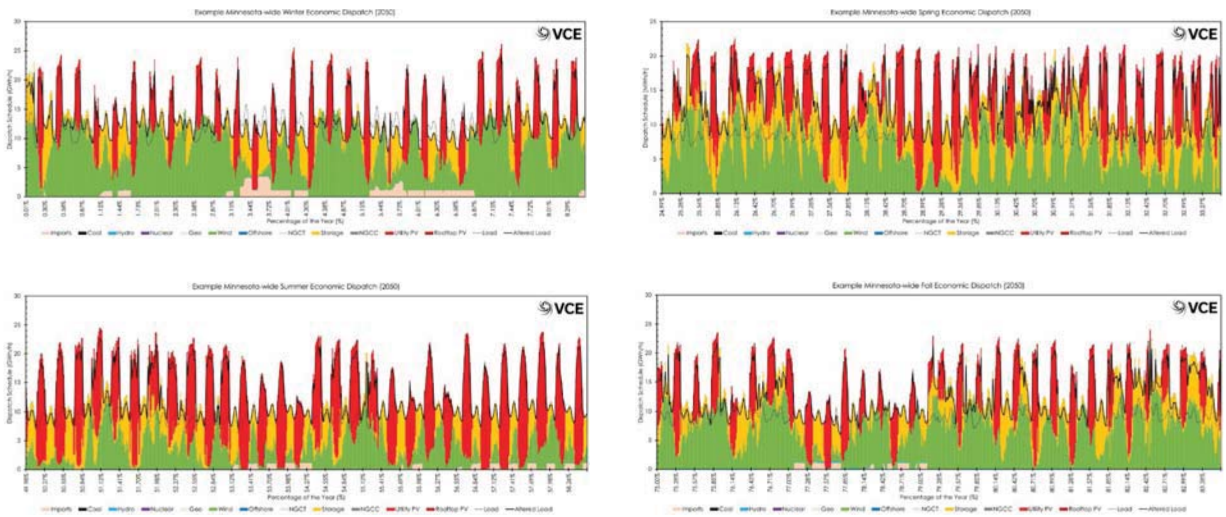


FIGURE 44: *Example monthly dispatch stacks and load curves for Minnesota in 2050 for the 100% w/o Tx branch (completely decarbonized electricity grid by 2050). Top-left represents Winter (January), top-right Spring (April), bottom-left Summer (July), bottom-right Fall (October). WIS:dom performs the dispatch for all parts of the Eastern Interconnection for each 5-minute interval for the investment period. Notice that the load is considerably altered by storage and demand-side resources. Lower generation availability is covered by demand-side resources, storage discharge, and limited imports.*

Figure 44 illustrates the different paradigm required to fill all electricity requirements with resources from within Minnesota. It is clear from the figure that storage and demand-side resources provide the flexibility to accommodate the variable resources.

The zero-emission electricity grid in Minnesota reduces economy-wide emissions by a further 3% from 2005 levels when compared with the MN deep decarbonization scenario. The cumulative energy cost increased beyond the MN deep decarbonization scenario by between $6.9 billion to $35.5 billion for that extra 3%. The additional spending may be required to meet climate mitigation requirements, but this scenario suggests there may need to be other avenues available to remove these final emissions. It should be mentioned that, in this scenario CCS was not deployed because there are still some emissions from combustion of natural gas (or coal) so cannot achieve zero-emissions with Minnesota alone, and for the w/ Tx branch the natural gas provided power for other regions in exchange for zero-emission power at other times; hence the CCS component was not chosen.

E. EASTERN INTERCONNECTION DECARBONIZES WITH MINNESOTA

This scenario analyzes the impact to Minnesota if the whole Eastern Interconnection electrifies and decarbonizes to meet the 80% reduction (from 2005 levels) in economy-wide emissions by 2050.

To execute this scenario, the other sectors for each state in the Eastern Interconnection had to be estimated and the electrification potential was assessed. WIS:dom, again, was provided input load profiles for each 5-minute interval for each investment period. The flexibility available through the electrification was computed and differentiated for each state, depending on their demand mix.

When the entire Eastern Interconnect decarbonizes along with Minnesota there is more competition for certain types of resources. The competition between entities within the Eastern Interconnection changes how Minnesota can evolve to meet the goal of 80x50. Due to this competition the cumulative energy savings are reduced compared with the MN deep decarbonization scenario. The cumulative savings are reduced to $41 billion by 2050 (a reduction of $10.4 billion compared with the MN deep decarbonization scenario), which results in the average annual household saving being $954 by 2050 ($211 lower). This reduction in savings is meaningful, but it should be noted that Minnesotans are still saving substantially on their energy bills compared with the Baseline scenario. Figure 45 shows the savings by investment period.

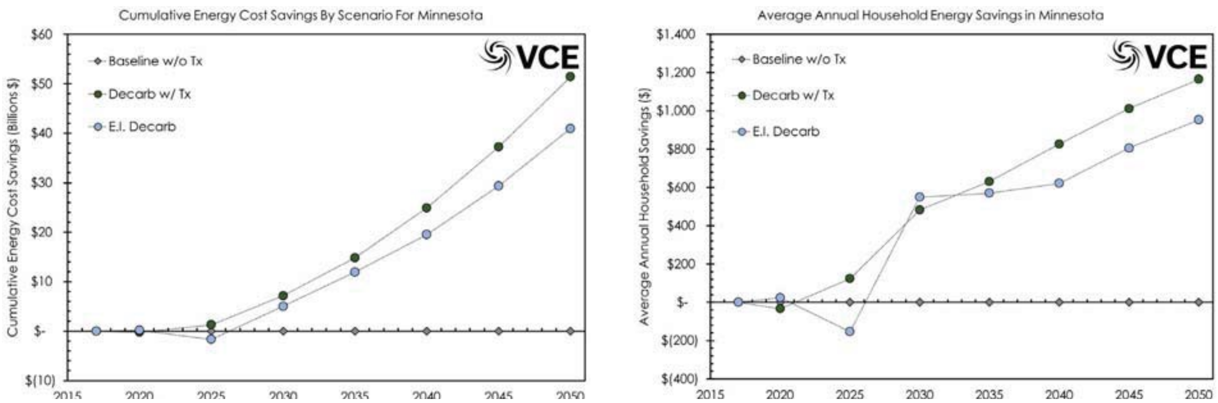


FIGURE 45: *The cumulative (left) and average annual household energy (right) savings or increases for the EI decarbonization scenario. The simultaneous electrification and decarbonization of the Eastern Interconnection creates competition for certain resource types. This alters Minnesota's pathway to reach its 80x50 target.*

This is the only scenario where the entire Eastern Interconnection is substantially altered compared with the Baseline scenario. The siting of generation is completely altered by the 80x50 target, since a transition to natural gas alone will not meet the emission reductions required. Figure 46 displays the siting that WIS:dom selects for this scenario. If compared with Figure 28 there are some striking differences. First, there are far fewer natural gas power plants. Secondly, there is higher amounts of wind and solar PV installations; in particular there is offshore wind on the East Coast. Thirdly, there is a resurgence of nuclear power to be able to meet the emission reduction targets at least-cost. Finally, there is a dramatic increase in rooftop solar PV, which is a reflection on the siting constraints in WIS:dom for utility-scale generation in protected regions. To achieve the emission reductions required, WIS:dom needs to install zero-emission technologies near load centers to help with peak demand, these sites are more suitable for rooftop solar PV.

Interestingly, Figure 46 does not appear to include much larger interstate transmission corridors. This is explained by the electrification component. Electrification provides flexibility, but also changes the seasonal profile of demand, which (with the energy efficiency) reduces the peak power needs. These two aspects of electrification actually reduce the burden on the transmission system.

The installed capacity across the Eastern Interconnection is shown in Figure 47. It highlights the dramatic differences between this scenario and the Baseline one. There is much less natural gas and higher capacities of variable generation. It also demonstrates the need of nuclear power for deep decarbonization under a resource constrained environment. For the same reason, Figure 47 depicts the installation of offshore wind in large quantities to help support decarbonization of the East Coast states.

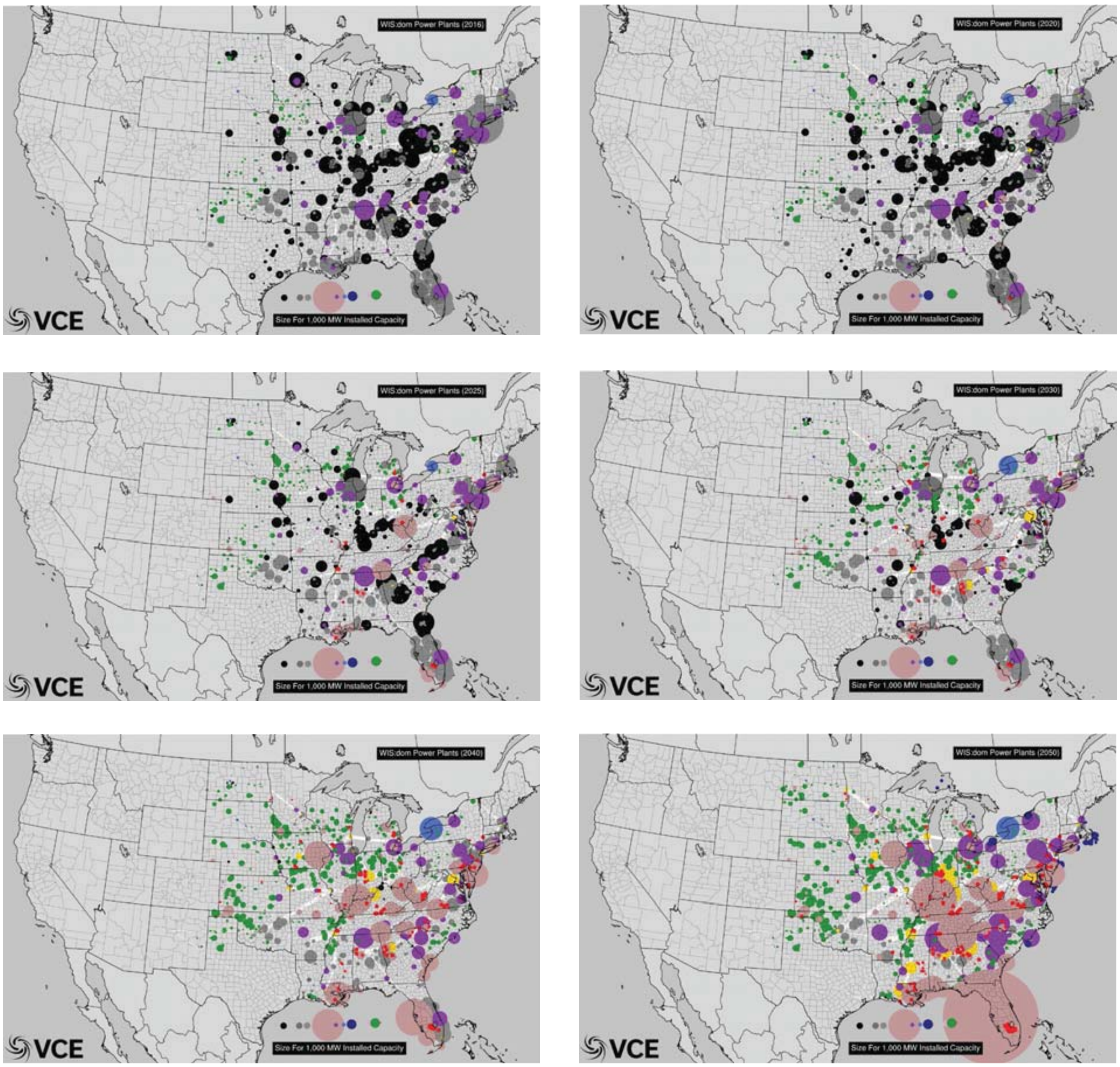
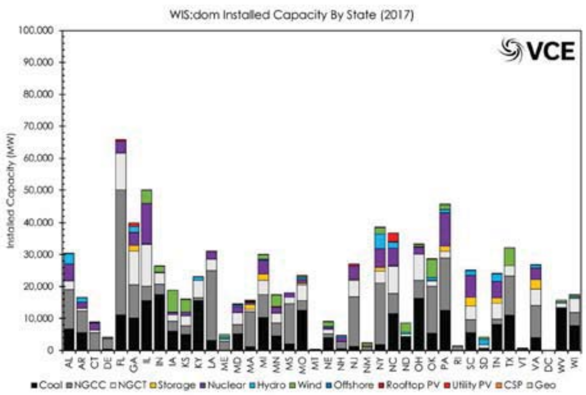
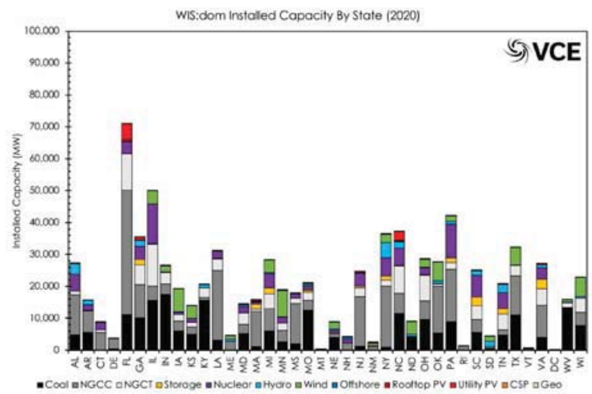
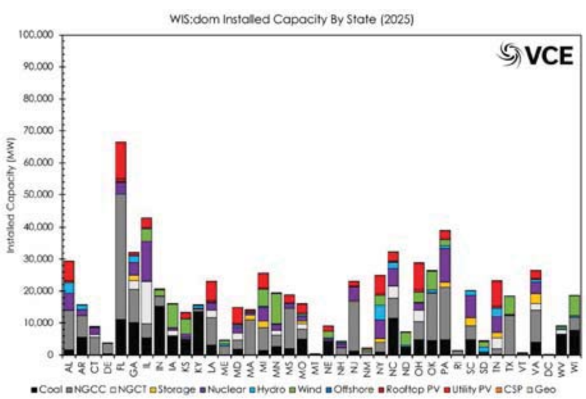


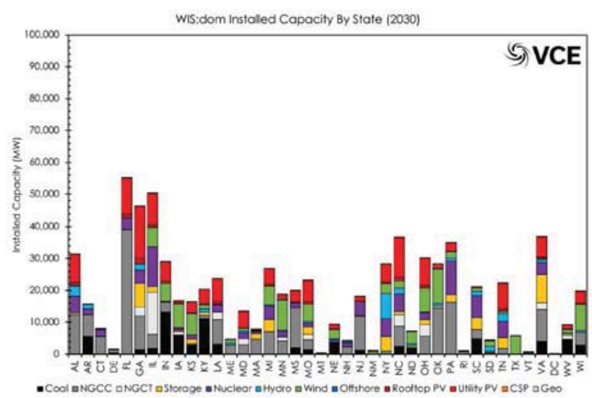
FIGURE 46: *The geographic siting of generation created by WIS:dom for the Eastern Interconnection Decarbonization scenario. The investment periods can be followed from 2017 in the top-left panel to 2050 in the bottom-right panel. The white lines represent the interstate transmission capacity. The thicker the lines the greater the capacity. The colors are (in order shown at bottom): black = coal, yellow = storage, dark grey = NGCC, light grey = NGCT, rose red = rooftop solar PV, purple = nuclear, light blue = hydroelectric, dark blue = offshore wind, pink = geothermal, green = onshore wind, red = solar PV.*

Figure 47 further highlights the diversity of the Eastern Interconnection and shows that some states have a more difficult process to decarbonize completely. Some of the states in the Eastern Interconnection consist entirely of variable generation and storage, while others are exclusively zero-emission generation, and a third category of states have natural gas supplementing the variable generation. Figure 48 aggregates together the information in Figure 47 for the entire Eastern Interconnection. The figure suggests that there are the resources available to electrify and decarbonize the Eastern Interconnection. Compared with Baseline the peak demand is much higher than synchronous generation, and this is supported by the demand-side resources and the storage being deployed (along with transmission links). Of course, the total capacity in the Eastern Interconnection is higher than in the Baseline. Figure 48 also shows the installed capacity in Minnesota. It suggests that if the Eastern Interconnect also electrifies and decarbonizes that the electricity grid would benefit from being more wind dominant. It also shows nuclear power existing in Minnesota through 2050.

