STATE OF MINNESOTA
PUBLIC UTILITIES COMMISSION

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In the Matter of an Investigation into Implementing Changes to the Renewable Energy Standard and theNewly Created Carbon Free	**Standard under Minn. Stat. § 216B.1691** **Docket No. E-999 /CI-23-151**

REPLY COMMENTS OF ENERGYTAG

April 16, 2025

Thank you for the opportunity to respond to comments in this docket.

EnergyTag is a global, mission-driven nonprofit working to advance global energy attribute markets towards greater granularity in time and space. To cut emissions and lower costs, we need clean, reliable power around the clock. To get there fast, we need the right incentives. Today that's not the case. Markets and policies are based on an outdated framework that allows companies to claim 100% clean energy annually, while they still rely on fossil fuels when there is no wind or sun. This flawed system sends the wrong signals and discourages investment in storage and flexible clean energy needed to cost-effectively integrate clean power—an absolute necessity to avoid unnecessary costs and inefficiencies as the clean energy transition continues. **EnergyTag exists to fix this.** By integrating granular time and location information into clean energy production and requiring granular matching policies and regulations, energy markets and incentives can more effectively drive us to clean power *every hour, everywhere*.

EnergyTag has expertise working in countries and jurisdictions around the world, has advised policymakers at the state and federal level in the United States on how to implement granular accounting policies and standards, and tracks examples of hourly matching clean electricity production to consumption to demonstrate today's feasibility for this practice.

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Support for the Department of Commerce initial comments

EnergyTag supports the Minnesota Department of Commerce's initial proposal to require hourly matching of carbon free electricity (CFE) to be in compliance with the new Carbon Free Standard (CFS):

> ***The Department recommends that the Commission order the following total retail electric sales matching requirements for electric utilities by the end of the year indicated:***
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> 1) ***2030: Annual matching of 80 percent for public utilities; 60 percent for other electric utilities***
> 2) ***2035: Hourly matching of 80 percent for public utilities; 60 percent for other electric utilities***
> 3) ***2040: Hourly matching of 90 percent for all electric utilities***
> 4) ***2045: Hourly matching of 100 percent for all electric utilities.***

Source: Department of Commerce Comment

The phased approach and tiered ambition for different sized utilities in Minnesota is a prudent, achievable, and impactful proposal for CFS implementation. Hourly matching of clean electricity supply with load has been demonstrated through numerous academic studies and governmental regulatory decisions to be the highest integrity process for accurate electricity-based emissions accounting and driving policy outcomes intended by an ambitious law such as this one.

The United States federal government has finalized rules for its 45V clean hydrogen tax credit that lean on hourly matching and deliverability regions to qualify low emissions hydrogen production using grid power and claiming clean supply via contractual arrangements.[1] In a Department of Energy memo outlining justification for these final rules, they state "Given hourly changes in grid GHG emissions, an hourly energy-matching standard provides much stronger assurance that changes in load are matched by changes in supply."[2]

Additionally, there has been significant academic research to demonstrate the long run emissions reduction potential of temporal matching requirements for supply and demand. These academic works refute studies commissioned by other parties in

[1] Federal Register, https://www.federalregister.gov/documents/2025/01/10/2024-31513/credit-for-production-of-clean-hydrogen-and-energy-credit.
[2] Department of Energy, https://www.energy.gov/sites/default/files/2023-12/Assessing_Lifecycle_Greenhouse_Gas_Emissions_Associated_with_Electricity_Use_for_the_Section_45V_Clean_Hydrogen_Production_Tax_Credit.pdf.

this docket that seek to argue hourly matching will lead to net increases in emissions.

Hourly matching is feasible today

Hourly matching is not a novel concept. In fact, power markets operate on a sub hourly granularity every day to match supply and demand of power, so the technical feasibility of tracking and matching types of electricity is not a true technical hurdle. While the full functionality of hourly attribute markets that can support implementation of proposals like this one are not yet fully mature, that is largely due to lack of demand, rather than any feasibility issue. This market will develop quickly given proper regulatory requirements. As more and more policies and regulations require granular accounting and hourly matching, the need for hourly attribute infrastructure and solutions will only increase and the market will respond quickly.