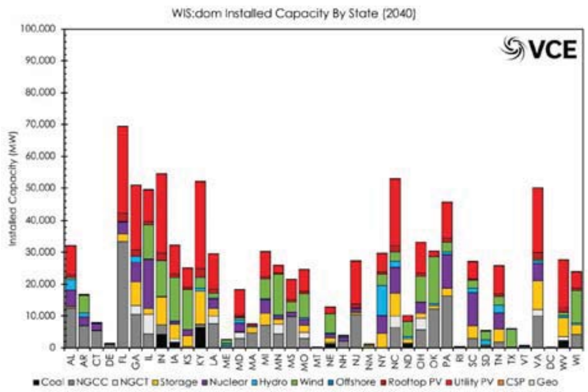








Attachment B to CEOs' Petition for Reconsideration



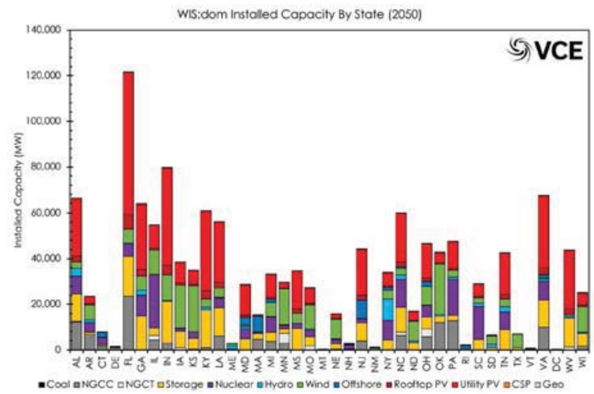
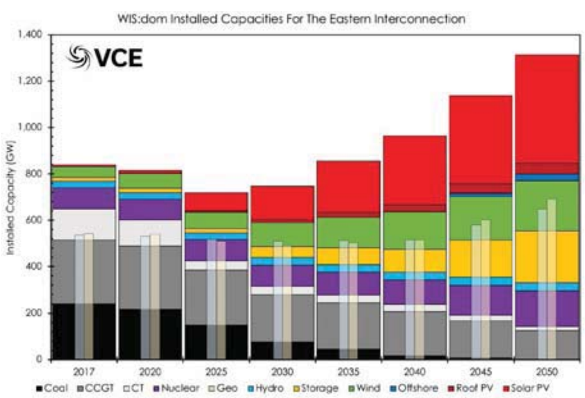


FIGURE 47: *The installed capacity for each state in the Eastern Interconnection for each investment period optimized by the WIS:dom model. The evolution of the electricity grid can be followed from the top-left (2017) to the bottom-right (2050). The system in 2050 for this scenario is dominated by wind, solar, nuclear and storage.*

Even with the Eastern Interconnection altering the scale and distribution of generation substantially, WIS:dom must still provide robust dispatch for each 5-minute interval for all of the investment periods across the EI. The dispatch for winter and summer time periods are shown in Figures 49 and 50. The power dispatch and flexibility are completely different to the Baseline, but power is provided without fail for all 5-minute intervals in all regions. The portfolio of resources can balance all the requirements across the Eastern Interconnection, while minimizing the system costs. It should be noted that the power connections between Mexico, Canada and the US are not expanded in this scenario.



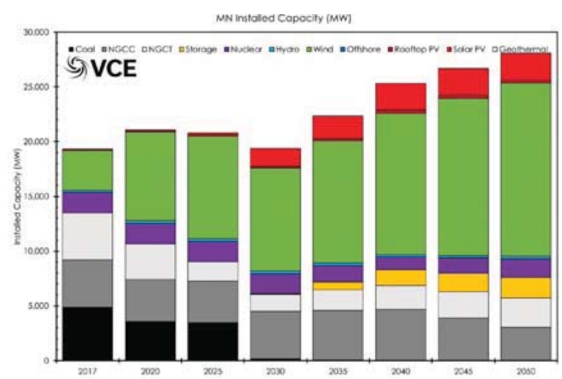


FIGURE 48: *The installed capacity across the Eastern Interconnection (left) and Minnesota (right) for the Eastern Interconnection decarbonization scenario. More nuclear is in this pathway compared to others. Minnesota is wind dominated, since it has better wind resources and solar PV resources are allocated by WIS:dom to better resource regions in the EI.*

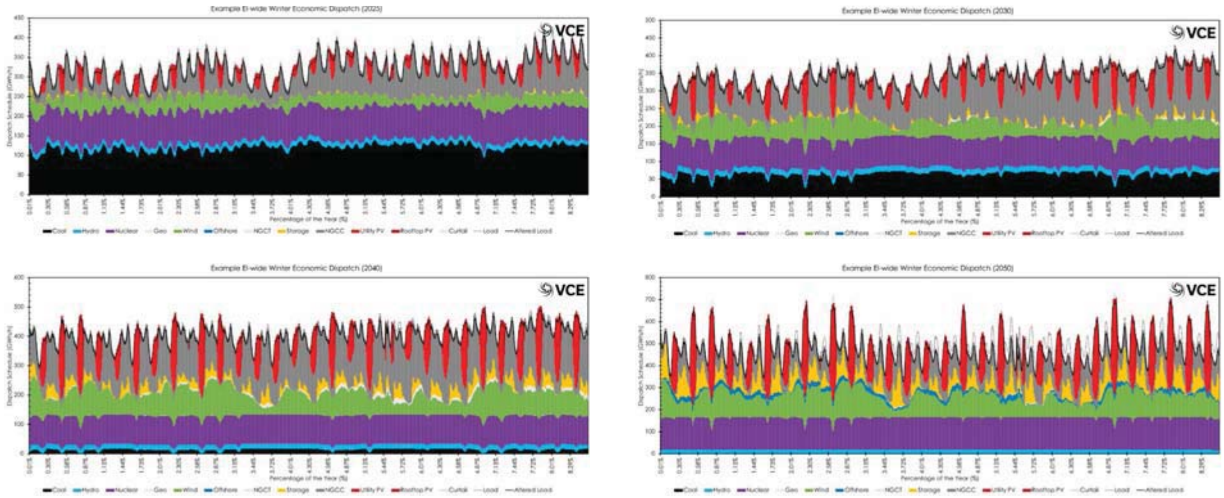


FIGURE 49: *The economic dispatch over the month of January for the Eastern Interconnection. The investment periods of 2017 and 2020 are not shown as they are similar to those in the Baseline scenario.*

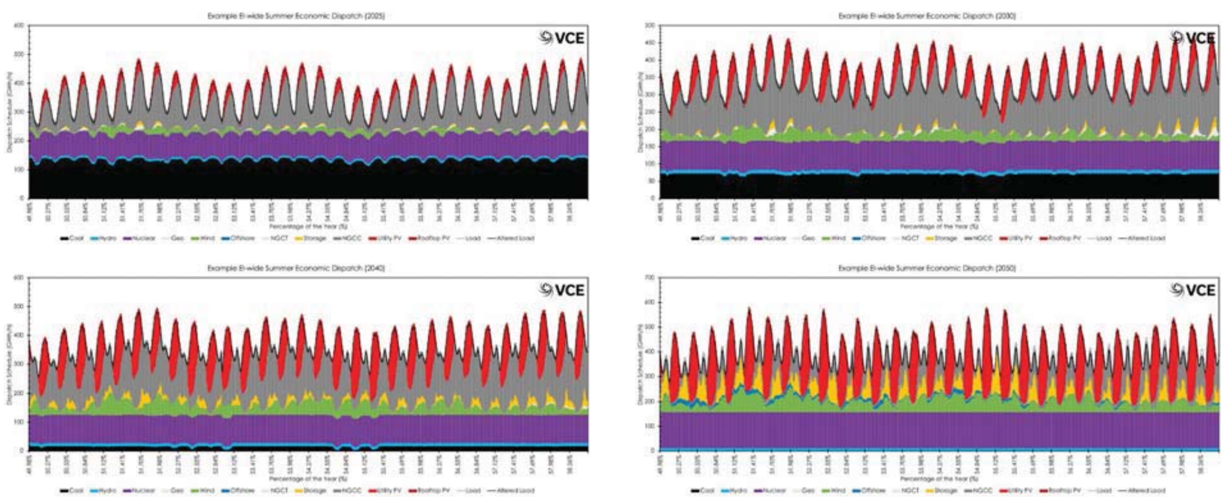


FIGURE 50: *The economic dispatch over the month of July for the Eastern Interconnection. The investment periods of 2017 and 2020 are not shown as they are similar to those in the Baseline scenario. It can be observed that the combination of generation and demand-side flexibility can accommodate large amounts of variable generation.*

With the altered dispatch and siting across the Eastern Interconnection, the generation shares are changed compared with the Baseline scenario. Figure 51 displays the generation shares for the Eastern Interconnection. It shows an electricity system dominated by clean resources. Approximately 60% of the generation comes from wind and solar, while 30% comes from nuclear and 10% from natural gas.

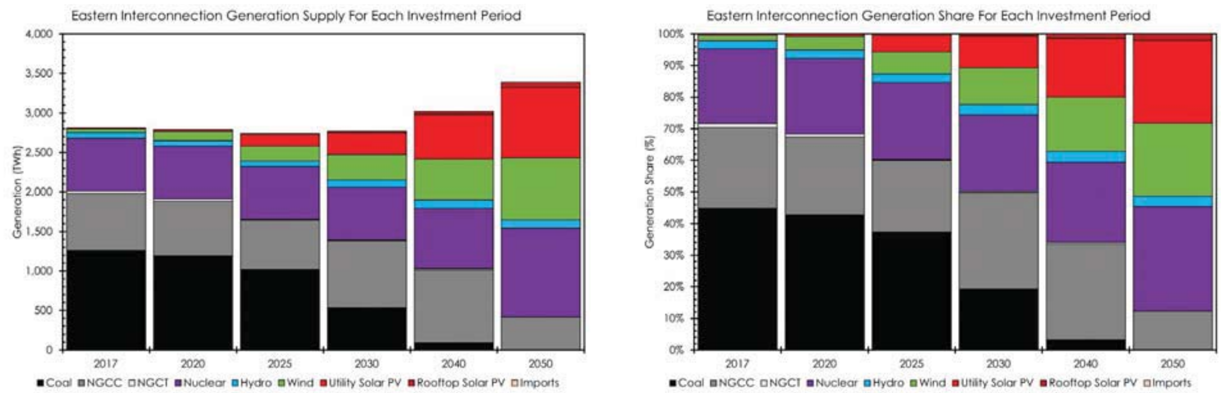


FIGURE 51: *The generation share for the Eastern Interconnection for investment periods. Due to resource scarcity (MW buildout), WIS:dom expands the nuclear capacity across the Eastern Interconnection to provide clean generation in support of the variable generation with storage.*

With the Eastern Interconnection decarbonizing alongside Minnesota there comes cost increases, as shown in Figure 45. However, if the EI doesn't decarbonize with Minnesota the emission reductions are much smaller. Therefore, the additional spend felt by Minnesotans is rewarded by much more dramatic emission reductions helping mitigate climate change. Figure 52 displays the carbon dioxide emissions for each state. Compared with the values in Figure 32, it can be computed that cumulative emissions from the electricity sector are reduced by 12,736 million metric tons. Further, the emissions from outside the electricity sector are also reduced dramatically. In total, the Eastern Interconnection emitted 20% the emissions that it did in 2005 under this scenario pathway.

The lower emissions in the rest of the Eastern Interconnection helps Minnesota integrate with the wider grid while decarbonizing, which allows the deployment of lower-cost generation more suited to the Minnesota climate. Nevertheless, this increases costs for Minnesota compared with the Eastern Interconnection being Baseline. Even with the added constraint of resource competition, Minnesota achieves its target of 80x50 with energy costs much lower than 2017. The costs could potentially be even lower, because as the Eastern Interconnection electrifies and decarbonizes the cost of natural gas would likely fall due to substantial demand reductions. The annual economy-wide emissions are lower than 750 million metric tons by 2050.

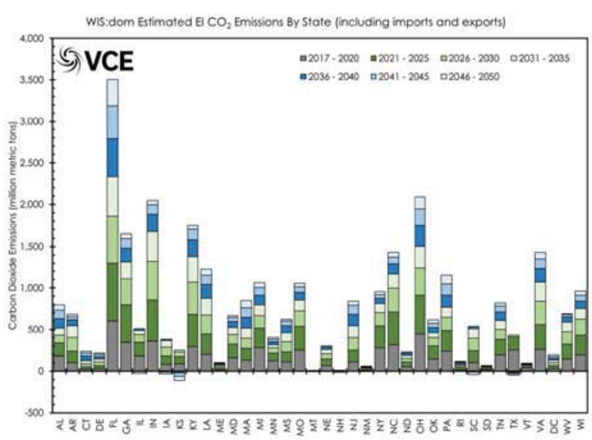


FIGURE 52: *The electricity sector emissions by state for all the investment periods. The electricity sector cumulatively emits 12,736 million metric tons less than in the MN deep decarbonization scenario. These emission reductions are amplified by the reduced emissions from all other sectors via the electrification. The annual economy-wide emissions for the Eastern Interconnection is below 750 million metric tons by 2050.*

F. MINNESOTA DEEP DECARBONIZATION WITH DOMINANT DERS

This scenario analyzes the impact of Minnesota achieving the 80x50 target using a different set of tools to those in the MN deep decarbonization scenario. It is assumed that additional energy efficiency can be achieved that results in electric demand being 10% lower than the MN deep decarbonization scenario for each investment period after 2020. It is further assumed that the level of flexibility from demand-side resources is increased by approximately 50%.

This scenario changes the focus of the electrification and decarbonization to more localized and distributed technologies. Figure 53 shows that the energy cost savings for Minnesotan's are similar to those in the MN deep decarbonization scenario, albeit slightly lower. It should be noted that the additional 10% energy efficiency is provided at no cost to the system in WIS:dom. The cumulative saving reduction is $1.4 billion compared with the MN deep decarbonization scenario and the average annual energy cost saving is reduced by $18 by 2050.

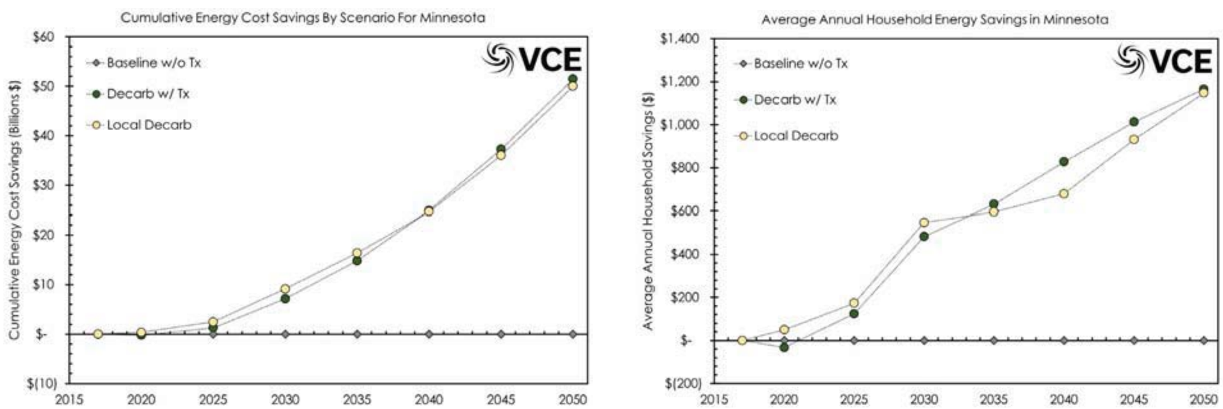


FIGURE 53: *The cumulative (left) and average annual household (right) energy savings for Minnesotans. The local decarbonization results in similar savings as the MN deep decarbonization scenario.*

From a generation perspective, WIS:dom replaces much of the utility-scale solar PV in Minnesota with rooftop solar PV. The additional rooftop solar reduces the burden on the transmission buildout within the state, but the resulting dispatch is relatively similar. This is because the generation aggregated over the state appears similar. Due the generation being closer to load centers, the amount of wind and other generation sources are changed slightly. Overall, the major change is related to solar PV deployments and transmission investments. WIS:dom still exchanges power with MISO because of the over-generation at the solar peak, which is partly absorbed by demand-side resources and storage, but requires an interconnected grid to balance efficiently. The installed capacities are shown in Figure 54.

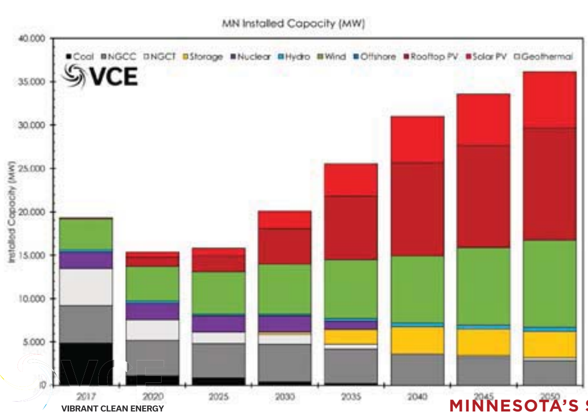


FIGURE 54: *The installed capacity in Minnesota. The rooftop solar PV substitutes the utility-scale PV, and because of its lower generation potential requires higher capacities to replace it.*

Other than the substitution of utility-scale solar PV with rooftop solar PV, much of the system performs as it did in the MN deep decarbonization scenario. With rooftop solar PV comes added peak load reduction due to thermal heat gain reductions and a diminishment of some transmission losses. Further the energy efficiency reduces the capacity requirements. These differences combined create a pathway that achieves the 80% reduction by 2050, using a different mixture of technologies.

G. MINNESOTA DEEP DECARBONIZATION WITH LESS FLEXIBILITY

This scenario is designed to determine how Minnesota could achieve the 80x50 target if the new loads that come from electrification have much lower flexibility capabilities than assumed in the MN deep decarbonization scenario. It is assumed that the flexibility is one quarter of that estimated in the MN deep decarbonization scenario.

The reduced flexibility means that the new loads become more inelastic and cannot respond to price signals to alter the demand as easily. WIS:dom finds adequate solutions at least-cost with the lower flexibility numbers. Moreover, there are few changes to the composition of the pathway. The most notable changes are more utility-scale PV and storage. This pairing compensates for the reduced flexibility. These additional resources reduce the energy cost savings (that are calculated by comparing each scenario with the Baseline scenario) by a cumulative $2.4 billion by 2050, thereby reducing the average annual household saving by $51 by 2050 as depicted in Figure 55.

In Figure 56, the dispatch stacks for 2050 are shown for a representative month for each season. Comparing the panels in Figure 56 with Figures 38 and 39 (the bottom-right panels) for winter and summer, respectively, it can be seen that the lower flexibility is completely substituted with solar PV generation and storage dispatch. In fact, the storage technologies are dispatched twice as much with the reduction of flexibility.

The change in the flexibility of the demand-side resources does not alter the emissions reduction profiles and does not adversely impact the system being provided power for each 5-minute interval for all investment periods without fail.

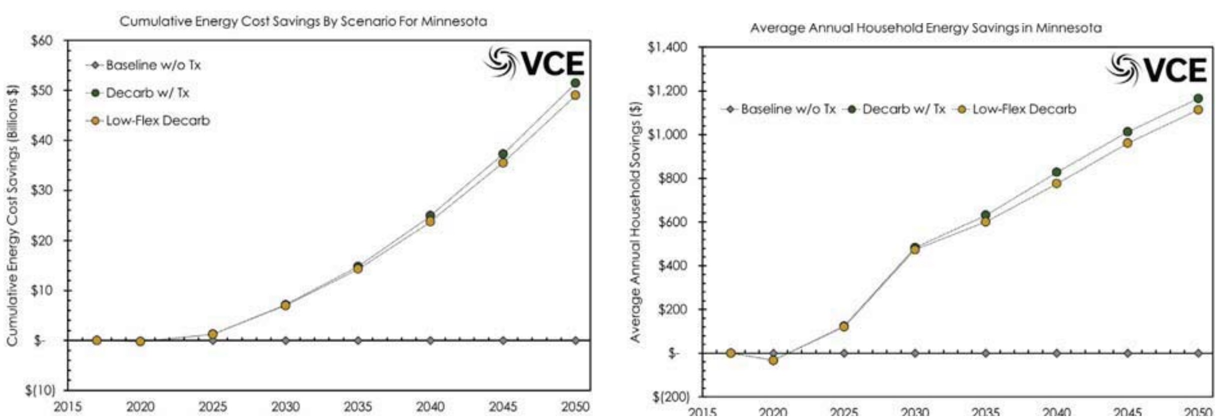


FIGURE 55: *The cumulative (left) and average annual household (right) energy savings for Minnesota. This scenario traces the MN deep decarbonization scenario closely. The additional spending is to provide more utility-scale generation and storage to compensate for the lower flexibility levels.*

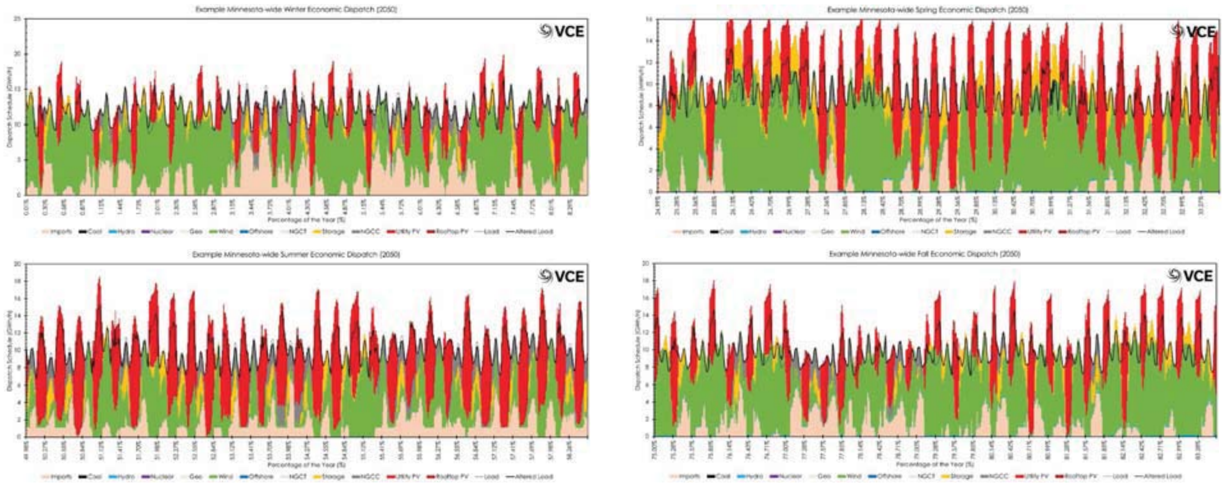


FIGURE 56: *Representative dispatch and load stacks for a month of each season. Compare the winter and summer month panels with those in Figures 38 and 39 for 2050. It can be seen that the lower flexibility is almost entirely compensated for by more solar PV and storage dispatch. The dispatch of storage is doubled in this scenario compared with the MN deep decarbonization scenario.*

H. MINNESOTA DEEP DECARBONIZATION NUCLEAR SENSITIVITY

This scenario assessed the impact to the Minnesota deep decarbonization if nuclear was allowed to retire early or relicense through to 2050. Essentially, for the early retirement, the WIS:dom optimization model had the ability to retire the two nuclear power plants in Minnesota before their scheduled relicense dates. The WIS:dom optimization model did not choose to retire the two power plants before the relicense dates, opting rather to retire them as scheduled. Therefore, no differences were created by this branch of the scenario.

For the relicense branch, the WIS:dom optimization model was constrained to relicense the two nuclear power plants in Minnesota through 2050. There are differences in this branch of the scenario. First, the relicense pathway reduces the overall cumulative energy cost savings by $2.4 billion by 2050 compared with the MN deep decarbonization scenario. This translates to lower average annual household energy savings by 2050 by $37 as shown in Figure 57.

The nuclear power plants being kept online through 2050 has a noticeable effect on the installed capacity of variable generation; yet almost no influence on the natural gas power plant capacities. As can be seen in Figure 58, storage installation by 2050 are 1,000 MW lower, wind installations are 2,000 MW lower, and solar PV is 3,000 MW lower. The installed capacity of the nuclear power plants is approximately 1,800 MW. The lower installed capacity reduces the total full-time jobs created by 2050.

The installed capacity is changed, but the emission reductions are similar. The cost of keeping the nuclear power plants online is more expensive that retiring them and building more capacity in variable generation. The EI decarbonization scenario illustrated that more nuclear capacity was necessary in a resource constrained environment. Thus, it seems beneficial to retire the nuclear power plants on schedule and consider expansion if the remainder of the Eastern Interconnection progresses with electrification and decarbonization along with Minnesota (if that is the pathway that occurs). This scenario suggests is that early retirement of these nuclear power plants is also not warranted based on economics.

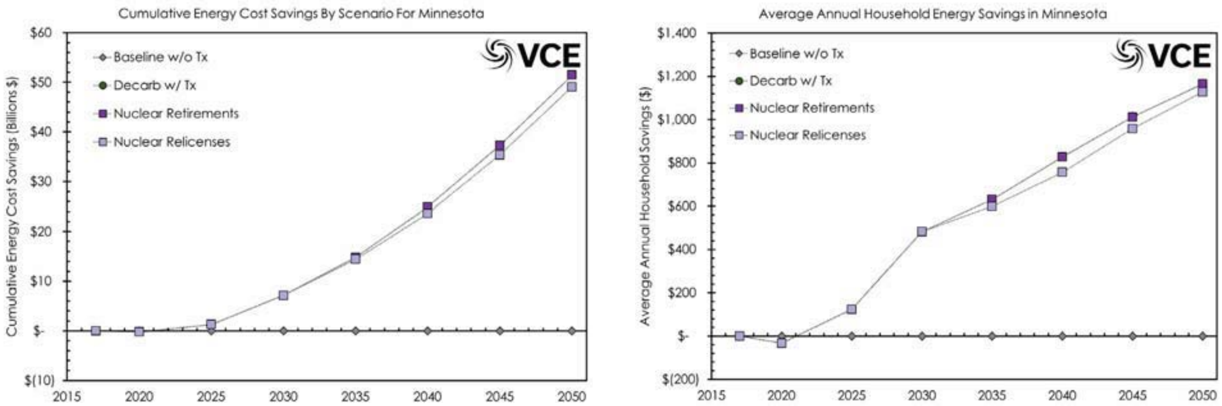


FIGURE 57: *The cumulative (left) and average annual household (right) energy savings for Minnesota. These scenario traces the MN deep decarbonization scenario very closely. In fact, the early retirement of nuclear branch is actually identical. The additional spending in the nuclear relicense branch is to pay for the more expensive nuclear plant than lower-cost variable generation with storage.*

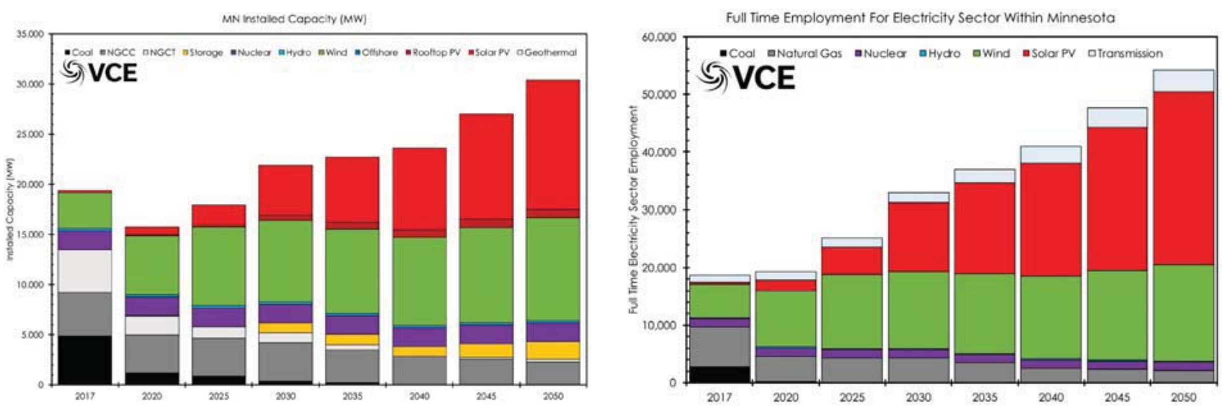


FIGURE 58: *The installed capacity (left) and full-time jobs (right) in Minnesota. The installed capacity is approximately 4,000 MW lower than in the MN deep decarbonization scenario. This is because nuclear (1,800 MW) remains online while 1,000 MW of storage, 2,000MW of wind, and 3,000 MW of solar PV are not built. The lower installed capacity reduces full-time jobs in the electricity sector.*

I. SCENARIO INFORMED RECOMMENDATIONS FOR MINNESOTA

This sub-section is dedicated to suggestions and recommendations for Minnesota based on the information and data that has been compiled by performing the eight scenarios with thirteen total branches. These are intended to provide the least-risk, learn-by-doing, least-cost activities that Minnesota can do to facilitate the largest array of pathways for the future of the Minnesota electricity grid so that it can achieve the goal of removing 80% of economy-wide emissions (from 2005 levels) by 2050. The suggestions and recommendation are only the opinions of the authors and their perspective of the modeling results.