Despite the lack of this hourly attribute market, actually doing hourly matching of electricity production and consumption is achievable and being demonstrated today.

Case studies

EnergyTag tracks projects around the world that are hourly and locationally tracking and matching more than 5 TWh of electricity.[3]

These projects do not require wealthy corporations with sophisticated energy teams to achieve hourly matching. In fact, just recently ENGIE and Einstein Bros. Bagels announced that ENGIE would provide hourly clean electricity for 25 Einstein Bros. Bagels locations in Texas at a 90% hourly matching rate.[4] A mid-sized company is able to secure hourly CFE *today* at a rate not required until 2040 by the Minnesota Department of Commerce under their proposal. While this announcement is focused on the Texas market, it exemplifies the high rates of hourly CFE possible today – especially in areas with strong natural resource availability such as Minnesota and the midwest region. This will be touched on further when looking at the Princeton analysis of the Department of Commerce proposal.

[3] EnergyTag, https://energytag.org/case_studies/
[4] PR Newswire, https://www.prnewswire.com/news-releases/engie-powers-einstein-bros-bagels-with-round-the-clock-renewable-energy-302403202.html

Existing policies

Hourly tracking and matching is being increasingly included and considered in policies around scope 2 emissions, utility power source disclosure, and clean product definitions.

United States

In the United States, the 45V clean hydrogen production tax credit will require hourly matching of clean electricity production with consumption to qualify for the highest value tax credit starting in 2030.[5] It also requires the use of Energy Attribute Certificates (EACs) to demonstrate that compliance, a market driver for the expansion of these markets as the hydrogen industry continues to grow.

California recently finalized rules to implement their hourly power source disclosure program.[6] This program requires all load serving entities in California to report their sources of electricity and associated emissions on an hourly basis starting in 2028.

Colorado currently has a tax credit in place that requires hourly matching of clean electricity production and consumption to take advantage of a clean hydrogen usage credit.[7]

International

Similar to the US 45V clean hydrogen standard, the United Kingdom and the European Union have both established rules for hourly accounting to meet low carbon hydrogen definitions.[8]

In Australia, a law was passed to update their current system of tracking certificates to a Renewable Electricity Guarantee of Origin (REGO) which includes an ability to time stamp each certificate at an hourly level.[9]

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[5] EnergyTag, https://energytag.org/a-closer-look-at-the-45v-final-rule/
[6] EnergyTag, https://energytag.org/californian-regulators-approve-hourly-power-source-disclosure/
[7] Colorado General Assembly, https://leg.colorado.gov/bills/hb23-1281
[8] UK Department for Transport, https://assets.publishing.service.gov.uk/media/675855ec82c7cd4258eb64aa/rtfo-guidance-for-renewable-fuels-of-non-biological-origin.pdf. European Commission, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_594.
[9] EnergyTag, https://energytag.org/the-future-of-australias-renewable-energy-market-understanding-the-role-of-time-stamped-rego-certificates/.

Standards

EnergyTag has developed voluntary standards, with input from power sector experts from around the world, that outline methodologies to properly account for electricity on an hourly and locational basis.[10] These standards are currently being used to inform the development of registries and companies going through the EnergyTag accreditation process which will support interoperability of hourly EAC markets and meet the needs outlined by some of the responders in this docket who say that a liquid EAC market does not exist and therefore the proposal is infeasible.

Tools to support the market

Registry acceleration fund

There is currently an open solicitation for funding available to registries interested in modernizing their systems to develop the capability to issue granular certificates. This fund, being led by the Granular Certificate Trading Alliance, will provide significant resources to accelerate the development of these granular registries, further answering the concerns of commenters that hourly EACs are not available in time for the proposed hourly matching timeline.[11]

FEA demonstration GC registry

Further, Future Energy Associates has developed an open-source, fully operable demonstration granular registry to be used as a tool for any registries updating their systems.[12] This system can be used by anyone to accelerate their software development process for moving from today's system of EAC issuance to one that incorporates granular certificate issuance and can even track granular certificates through energy storage systems. This registry software is all aligned with EnergyTag's standard to ensure a high level of integrity and transparency and support registries hoping to align with this standard.