List of suggestions and recommendations:

- Consider planning the electricity systems within Minnesota with consideration of generation, transmission, storage, EVs, DSM, DR, and the wider Eastern Interconnection impacts included.

- Update the planning frequently, in the order of every year, to capture the changing economics and technologies that can be included in the evolution of the electricity system.
- Encourage electrification of transportation (particularly light-duty vehicles) and new construction with heat pumps for space and water heating. Retrofit old furnaces and water heaters with heat pump alternatives.
- Educate on the value of electrification with respect to emission reductions, load growth potential, and the added flexibility it can bring.
- Retire the coal-fired power plants in Minnesota as rapidly as possible. No coal-fired power plants are necessary after 2030.
- Keep the Monticello and Prairie Island nuclear power plants online until their scheduled relicense dates, at which point retire them.
- Only replace natural gas power plants (both combined cycle and combustion turbines) that are due to retire with equal capacity. Do not add new net capacity for these technologies in Minnesota. They run the risk of becoming stranded due to reducing cost renewables and exposure to possible fluctuating fuel prices.
- Build, at least, another 2,000 MW of wind by 2025, and target 10,000 MW by 2050.
- Make accommodations and install at least 2,000 MW of rooftop solar by 2050, there should be 1,000 MW installed by 2030.
- Have over 2,000 MW of utility-scale solar PV by 2030 within Minnesota. Aim to construct 10,000 MW by 2050.
- Connect 1,000 MW of electric storage by 2030. The duration of this storage can be short (<15 minutes). By 2050 have 2,000 MW of storage in Minnesota with an average of 5 hours of energy capacity.
- Expect installed capacity in Minnesota to increase by approximately double by 2050 if electrification has taken place to enable the decarbonization with variable generation.
- Consider wider regional interconnection with MISO, through more interstate transmission to access other geographies for variable resources more frequently.
- Provide guidance to other states on the approaches and methods adopted that are successful and ones that are not.

VI. THE WIS:DOM OPTIMIZATION MODEL

The WIS:dom (Weather-Informed Systems: design, operation, markets) optimization model is the flagship, state-of-the-science, software product created by VCE. A precursor to WIS:dom was the seminal C-OEM (the Co-Optimized Energy Model), which was the first commercial model to be able to co-optimize variable generation, conventional generation, transmission, storage and power flow at a granularity of 13-km and 60-minute for the entire continental United States for a full year, while performing a resource planning for the electricity system from 2015 to 2050. See the link in the footnote[23] for the report produced as part of a planning study performed by VCE for MISO in 2015, using C-OEM.

The WIS:dom optimization model contains numerous improvements and upgrades beyond C-OEM; including its description of generators (and their attributes), weather datasets for variable renewable

23 http://www.vibrantcleanenergy.com/wp-content/uploads/2016/05/VCE_MISO_Study_Report_04252016.pdf

energy (VRE) [now utilizing 3-km, 5-minute gridded data[24]], transmission lines and power flow, investment time periods, retirements, pollutant tracking, hourly (or 5-minutely) dispatch, reserve requirements, emission constraints, employment and revenue output/input, and economic inputs/outputs. The WIS:dom optimization model will plan the system in customizable investment time periods [1-, 2-, 5-, 10-year] out to a desired time horizon; typically, 2050. Furthermore, WIS:dom has been designed to work at all geographic scales (particularly in the United States) as well as include a wide range of technologies that are appropriate for numerous studies/analyses. The WIS:dom optimization model divides the US into three main regions: The Eastern Interconnect (EI), Western Interconnect (WECC), and ERCOT (Figure W-1). Offshore wind is also considered as an additional layer, along with regions external to the interconnects.

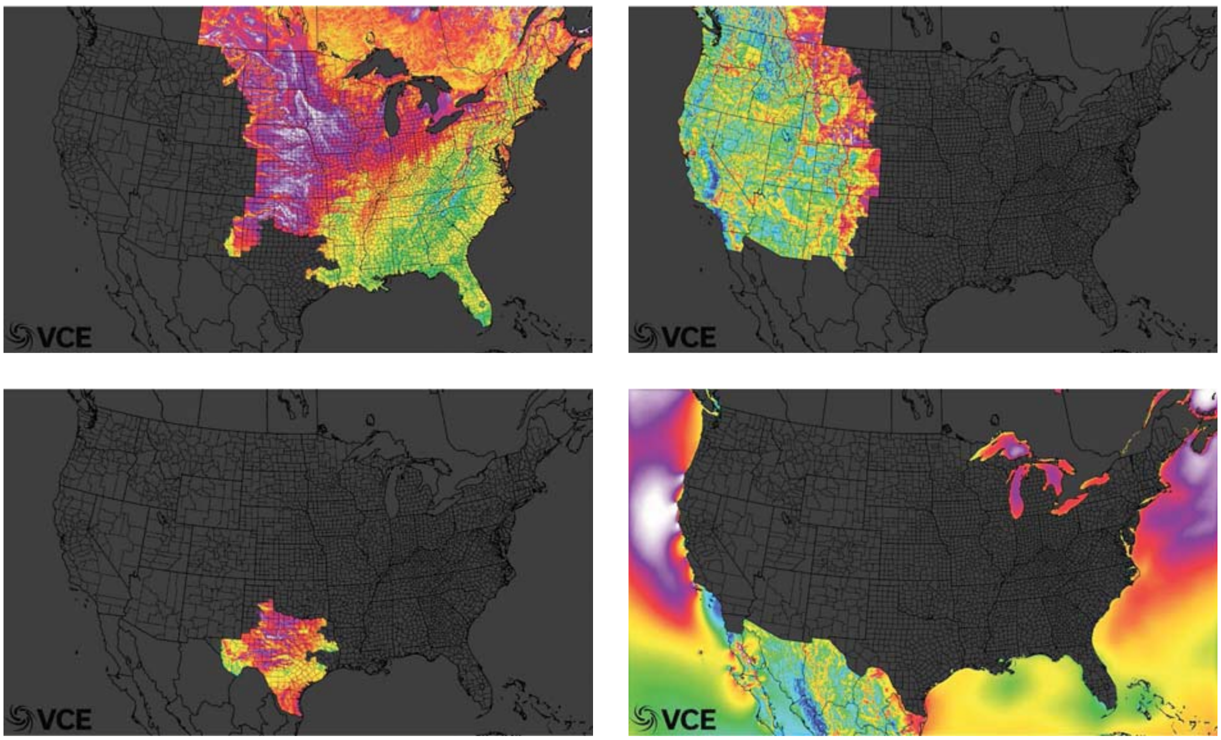


FIGURE W-1: *Illustrating the interconnections that WIS:dom considers in the United States using wind capacity factors from the model's 3-km built-in weather/power datasets.*

The WIS:dom optimization model representation of the electricity grid is then further divided down into the ISO/RTO regions. For example, one that has been utilized extensively is the MISO footprint. The regions can be subdivided further; depending upon the use profile. For example, the WIS:dom optimization model was used for a storage study over the entire MISO footprint (report25 and presentation26).

WIS:dom is the only commercially (or academically) available optimization model that can perform 5-minute (or hourly) chronological economic dispatch for the entire United States footprint, while considering 3-km (or 13-km) resource sites for generation, transmission, storage, and demand-side

24 https://www.youtube.com/watch?v=OFPapVWCWk0
25 http://www.vibrantcleanenergy.com/wp-content/uploads/2017/07/Modernizing_Minnesotas_Grid_LR.pdf
26 http://www.vibrantcleanenergy.com/wp-content/uploads/2017/07/MN_PUC_July11th_2017_VCE-LR.pdf

resources capacity expansion simultaneously. For example, the WIS:dom optimization model can answer the questions of resource adequacy, generation retirement and expansion, dispatch of each generator, pollution tracking, policy drivers, and power flow in the electricity system all in a single scenario.

To make the WIS:dom optimization model practically useful, the model has the ability to read in different data sets for different geographic regions and different study scopes. The consistent modeling framework, while complicated at the outset, allows for simpler transition to new areas of investigation and easier dataset exchange. In the next sub-section, the internal generic assumptions for WIS:dom are described. These include the cost of technologies, retirement treatment, reserves monitored, dispatch characteristics, and initialization grid data.

A. INTERNAL ASSUMPTIONS

The WIS:dom optimization model is designed to solve a capacity expansion and production cost problem for the entire United States. As such, the initialization data, cost assumptions, and demand-side resources are provided for everywhere in that footprint. WIS:dom has the ability to shutdown portions of the domain during its compilation stage via regional identifiers. For this study the Western and the ERCOT interconnections were ignored and flows between those interconnections and the Eastern Interconnect were assumed to be zero. The international transmission lines between Canada, Mexico and the Eastern Interconnection were initialized with their 2017 estimated capacities. The assumed capacity between the EI and Mexico is 0 MW, while the transmission capacity between Canada and the EI is 9,833 MW through six states (Maine, Michigan, Minnesota, New York, North Dakota, and Vermont). To purchase electricity from Canada those states must pay $53.18 per MWh, while exports to Canada provide $40.46 / MWh in revenue. These import and export transmission capacities define the geographic boundary conditions for WIS:dom. No electric power can leak out of this pre-defined system.

The WIS:dom optimization model, as with any modeling software, initializes with data inputs and assumptions. To build the initialization, WIS:dom calculates the location of all the existing generators and transmission lines (greater than or equal to 69 kV). The generator units are aggregated by technology type within each closest 3-km resource grid cell site. The WIS:dom generator for a specific technology types (within the 3-km grid resource site) is assigned the weighted average characteristic, per kW or kWh, of all the generation units. These characteristics include heat rates, variable costs to operate, fixed costs, capital costs, age, and power factor. The capacity of the WIS:dom generator is the combined capacity of all the units. WIS:dom is initialized in this manner to maximize the utility of the weather datasets that will interact with the generators and provides a uniform grid within which all resources will be sited. The transmission lines are aggregated within the same 3-km grid cells for several voltage bands (69kV and below, 115-138 kV, 230 kV, 345 kV, 500 kV, and 765 kV+). The length of the lines is computed using geodesics between sub-stations within the 3-km grid cells. The capacity of the lines is estimated using the SIL (Surge Impedance Loading) method with the information about the length of the transmission lines. Figure W-2 displays the SIL estimates by voltage and existing US transmission system. Demand sinks are assumed to be the largest cities in each US county, each being assigned to a 3-km grid cell. Every 3-km grid cell across the US is then processed to determine the transmission capacity available to the nearest demand sink. If no transmission line capacity is found, WIS:dom calculates the distance to the nearest transmission line that does go to the load sink. A cost is assigned for the existing (or interconnection transmission necessary) for each 3-km grid cell. Additionally, an estimated loss function for the transmission to the nearest load sink is determined. It is assumed that electric losses on transmission lines are 3.5% per 100 miles for lower voltages (69kV to 138kV), 2.2% per 100 miles for medium voltages (230 kV to 345 kV) and 1.5% for higher voltages (500kV plus). The distance is the computed for each 3-km grid cell.

Separately, transmission capacity is computed between each of the load centers using the same process of tracing the existing transmission lines. The losses are again estimated from their voltages. Finally, the initialized, reduced form transmission is fixed. In short, WIS:dom estimates costs, electric loss functions, and distances for each 3-km grid cell twice. Once to get resource sites to the zonal load sink and a second time for nodal links between the load sinks. If a resource site is selected in the capacity expansion in WIS:dom, it must pay for the transmission interconnection at that site, and provide power to overcome the electrical losses to transmit the power to the load sink. If the load sinks need to expand capacity between closest neighbors, WIS:dom must pay for that transmission line to be upgraded. If a transmission link does not exist, and one is allowed, WIS:dom must determine if new construction is required, and must pay for that; with costs shared between the two neighboring load sinks.

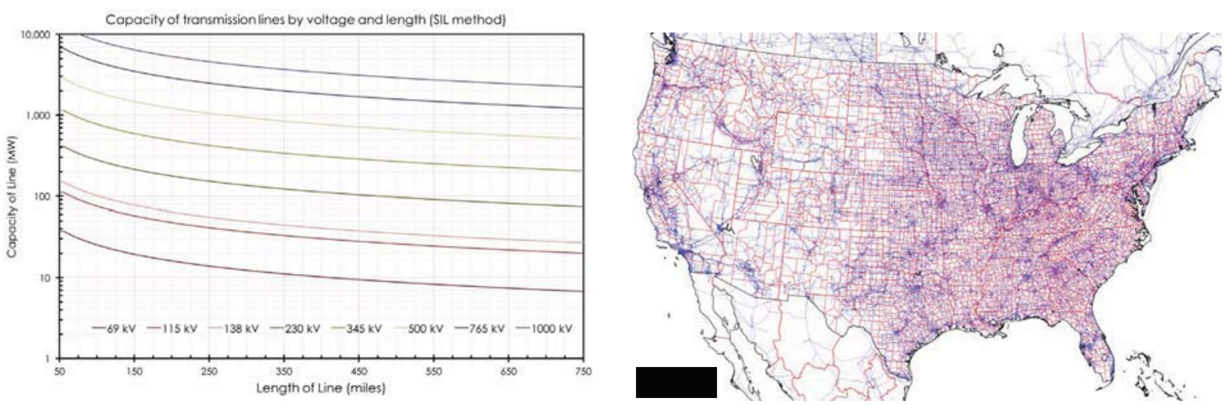


FIGURE W-2: *The typical capacities of transmission lines by voltage as a function of length (left) and the existing transmission system in the United States for all voltages down to as low as 69 kV (right).*

The transmission line costs are $1,853.79 per MW-mile for all voltage classes. For HVDC transmission lines the costs are $633.18 per MW-mile of line and $293,760 per MW for the stations. Transmission lines that cross RTO/ISO boundaries pay a penalty of 3x for building or upgrading transmission. There is a similar penalty function for crossing state lines of 1.5x. Figure W-3 displays the initialization of the generators and reduced form transmission for WIS:dom.