Configuration 3 matching today

Even before the hourly EAC markets fully develop, as we expect they will in the near future, there is a high integrity process for proving hourly matching using granular certificates today.

[10] EnergyTag, https://energytag.org/standards/.
[11] LevelTen Energy, https://go.leveltenenergy.com/registry-acceleration-fund.
[12] Future Energy Associates, https://www.futureenergy.associates/granularcert-os.

Under what EnergyTag refers to as “Configuration 3”, an EAC that is produced today (usually a REC that is today used for monthly or annual accounting) can be combined with the hourly generation data of a renewable asset (which is known for any modern power contracts) to create hourly certificates without the involvement of an existing registry.[13] This process does not create the trading market likely to evolve in the coming years, but it puts to rest any argument that the technical capacity for proving hourly matching does not exist today.

Princeton analysis shows that high levels of hourly matching is practical in Minnesota

Recent analysis from Princeton University shows that the Department of Commerce proposal can be extremely achievable by utilities in Minnesota at moderate costs.

In juxtaposition to other studies funded and cited by commenters in this docket, Princeton University’s Zero Lab has put together an analysis looking at high levels of hourly matching for utilities in Minnesota as described by the Department of Commerce’s proposal. Their open source methodology provides transparency into their assumptions and processes. This analysis finds that the proposal to meet a 100% hourly carbon free requirement is achievable *at no excess cost to ratepayers* with a flexible regional boundary for procuring EACs.[14]

Implementation decisions matter

As noted, the most flexible interpretation of an hourly implementation of this law means utilities can easily comply as hourly EAC markets come into existence. However, it should be noted that Princeton’s analysis also finds that this version of implementation–the one with no additional costs–also will not significantly move the needle on emissions reductions compared to the baseline emissions reductions expected by natural course of clean energy deployment. Princeton is comparing what they *expect* based on projected capacity expansion modeling against what would be expected with certain constraints, like certain percentage hourly matching requirements and limited regions from which to source EACs. So it does not mean that emissions will not be going down under this policy, but the analysis does help explain how certain implementations can result in greater than expected emissions reductions, which naturally can increase costs to ratepayers compared to the baseline.

[13] EnergyTag, https://energytag.org/hourly-matching-exists-today-you-just-have-to-look/.
[14] Princeton University, https://zenodo.org/records/15213510.

Importantly, just because the Princeton analysis suggests there may not be a difference in emissions reductions between the basecase and one requiring 100% hourly matching with more flexible procurement boundaries, does not mean those emissions reductions predicted in the basecase are guaranteed. In fact, utility planning processes that do not always reward least cost, optimized deployment combined with federal action to slow clean energy deployment and artificially support generation sources like coal means strong policies like this one, that ensure hourly matching of clean energy with load going forward will *ensure* these emissions reductions. At the very least, this is a critical safety net necessary to ensure the buildout of these technologies in Minnesota and across the MISO north market.

As the analysis demonstrates, limiting the deliverability region from which utilities can procure EACs to comply with this policy will impact expected additional emission reductions and costs to ratepayers. These decisions should be further dissected to find an appropriate implementation threshold, but the bottom line is meeting high levels of hourly matching is extremely doable for utilities in Minnesota.

Highest costs come at the final few percentage points of decarbonization

In every scenario modeled by Princeton, costs remain fairly moderate up to a 90% matching requirement, and the transition from 90% matching to 100% matching requirements represents the largest jump in expected costs above baseline. This is consistent with Peninsula Clean Energy's modeled 24/7 portfolio, in which they found that decarbonizing the final 1% increased the cost by 10%.[15] This does not mean the pursuit of a 100% decarbonized system is infeasible to pursue, but it should illuminate how much decarbonization impact can occur with very high levels of hourly matching *before* the highest costs are incurred as the system approaches 100% hourly matching. These cost increases occur because of the need for greater storage and higher cost technologies like clean firm generation.