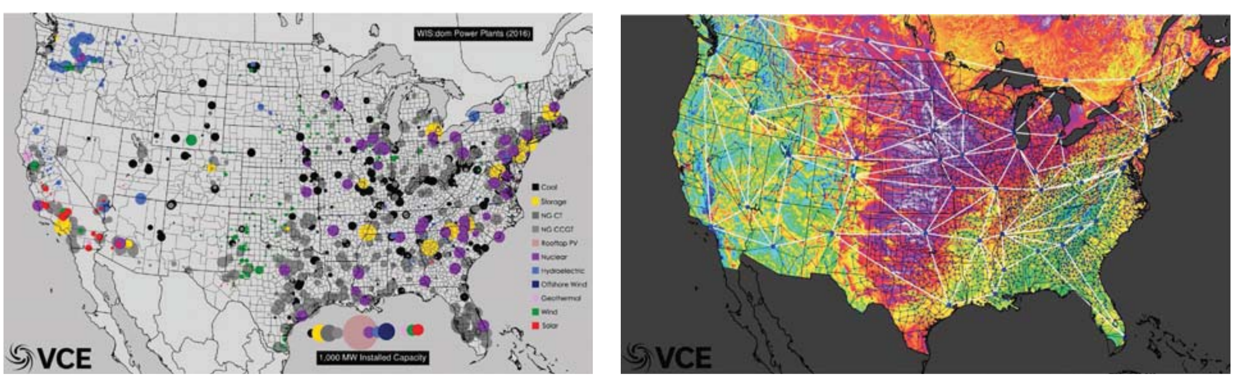


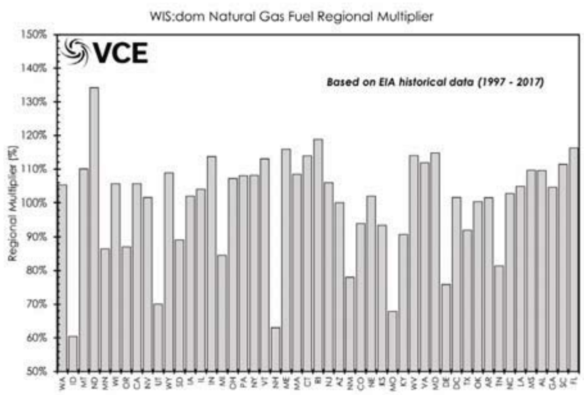
FIGURE W-3: *The initialization of the WIS:dom optimization model; generators (left), reduced form transmission lines (right). The white lines on the right image are interstate transmission aggregation.*

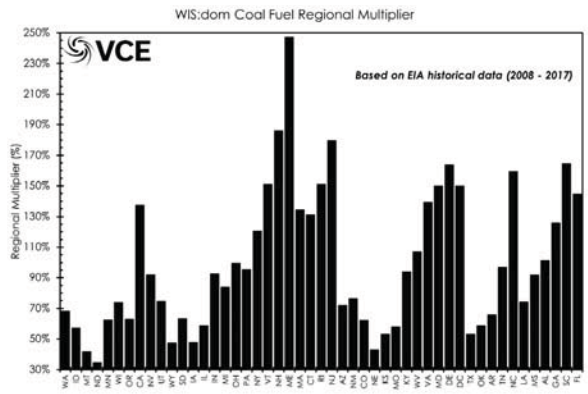
For the input data and assumptions, VCE tries to uses publicly available datasets. When public data is not available or incomplete, VCE will create new datasets internally. The publicly available data comes from EIA, FERC, NREL, and other DOE publications. The specific electricity grid data that is provided to WIS:dom includes: Heat rates for thermal generators, minimum loading for thermal generators, fuel costs for thermal generators, fixed O&M costs for all generators, non-fuel variable O&M costs for all generators, remaining capital costs for all generators, transmission topology for all voltages above 69 kV, estimated relicense costs for nuclear generators, repower costs for variable generators, the age and expected life of all existing generators, the power factor of all existing generators, the near-term generator interconnection queue, and existing demand by sector. To summarize the input data sources for the standard build of WIS:dom, Figure W-4 is displayed below.

Input ID	Input Name	Existing	New
1	Heat Rate	All Current Thermal Data	NREL ATB 2017 Value
2	Minimum Load	All Current Thermal Data	Fleet Average
3	Power Factors	All Current Generator Data	Fleet Average
4	Fuel Costs	All Current Thermal Data For Multiplier	NREL ATB 2017 Value
5	Fixed O&M Costs	All Current Generator Data	NREL ATB 2017 Value
6	Non-fuel Variable O&M Costs	All Current Generator Data	NREL ATB 2017 Value
7	Capital Costs	All Current Generator Data	NREL ATB 2017 Value
8	Relicense / Repower Costs	All Existing Nuclear, Wind, and Solar Generators	45% For VRE, N/A For Nuclear
9	Discount Rates	Uses Same Rate as "New"	5.87% Real
10	Economic Lifetimes	All Current Generator Data	NREL ATB 2017 Value
11	Transmission Costs	Uses Same Cost As "New"	ABB / Blended Existing Costs
12	Transmission Topolgy	Current Above 69 kV Aggregated To Reduced Form	New Lines Allowed Within WIS:dom; constrained by user
13	Demand	Current Demand By Sector	Growth Estimates Provided By Sector By VCE
14	Weather / Power Data	N/A	One Year Of Hourly Power Data For Wind & Solar Over EI
15	Policy & Regulations	Apply All Existing Policies & Regulations	Input As Constraints On Future Scenarios
16	Locational Multiplier	N/A	Black & Veach / NREL Public Data Combined By VCE

FIGURE W-4: *Summary table of the major inputs to the WIS:dom optimization model, along with their sources.*

The standard cost assumptions for all new builds of generators are provided by the NREL ATB. The values provided in the NREL ATB are averages for the whole US. WIS:dom converts national average values to localized ones via regional multipliers. There are regional multipliers for capacity and fuels and these are shown in Figure W-5.





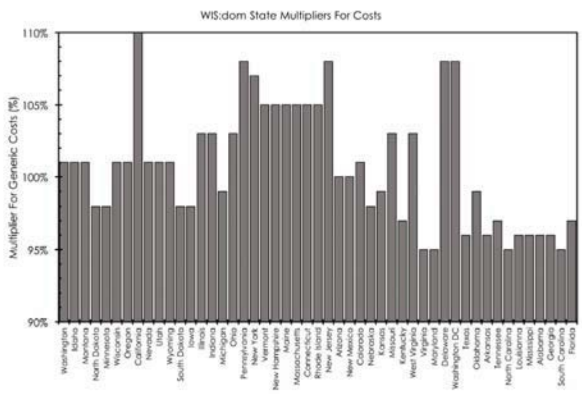


FIGURE W-5: *The locational multipliers for each state in the US for natural gas fuel (top-left), coal (top-right) and generator siting (bottom). These multipliers convert the NREL ATB values into state values.*

The NREL ATB 2017 cost values used in WIS:dom are shown in Figures W-6 to W-8. The heat rates and expected lifetimes are shown in Figure W-9. In addition to the regional multipliers, shown above, there is a temporal multiplier for natural gas throughout the year, to reflect the intra-annual variability of natural gas prices. WIS:dom has the ability to alter the inter-annual natural gas prices, between investment periods, by computing the elasticity between supply and demand; however, the capability was not used in this study.

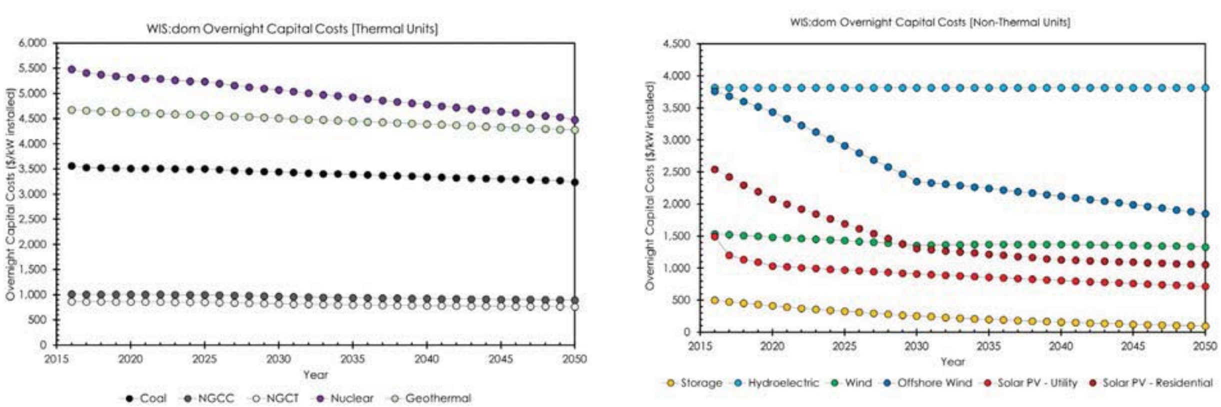


FIGURE W-6: *The overnight capital costs (excludes financing cost & assumes a plant can be built overnight) in real $/kW-installed for thermal (left) and non-thermal (right) power plants in WIS:dom. All costs are from NREL ATB 2017, with the exception of storage costs, which come from Navigant / Strategen Consulting.*

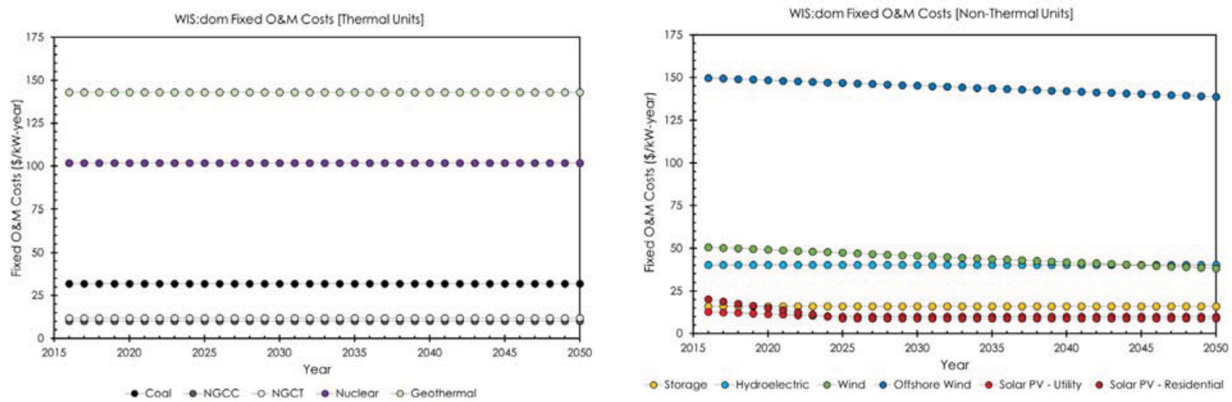


FIGURE W-7: *The fixed operations and maintenance (O&M) costs in real $/kW-year for thermal (left) and non-thermal (right) power plants in WIS:dom.*

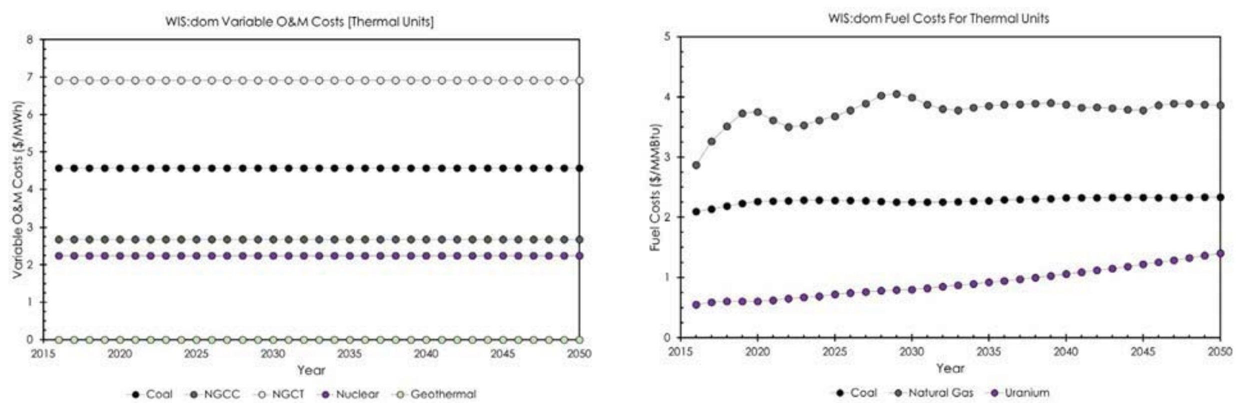


FIGURE W-8: *The non-fuel variable O&M (left) and the fuel (right) costs for thermal generators in WIS:dom. The variable O&M costs are in real $/MWh, while the fuel costs are in real $/MMBtu. The non-thermal units have zero cost variable O&M as those costs are combined into the fixed O&M costs.*

In addition to the capital costs, an important assumption is the cost of debt. WIS:dom uses the WACC (Weighted Average Cost of Capital) and it is assumed to be 5.87% (real) for all assets purchased by WIS:dom in its solver. Once a generator is connected to the grid, it has sunk capital costs. To retire that plant, WIS:dom must repay all the capital debt. Once the power plant is older than its economic life, WIS:dom can retire the power plant for no penalty. As power plants age, WIS:dom makes them less efficient to reflect the wear-and-tear.

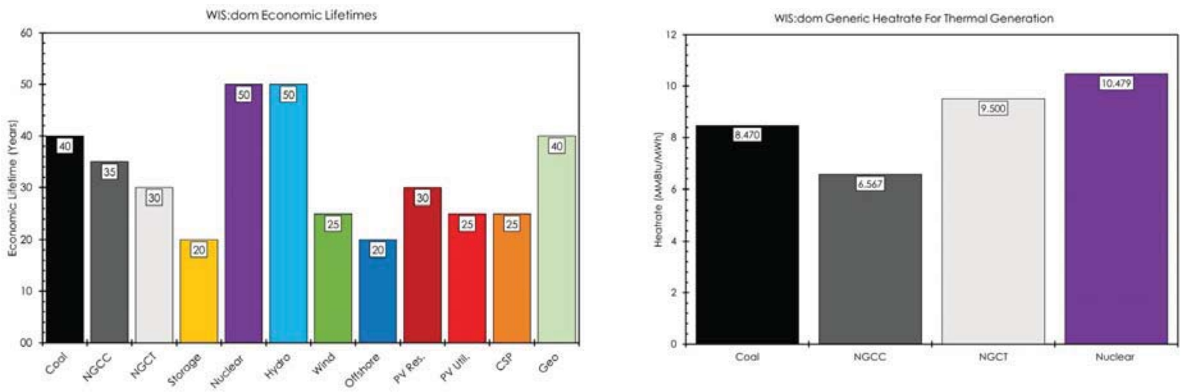


FIGURE W-9: *The expected economic life for each generator (left) and heat rates for new thermal generators.*

The WIS:dom optimization model must supply electricity demand for each 5-minute interval for, at least, an entire year across the footprint being solved over. It must do so while retaining operating (7% of 5-minute demand) and planning reserves (different for each region, but typically above 15%), and considering transmission power flow and associated losses. To do this, WIS:dom requires input load forecasts for each of the investment periods. WIS:dom is supplied the load data input at a county level. Within the demand profiles there can be electrification. These assets are known as demand-side resources and can be dispatched by WIS:dom. These features will be discussed more later, but in general, the load/demand data is separated into the sectors of residential, commercial, industrial, and transportation. The sector breakdown facilitates Demand Side Management (DSM), Demand Response (DR), Electric Vehicle (EV), heat pump transitions to all be accounted for and estimated for flexibility and growth/reduction on the demand side. For WIS:dom to deploy the demand-side resources in the dispatch it must pay for it. The cost of DSM is assumed to be inelastic. WIS:dom determines the level at which these resources are dispatched for each 5-minute interval. Figure W-10 displays the average amount of demand-side resources for flexibility by investment period and the cost to dispatch those resources.

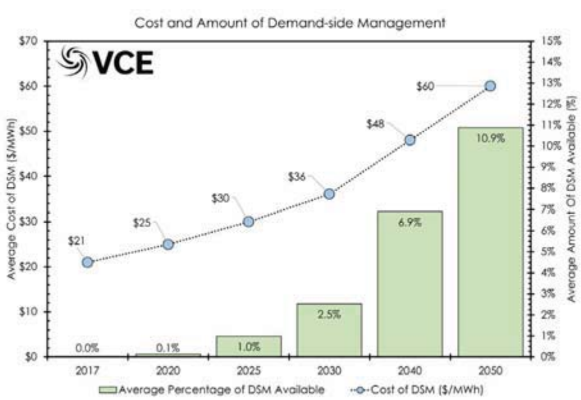


FIGURE W-10: *The percentage of the demand each hour assigned to EVs and DSM (bars, right axis) and the cost of DSM to the energy provider in $/MWh (circles, left axis).*

WIS:dom was built to be able to provide analytical rigor to analyzing policies, impacts and societal changes that result from the electricity grid evolving. It was specifically designed around incorporating vast amounts of weather data as well as generator, transmission, and customer operational data. To that end WIS:dom includes, as standard, the tracking and outputting of policy, economic, and pollution metrics. For example, WIS:dom tracks several species of pollution, namely: Carbon Dioxide (CO2), Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Oxides (NOx), Methane (CH4), Nitrous Oxide (N2O), Volatile Organic Compounds (VOC), and particulate matter (PM2.5 and PM10). The data from these pollutants are output by power plants and aggregated by state (typically). The plant-level data is stored. For special cases, the pollution is passed through the CAMx and EASIUR models from Carnegie Mellon University to determine the social cost impact of the pollution as well as the mortality and morbidity impacts. Since WIS:dom has such a fine granularity, CAMx can be explicitly driven by WIS:dom results; however, typically EASIUR provides a more rapid and state-level estimate that is adequate for most purposes. The pollution and emissions from the power plants is related to their heat rates, their emission controls, the fuel being burned, and the weather in the vicinity of the power plant. In addition to changes in pollution emissions, WIS:dom calculates the cumulative emissions, typically, by state to illustrate the buildup of emissions that are leaving the states into the atmosphere.

WIS:dom also computes and tracks the real-time costs of providing electricity as well as the average cost for each state over each investment period. In doing so, the model can estimate the impacts on rates and cost of electricity for consumers based upon the evolving composition of the electricity grid. Another important economic indicator that WIS:dom computes and tracks within the modeling framework is the full-time jobs that are created and destroyed in each state for each technology. Currently, WIS:dom does not possess estimates for the job numbers that would be provided by storage installations. VCE is working on building estimates for this. For all other technology types VCE uses publicly available data, particularly the NREL JEDI model for developing the inputs for WIS:dom to calculate the job impacts.

B. LOGICAL & OPTIMIZATION OPERATIONS

The WIS:dom optimization model can be considered a blended capacity expansion and production cost model. It is, therefore, a synthesis model. WIS:dom constantly seeks the lowest cost system(s) it is optimizing over; considering all the constraints and commitments built into the initialization. WIS:dom is typically run in linear programming (LP) mode. This means that all variables are real number values; allowing a more detailed inspection of the changes to the electricity grid composition. WIS:dom solves for each of the markets that are in entire footprint, while considering the transmission corridors between the markets, committed units for certain markets and some other market friction/inefficiencies. These can be relaxed with WIS:dom selecting transmission corridors to invest in over investment periods. Users of WIS:dom can constrain the amount of cooperation and transmission build out. Since WIS:dom is an LP optimizer, if transmission is completely constrained between markets, each market will be solved separately.

For the WIS:dom optimization model to solve, it must minimize the objective function, which is the sum of the total costs for each of the systems it is considering. The system costs include: capital repayments, fixed costs, variable costs, fuel costs, transmission costs, reserve payments, market clearing costs, integration costs, demand-side payments, retirement costs, and re-powering costs.

The minimization of the total system costs is under tension/pressure from the enforcement of constraints, which act to enforce reality on WIS:dom, and will change the composition of the solution vector; typically increasing the total system costs in the process. One of the important constraints is enforcing a market clearing price for each market, which is taken as the highest marginal cost of generator necessary to fulfill demand. This additional cost is added to the total system costs. Physically, these are not system costs, but profit, or revenue for the generators; but act to increase the cost to the overall system from the market perspective.

The main logic equations within WIS:dom are described in Figure W-11. The figure attempts to estimate the impact of each equation set.

Constraint ID	Equation Name	Equation Purpose	Impact Estimation
1	Total System(s) Cost Objective	To define the objective that is being minimized	**Critical** Other objectives may alter solutions significantly
2	Reliable Dispatch Constraint	Enforce WIS:dom meets demand in each region each hour without fail	**Critical** Strict enforcement of zero loss of load
3	Market Clearing Price Adjustment	Allowing WIS:dom to estimate the dispatch stack & attribute price vs cost	**Critical** Different market structures could impact deployment choices
4	DSM Balancing Constraint	Ensures that DSM providers can balance their demand	**High** Changing the description of DSM and costs could alter solutions
5	Transmission Power Flow Constraint	Produces the optimal power flow matrix and associated losses	**Critical** Transmission power flow significantly impacts dispatch and deployment
6	Transmission Capacity Constraint	Calculates the capacity of each transmission line	**Critical** Without this constraint, power flow could become artifically large
7	Planning Reserve Constraint	Ensure planning reserve margins are maintained	**High** Capacity credit for VREs can alter deployment decisions
8	Coal, NGCC, NGCT, Nuclear, Hydro, Geo Capacity Constraints	Maintain the capacity of generators above their peak production	**High** Without the constraints generations can be incredibly based on marginal costs alone
9	Storage Power & Energy Capacity Constraints	Complex equations & constraints to determine the utilization of storage	**Critical** Storage correctly modeled can change all investment decisions and dispatch
10	Coal, NGCC, NGCT, Nuclear, & Geo P_min Constraints	Constraints that force WIS:dom to adhere to P_min attributes for thermal generators	**Medium** P_min enforcement has lower impacts on decision
11	RPS & Emission Constraints	To enable WIS:dom to understand policy, regulatory and societal limitations	**Critical** When emissions enforced investment decisions are completely changed
12	Generator & Transmission Capacity Expansion Constraints	To require WIS:dom to keep investments in new generation & transmission to specific levels	**Low-Medium** Very tight enforcement could impact decisions, but realistic values do not substantial change solutions
13	Coal, NGCC, NGCT, Nuclear, & Geo Ramping Constraints	Describing the speed at which generators can alter their output for WIS:dom	**Medium** Faster ramping thermal generation is more favorable in lower emission scenarios, so this constraint impacts decisions in those cases
14	DER Deployment & Cost Constraints	Specifies to WIS:dom the amount of DERs to be constructed and/or cost to system of these assets	**Low** Has minimal impact on the overall system costs and investment decisions of utility scale generators
15	CIL & CEL Constraints	Describe the import & export limits between markets, countries, states, and interconnections	**Medium-High** Transmission expanding from existing lines & the addition of market impacts can dramatically alter decisions in some high emission reduction scenarios
16	Spatial Limitation Constraint	Allow WIS:dom to understand the space requirement for generators and competition for land use	**Medium** Without this constraint land use can be over used and over count the amount of generation in a location/site
17	Extraction Limits For VRE	Determines the limits to VRE extraction for nearby sites	**Medium** Impactful for wind siting considerations but much lower for solar PV siting
18	Nuclear & Hydro Dispatch Schedule	Informs WIS:dom that nuclear and hydro must conform to addition constraints regarding the water cycle, water temperature, and refuelling	**Low-Medium** Nuclear suffers a small amount due to offline times & hydro flexibility limited by constraint to assist with other VREs
19	Relicense / Repower Decision	Facilitates WIS:dom opting to relicense or repower an existing nuclear or VRE site	**Medium-High** Repowering can substantially improve existing sites at lower cost, while relicensing enable nuclear to remain within markets for longer
20	Load / Weather Forecast Error Estimator	Enables WIS:dom to detect regions with poor weather and/or load forecasts for consideration during investment decisions	**Low-Medium** Load & weather forecasts are small enough over EI markets that the invesments are not substantially altered. For WECC, the impact is much higher

FIGURE W-11: *The main equation sets that WIS:dom computes and solves over during its optimization procedure. Not all equation sets are shown; only the most important to the study are displayed.*

The equations described in Figure W-11 are initialized for each of the investment periods (2017, 2020, 2025, 2030, 2040, and 2050). WIS:dom solves for each investment period in chronological order. When WIS:dom completes a solve for an investment period, all the data / solution vectors are stored and passed to the next investment period to allow conditions to be constrained based upon previous decisions. In that way, WIS:dom is operating in "myopic mode". In other words, previous investment decisions impact future ones, but future ones do not impact previous decisions. To complete an investment period, WIS:dom must simultaneously: determine the generator capacity and siting, determine the transmission capacity and siting, determine the storage capacity and siting, compute retirement decisions, decide upon all the dispatch profiles for all the generation and transmission, compute the cost for each market region, incorporate the VRE dispatch based upon weather drivers, calculate the emissions produced at each site, and finally conform to every constraint imposed (without fail).

One of the most unique features of WIS:dom (in addition to the high temporal granularity of the dispatch over a long time period and spatial scale) is its ability to site the generators, storage, transmission, and demand-side resources. It does this at a 3-km resolution. Therefore, after a simulation is executed, a user can get the specific siting, capacity, transmission necessary for each asset within the footprint. WIS:dom is not a replacement for a full stability study or AC power flow analysis, rather it is a synthesis model that encompasses the combined capabilities of traditional production cost and capacity expansion models. By performing its solving sequence in this manner, WIS:dom facilitates information exchange between the different scales while co-optimizing the build out of assets. In short, WIS:dom allows more solution options and more information for the model to base its decisions upon, thus finding new pathways that are not available to other modeling platforms that exist in the market today.

Another assumption/input that WIS:dom accounts for in its internal logic is the constraints on nuclear and hydroelectricity generation with regards to weather and refueling schedules. Hydroelectricity is heavily dependent on the weather, and nuclear has somewhat strict maintenance and refueling schedules. This manifests with the fleet of nuclear and hydroelectricity changing their capacities month by month. For WIS:dom, VCE determined the last 10 years of data for the nuclear fleet cycling due to maintenance and refueling and apply the average of those 10 years to the nuclear fleet (specified by state). For hydroelectricity, WIS:dom is forced to release the same amount of water as was released in the weather years for each 5-minute interval. The implication for hydroelectricity is that it can be more flexible to changing electricity grid mixes, but must retain steady water flow as to not alter other uses for the water. This is done because many hydropower plants are run-of-river and cannot store the water and others are used for many other purposes other than electricity generation. A final reason to deal with hydropower in this way is to consider the changing weather patterns and how they influence the stream flows for the hydropower.

WIS:dom incorporates existing generation, existing short-term queue, existing transmission, proposed transmission (if required), retirement dates (enforced or economic), set pathways, emission targets, RPSs, EV projections, DSM/DR projections, and other aspects warranted.

C. WEATHER, POWER, DEMAND, & TECHNOLOGY RESOURCE DESCRIPTIONS

The weather data used in WIS:dom includes 3-km and 13-km hourly granularity as well as 5-minute data at 3-km. These data run over 5 to 13 years. The weather data years are 2006 to 2018 at 13-km, hourly and 2014 to 2018 at 3-km, 5-minutely. VCE has created sophisticated algorithms (the Solar Power Model and the Wind Power Model) to convert the weather data to variable power potential. The weather data is also used to constrain the load forecasts, alter the power flow potential, and determine extreme events within the system. The weather data is based upon NOAA NWP data assimilation that includes 10,000 - 25,000 observations each hour. The observations include aircraft, ground-based measurements, satellites, radar, and more. With the high density of observations, the data-assimilation is utilized to create an approximation to the state of the atmosphere at a given time. VCE takes the data assimilation and strengthens the correlation between observations and model. VCE also considers the forecast errors that appear in weather models and creates unique time series for each of the resource sites in the US. The time series for each resource site is then processed to create potential variable generation and is then further used in estimating electric loads for each resource site. Finally, the data is calibrated along transmission lines to determine the rating of the existing transmission infrastructure. The weather data is assembled in a database structure only readable by WIS:dom. The purpose of the database is that it is interchangeable with other weather datasets (if necessary) for comparison or dispatch characteristics under various scenarios. A further benefit of the database structure is that the WIS:dom optimization model can read in the dataset in less than 5 minutes for ~2 million resource sites and 105,120 5-minute timesteps.

For existing wind and solar sites, existing parameters were input into the wind and solar power models to overwrite the potential VRE resource. If WIS:dom determines repowering a site is worthwhile, the potential VRE resource will replace the existing values when the repowering takes place; thus, providing the enhancement to the generation at that site. The siting constraints for the whole US are calculated by VCE using the latest (and highest resolution) land use datasets. The datasets allow WIS:dom to have realistic bounds on siting for the variable generation. Figure W-12 displays the land use data set that is incorporated into WIS:dom for siting constraints of renewables. Figure W-13 shows the wind (at 80m) and solar PV (single axis tracking) potential over the United States.

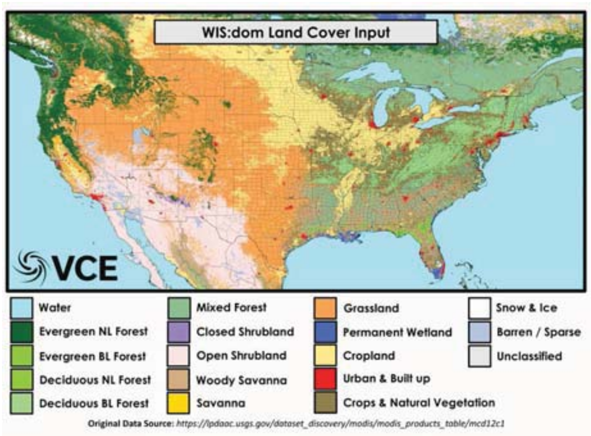


FIGURE W-12: *The land use dataset that is used within WIS:dom to determine the appropriateness of locations for development of variable generation. Other layers are applied to the land use dataset, such as topographic, critical species, migration paths, etc.*

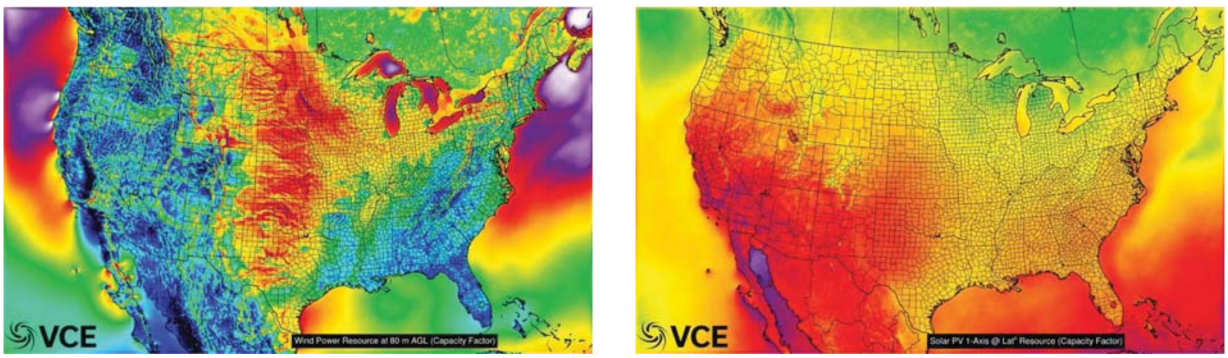
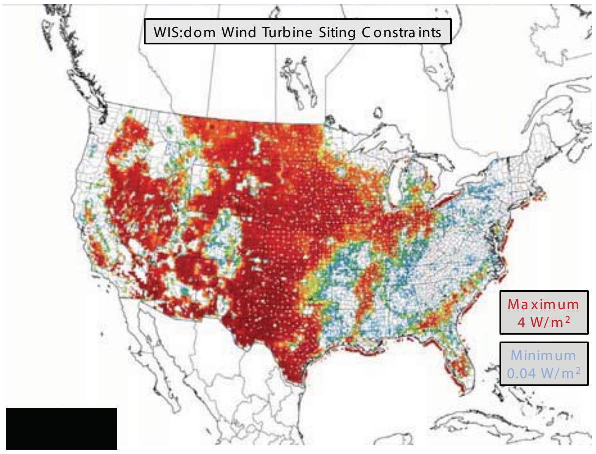
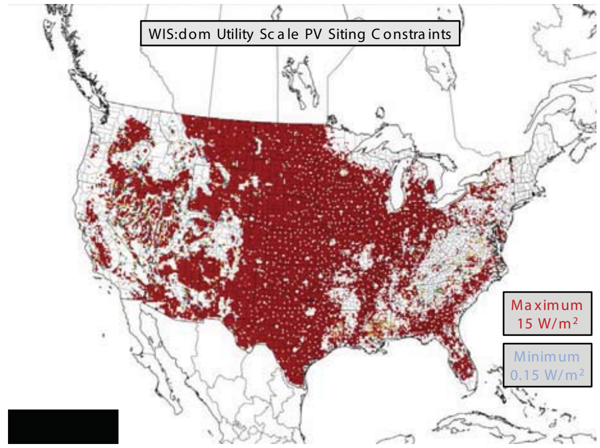


FIGURE W-13: *The average wind (left) and solar PV (right) resource potential for the US. The potential is defined in capacity factors. WIS:dom includes multiple sub-categories in each generation type.*

The land use dataset depicted in W-12 is used with other datasets to determine the potential siting locations for generators. The upper limits provide guidance to WIS:dom about the appropriateness of a region for different technologies and what resources are available. The WIS:dom optimization model can have more information added for constraints within its siting procedure. Figure W-14 shows the standard siting limitations for wind, solar PV, and rooftop PV. To determine the rooftop PV siting constraints, VCE produced a screening procedure to determine the number of rooves available per 3-km grid cell, estimated the angle of the rooves and calculated the capacity available for energy production.





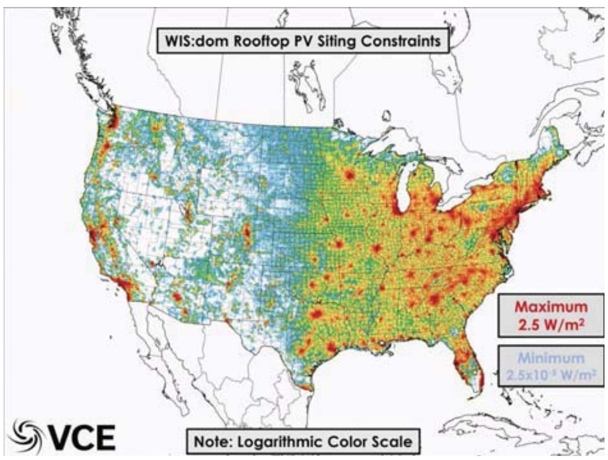


FIGURE W-14: *The wind (top-left), utility-scale PV (top-right) and rooftop solar PV (bottom) siting potential across the CONUS footprint.*

For the demand-side resources, WIS:dom assigns a value to each 5-minute interval for flexibility based upon the demand mix (the electrification amount, the composition in terms of EVs, water heaters, heat pumps, etc.). The two largest areas for flexibility are EVs, DSM (primarily representing space and water heating in residential and commercial sectors), and DR (almost entirely interruptible industrial demands). WIS:dom assigns a price to EV charge shifting, DSM and DR within the WIS:dom market. The cost is to allow WIS:dom to recognize that there are costs to providing flexibility. The demand-side resources are full participants in the energy markets and can be dispatched by WIS:dom as such. The principle behind the modeling of the flexibility resources centers around the input load profiles. VCE estimates the native load, in the absence of price signals or generation scarcity. Simply put, how would the demand behave if left to the environmental, physical and human constraints on the system. WIS:dom, when solving, has the ability to remove some of the demand, for a cost, and shift it to another time period, or simply provide the native demand with generation.

One final important distinction needs to be made with respect to WIS:dom's handling of nuclear power plants. They are processed differently to other thermal generators because of their need for relicensing. For each of the nuclear power plants, the relicense costs and dates (as well as fixed costs) are estimated and included in WIS:dom. The values are shown in Figure W-15. Once a nuclear power plant reaches its relicense date WIS:dom must decide whether to relicense the plant or retire it, and replace it with other generation. Of course, WIS:dom can construct a new nuclear power plant, and those decisions are based on the input costs for new builds. A new relicense schedule is developed for new plants. First relicense after 40 years and the second after 60 years.

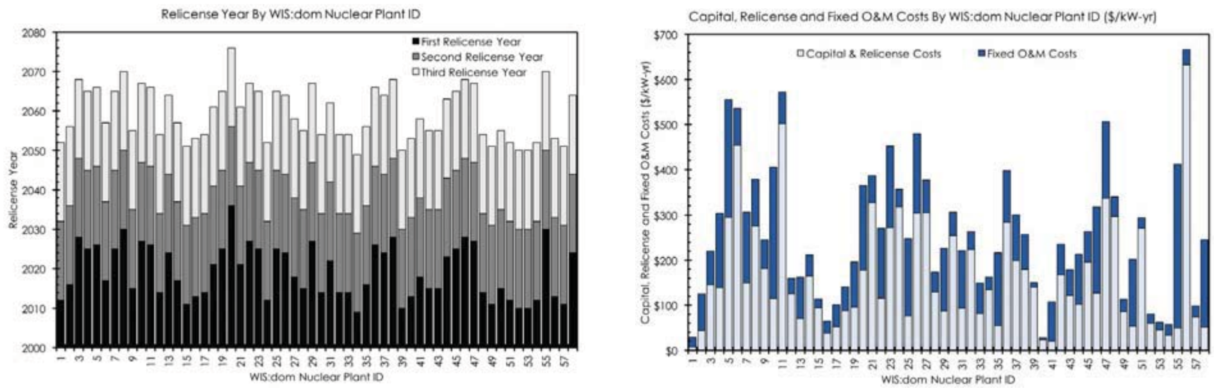


FIGURE W-15: *Relicense year by nuclear plant ID (left) and relicense and fixed O&M costs by nuclear plant ID (right). The names of the nuclear power plants are removed purposely.*

D. OVERALL WIS:DOM FUNCTIONALITY

Resource Siting Constraints:

- Wind and solar have a base GIS data layer for forbidden development sites;
- Conventional generation is limited to current or specified sites;
- Grid tied storage can be sited in utility or Behind the Meter;
- Distributed Energy Resources can only be sited in urban areas;
- Can model the entire US, but typically reduced to interconnect or ISO/RTO;
- Spatial constraints are applied within the gridded data to ensure no double use.

Transmission Expansion Constraints:

- Transmission upgrades can be limited by the user/client;
- Transmission and storage can be considered together as similar style assets;
- Explicit lines of interest can be included to determine the benefit/disadvantage of the lines;
- Multiple optional expansion can be offered to the model and it will determine the least-cost built out, while simultaneously considering the generation and load at dispatch intervals.

Inter- and Intra- Annual Weather Datasets:

- A minimum of 3 years of hourly weather data is always available used;
- The hourly data can be at 13-km or 3-km (or both, if desired);
- The hourly data can also include forecasts (2-hr, 6-hr), to assess the impact of forecast error [for real-time dispatch in WIS:dom];
- 3-km 5-minute data is also available for the model;
- Capacity credit evaluation based upon various penetrations and weather variability.

Interconnection Influences of External regions:

- Model different geographic scales to determine the adjustment to client's plans based upon external influences;
- Geographic extent available: National; Eastern Interconnect, MISO, Michigan, Utility only (note other areas are available if utility is in other US regions);
- Rapid sensitivity analysis available with batch mode running optional.

Distributed Resources and Other Considerations available:

- Electric vehicle adoption;
- Sector electrification and load shape changes;
- Residential/Commercial storage;
- Rooftop solar PV;
- Demand response/management;
- Role of charging/discharging vehicles on grid;
- Planning and following reserve requirements in a changing resource mix.

Main Technologies Available in the WIS:dom Optimization Model:

1. Solar Photovoltaics
   a. Fixed axis,
   b. 1-axis tracking,
   c. 2-axis tracking,
   d. Rooftop solar PV;

2. Grid tied energy storage
   a. Li-Ion,
   b. Flow batteries;

3. Wind Turbines
   a. 80 m hub height,
   b. 100 m hub height,
   c. Other [120-160 m] hub heights,
   d. Turbine designs,
   e. Rotor diameter;

4. Electric Vehicles
   a. Charging/discharging behavior,
   b. Amount and location of EVs,
   c. V2G, G2V, etc.;

5. Distributed Energy Resources
   a. Storage,
   b. Heat pumps,
   c. Other demand management;
   d. Large scale demand management.

VII. WIS:DOM OUTPUT DATA FILES DESCRIPTION

A. Data and Images All Reside within this google drive folder: https://drive.google.com/open?id=1yUnLVDTXC7dIgbljJ1_VFGeOPNnyF-su

B. Images for all the scenarios are constrained in this hyperlink: https://drive.google.com/open?id=19yIYUYojEisKJ9hsOpEdH3luTlZ7oA2h

C. The scenario data are contained in zip files. Unzipping each file will require ~7 GB of space, *so please beware!* The spreadsheets and images should suffice for most purposes. The data files contain all the dispatch files that aggregate for states and the whole Eastern Interconnection, transmission power flow between states, location (latitude and longitude) of installations, emissions, costs, etc. All files are reduced in size using k-means clustering (Lloyd's algorithm) to 13-km & hourly from the 3-km 5-minutes. Otherwise each directory would be ~1,500 GB rather than the ~7 GB.

D. This end of study presentation and summary images are also available: https://drive.google.com/open?id=1ARU9aQ2YGuXAVjr27w9LR9Kg
8IVBrkng

E. Each set of images have the same numbering format. **001 to 053 are for the aggregate Eastern Interconnection values**. Some images are broken down to individual states, while others are aggregated by EI. Each image has a title and labeled axes. Further, for all the scenarios the images can be found in the accompanying spreadsheet, where the data for the image is also contained. **Images 054 to 087 are specific to Minnesota.** The images include the dispatch within Minnesota, the capacity installed, the emissions, the cost of electricity, the generation share, and jobs. **Images PowerPlants_XXX are the spatial data** for the installed capacity across the Eastern Interconnection. Further, the images show the interstate transmission capacities.

F. The data in the spreadsheets are linked to data in the zipped files. There is more data in the zipped files than in the spreadsheets. The additional data is focused on the dispatch, power flow, capacities, hourly emissions, plant data for *Minnesota – namely, hourly costs, emissions, dispatch for each plant in Minnesota.*

G. Each data file that has a number at the front is for a specific year. They are numbered 1 to 6 and they represent 1=2017, 2=2020, 3=2025, 4=2030, 5=2040, 6=2050.

H. Inside the data files are different levels of data. When there is a "state" in the file name, that means that each state is represented in the file. Normally, a summation for each state, which are denoted in the model as the following:

   1 = WA, 2 = ID, 3 = MT, 4 = ND, 5 = MN, 6 = WI, 7 = OR, 8 = CA

   9 = NV, 10 = UT, 11 = WY, 12 = SD, 13 = IA, 14 = IL, 15 = IN, 16 = MI

   17 = OH, 18 = PA, 19 = NY, 20 = VT, 21 = NH, 22 = ME, 23 = MA, 24 = CT

   25 = RI, 26 = NJ, 27 = AZ, 28 = NM, 29 = CO, 30 = NE, 31 = KS, 32 = MO

   33 = KY, 34 = WV, 35 = VA, 36 = MD, 37 = DE, 38 = DC, 39 = TX, 40 = OK

   41 = AR, 42 = TN, 43 = NC, 44 = LA, 45 = MS, 46 = AL, 47 = GA, 48 = SC, 49 = FL.

I. The dispatch files, or other files that are done by time steps for each investment period have 8,403 hourly values for each variable they are describing. This is done for costs, LCOE, pollution, dispatch, etc. This is a product of taking the 105,120 5-minute intervals and clustering them around the 8,403 cycles of hourly weather data that VCE created. This allows VCE to compares results directly with the hourly version of WIS:dom.

J. There are also files that have each of the class of generation split out for interpretation:
   1 = Coal, 2 = NG CCGT, 3 = NG CT, 4 = Storage, 5 = Nuclear, 6 = Hydroelectric, 7 = Wind, 8 = Offshore, 9 = Rooftop PV, 10= Utility PV, 11 = CSP, 12 = Geothermal, 13 = CCS.

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NOTE

Preliminary US Emissions Estimates for 2018

Energy & Climate Staff
January 8, 2019

After three years of decline, US carbon dioxide (CO_2) emissions rose sharply last year. Based on preliminary power generation, natural gas, and oil consumption data, we estimate emissions increased by 3.4% in 2018. This marks the second largest annual gain in more than two decades — surpassed only by 2010 when the economy bounced back from the Great Recession. While a record number of coal-fired power plants were retired last year, natural gas not only beat out renewables to replace most of this lost generation but also fed most of the growth in electricity demand. As a result, power sector emissions overall rose by 1.9%. The transportation sector held its title as the largest source of US emissions for the third year running, as robust growth in demand for diesel and jet fuel offset a modest decline in gasoline consumption. The buildings and industrial sectors also both posted big year-on-year emissions gains. Some of this was due to unusually cold weather at the start of the year. But it also highlights the limited progress made in developing decarbonization strategies for these sectors. The US was already off track in meeting its Paris Agreement targets. The gap is even wider headed into 2019.

A Sign Change in US Emissions Trends

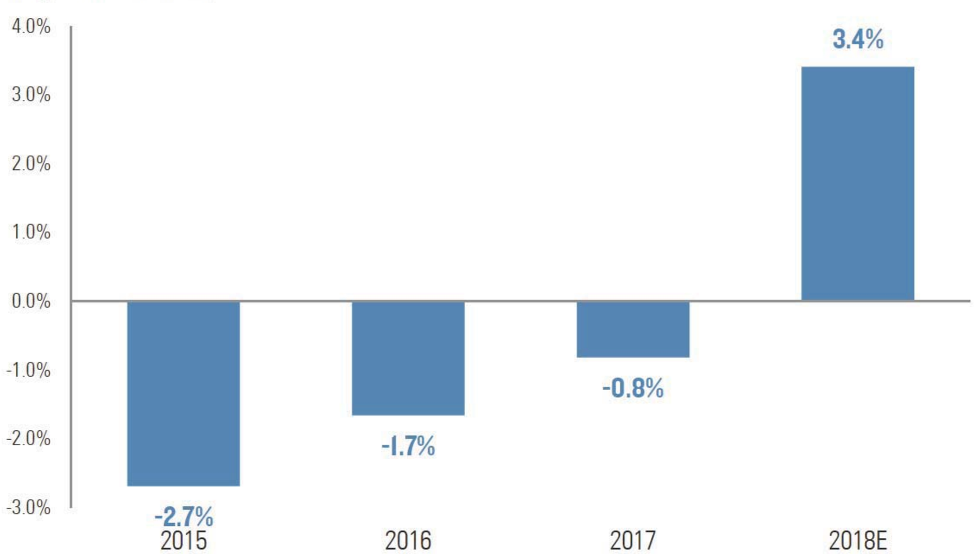
CO_2 emissions from fossil fuel combustion in the US peaked in 2007 at just over 6 billion tons. Between then and the end of 2015, emissions fell by 12.1% — an average rate of 1.6% per year. The Great Recession played a significant role in that decline, but pace of US emissions decline has slowed, from 2.7% in 2015 to 1.7% in 2016 to 0.8% in 2017 (Figure 1). As we noted this time last year and in our annual Taking Stock report, that slowdown in progress, combined with a lack of new climate policy action at the federal level, risked putting the US emissions reduction goal under the Paris Agreement — a 26-28% cut below 2005 levels by 2025 – out of reach.

Preliminary data from last year suggests that the gap the US needs to close to meet that target got bigger, not smaller. Based on emissions data from the Energy Information Administration (EIA) for the first three quarters of the year, weekly EIA petroleum supply data, plus daily power generation and natural gas data from Genscape and Bloomberg, respectively, we estimate that energy-related CO_2 emissions increased by 3.4% in 2018. That's the second largest annual gain since 1996 — surpassed only by the 3.6% increase that occurred in 2010, when emissions rebounded from a recession-driven 7.2% decline the year before.

While we don't expect a repeat of 2018 this coming year, the data provides some important insights into the emission reduction challenges facing the US.

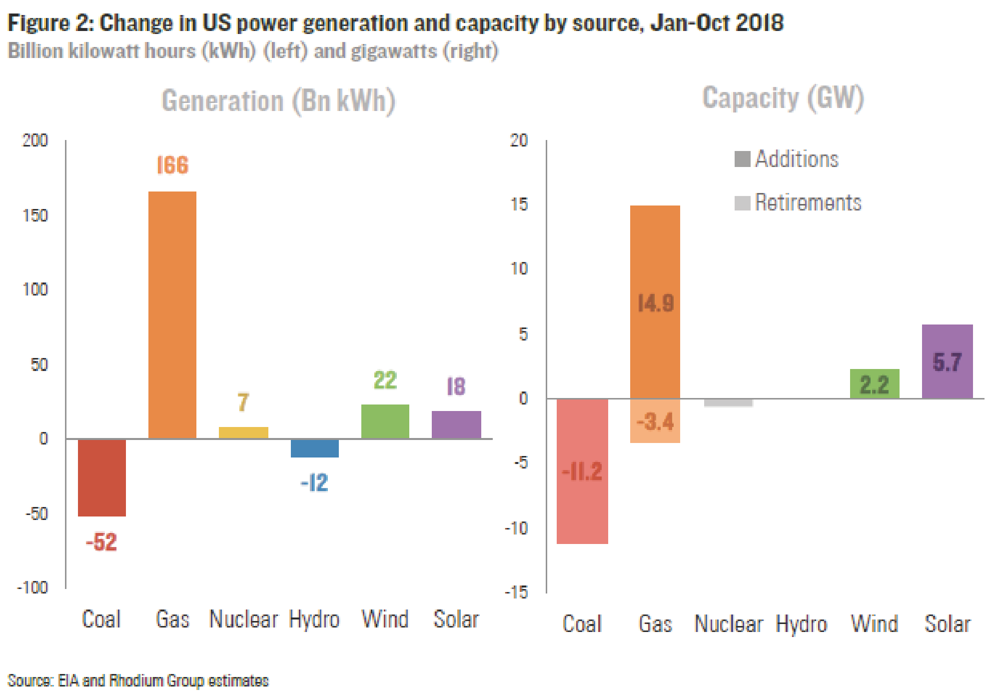
Figure 1: Annual change in US CO_2 emissions

Energy combustion only



Source: Rhodium US Climate Service, based on data from the EIA, Bloomberg and Genscape

As of the end of October, 11.2 gigawatts (GW) of coal-fired power generation capacity had closed in the US (Figure 2). With another 2.5 GW of capacity scheduled for retirement by the end of December, 2018 could end up being the biggest coal plant closure year on record.

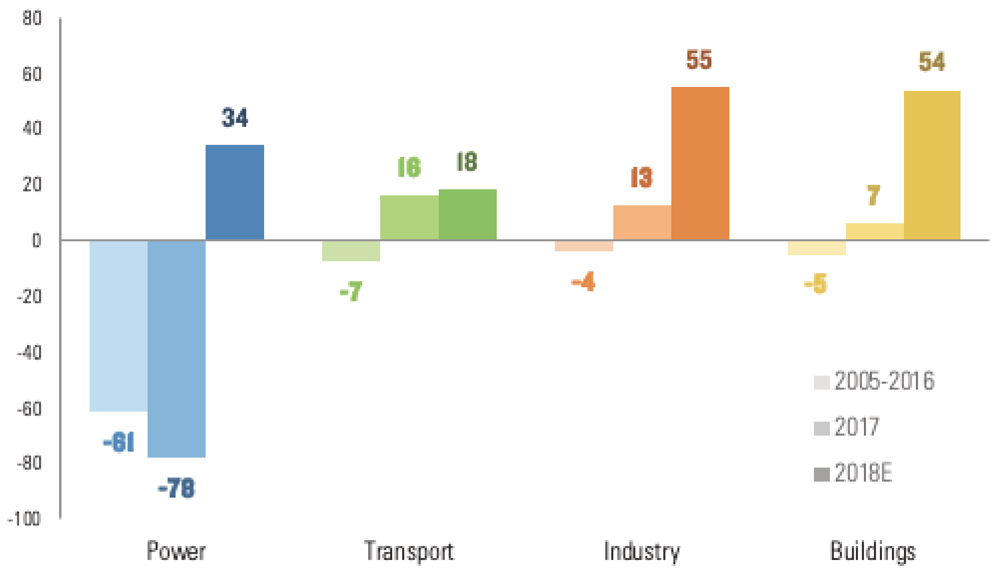


Coal-fired power generation was down sharply last year as well — more than in 2017 though not nearly as much as in 2012, 2015 and 2016. Unlike those years, where electricity demand was either flat or declining, US power consumption increased meaningfully in 2018. Natural gas not only replaced most of the lost coal generation but also fed the vast majority of the load growth last year. Between January and October, US power companies added a greater share of gas capacity than the share of retired coal capacity, and twice as much gas went online as combined wind and solar capacity additions (including distributed solar) during that period. Natural gas-fired generation increased by 166 billion kWh during the first ten months of the year. That's three times the decline in coal generation and four times the combined growth of wind and solar.

in 2018, compared to a decline of 78 million metric tons in 2017 and a 61 million metric ton average annual decline between 2005 and 2016 (Figure 3). But power wasn't the only sector where emissions increased. We estimate significant gains from transportation, industry, and buildings as well.

Figure 3: Average annual change in US CO_2 emissions by sector

Million metric tons



Source: Rhodium US Climate Service, based on data from the EIA, Bloomberg and Genscape

The More Stubborn Parts of Transportation

The transportation sector retained its title as the largest source of CO_2 emissions in the US for the third year running (Figure 4). During the first nine months of the year, gasoline demand declined by 0.1% as modest efficiency gains offset a minor increase in vehicle miles traveled (Figure 5). But robust growth in demand for both trucking and air travel increased demand for diesel and jet fuel by 3.1% and 3.0%, respectively. This highlights the challenges in decarbonizing the transportation sector beyond light-duty vehicles. Here we see efficiency improvements and electrification beginning to make a dent, albeit not nearly a big enough one to meet medium- and long-term US emissions targets.

three quarters of the year. All told, we estimate that transportation emissions grew by 1% in 2018, roughly the same as the 2017 growth rate.

The largest emissions growth in 2018 occurred in the two sectors most often ignored in clean energy and climate policymaking: buildings and industry. We estimate that direct emissions from residential and commercial buildings (from sources such as fuel oil, diesel and natural gas combusted on site for heating and cooking) increased by 10% in 2018 to their highest level since 2004. Part of this was due to a colder winter — the number of heating degree days (HDDs) across the US increased by 15% during the first quarter of 2018 relative to the same period the year prior. But it was the relative warmth of 2017 that was the anomaly more than 2018. The first three months of 2018 were still warmer than the average during for the quarter during the 20 years prior. While there have been modest improvements in the efficiency of oil and natural gas furnaces, it is not enough to offset the emissions impact of population growth and increased demand for heating and other non-electric building energy services. Building electrification has recently gained traction as a concept within the energy and climate wonkosphere, but much less headway is being made on the ground among actual building owners and operators.

While buildings have begun to attract some creative policy thinking, the industrial sector is still almost entirely ignored. At the state and federal level few good strategies have been implemented to begin decoupling production from emissions. Our preliminary estimates suggest the industrial sector posted the largest emissions gains in 2018 at 55 million metric tons. That was due mostly to growth in industrial activity. The value of shipments across all manufacturing industries rose 7.3% during the first nine months of the year, compared to 4.5% during the same period the year before. The Federal Reserve's industrial production index for manufacturing was up 2.5% year-on-year between January and November 2018, compared with 1.4% during the same period the year before.

Absent a significant change in policy or a major technological breakthrough we expect the industrial sector to become an increasingly large share of US greenhouse gas (GHG) emission in the years ahead (including non-CO_2 gases). We expect it to overtake power as the second leading source of emissions in California by 2020 and to become the leading source of emissions in Texas by 2022.

The estimates provided in this note are for energy-related CO_2 emissions only, which account for roughly three-quarters of total GHG emissions in the US. Official EPA 2018 inventory numbers for all GHGs will not be available until 2020. But this spring we will release our annual public forecast of US GHG emissions under current federal and state policy that will incorporate these recent energy-related CO_2 trends. Other factors will impact that outlook, including policy, market, economic and technology developments since our last public report. That said, the growth in energy-related CO_2 emissions that occurred last year stretches the gap the US has to close to meet its Paris Agreement target even wider.

Energy-related CO_2 emissions ended the year 11.2% below 2005 levels. That's an uptick compared to 14% below 2005 at the end of 2017 (Figure 6). The US target under the Copenhagen Accord is a 17% reduction in all GHG emissions by the end of 2020. Assuming proportional reductions in other gasses, the US will need to reduce energy-related CO_2 emissions by 3.3% per year, on average, in 2019 and 2020 to meet the Copenhagen target. That is significantly faster than the 1.2% average annual reduction between 2005 and 2017. In reality, the pace of energy CO_2 emission reductions will likely need to be even faster as the decline in non-CO_2 gasses has underperformed that of energy-related CO_2 in recent years.

To meet the Paris Agreement target of a 26-28% reduction from 2005 levels by 2025, the US will need to reduce energy-related CO_2 emissions by 2.6% on average over the next seven years — and faster if declines in other gasses do not keep pace. That's more than twice the pace the US achieved between 2005 and 2017 and significantly faster than any seven-year average in US history. It is certainly feasible, but will likely require a fairly significant change in policy in the very near future and/or extremely favorable market and technological conditions. We will explore both in our updated US emissions forecasts in late spring/early summer.

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I, Eric Lindberg, hereby certify that I have this day, served copies of the following document(s) on the attached list of persons by electronic filing, certified mail, e-mail, or by depositing a true and correct copy thereof properly enveloped with postage paid in the United States Mail at St. Paul, Minnesota with the exception of Paper Service recipient John Linc Stine, former Commissioner of the Minnesota Pollution Control Agency. Paper Service was made on Laura Bishop, current Commissioner of the Agency.

- **Petition for Reconsideration**
- **Attachments A – C**

Filed on behalf of Clean Energy Organizations.

Paper service recipients are notified that the attachments, being voluminous, are available electronically by request and via e-dockets.

In the Matter of Minnesota Power's Petition for Approval of the Energy*Forward* Resource Package

Docket No.: E-015/AI-17-568

Dated this **13th** day of **February 2019**

/s/Eric Lindberg

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