The Princeton modeling also considers a "circuit breaker" policy mechanism that allows for an alternative compliance payment if costs become too high. This kind of approach could help achieve both the intended impact of the policy while addressing concerns of feasibility and affordability.[16]

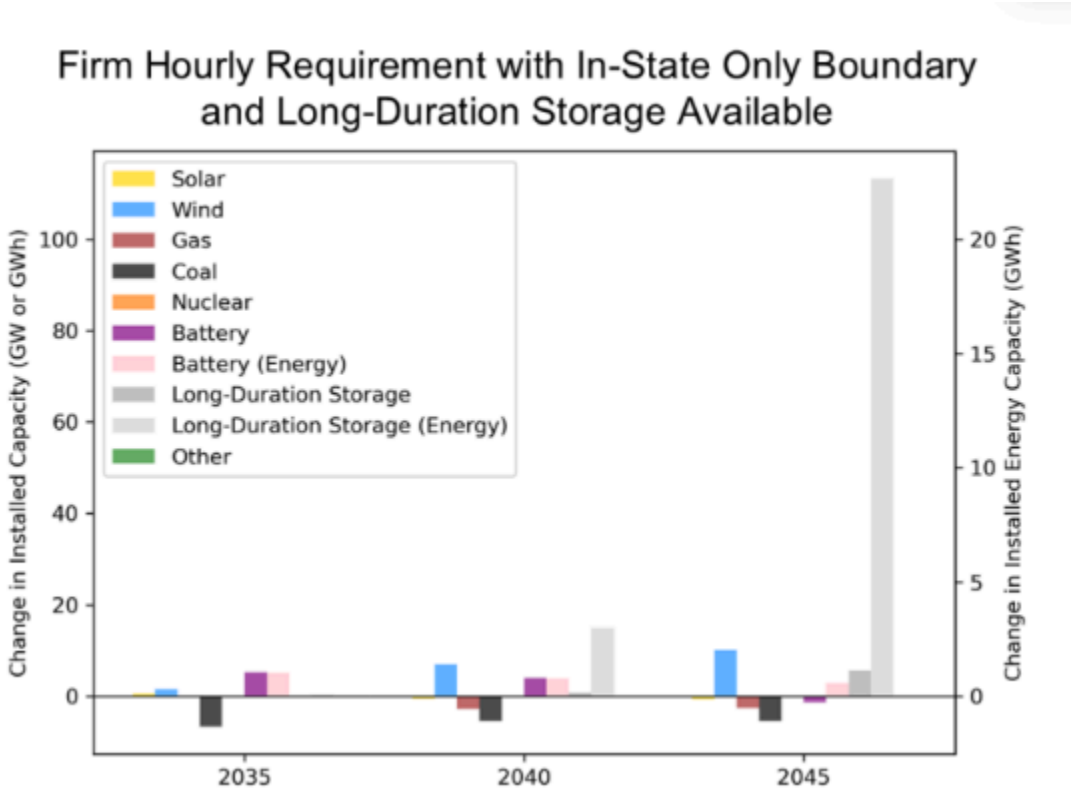
[15] Peninsula Clean Energy, https://www.peninsulacleanenergy.com/wp-content/uploads/2023/01/24-7-white-paper-2023.pdf.
[16] Princeton University, "When the breaker mechanism is utilized, the effective hourly matching rate in 2045 is still 98.5% and emissions fall by 16 MMT/yr."

Hourly matching enables a needed market for new decarbonization technologies

The reality is that the power sector will need to eventually achieve 100% hourly decarbonization to achieve the desired end state of carbon-free electricity production. There are key, advanced clean energy technologies that will likely be necessary to achieve that end state. Despite their higher costs today, policies and commitments help to drive market investments and cost declines that make those technologies available for significant decarbonization in the future.

The Princeton research highlights this additional potential decarbonization and economic impact of the Department of Commerce's proposal: seeding a new market for long duration energy storage.

When the model allows for the buildout of long duration energy storage, a 100% hourly matching requirement with a tighter deliverability boundary drives deployment of long duration energy storage and cuts the cost premium in half.



Source: Princeton ZeroLab

This boon for the long duration energy storage market could drive economic development in Minnesota and would serve to support greater in-state resiliency and

energy security. These results echo a conclusion drawn from all of the modeling results: the higher the matching percentage and the tighter the deliverability window, the greater impacts on Minnesota-specific decarbonization and energy security. These results are aligned with recent research showing how high rates of hourly matching, like 24/7 climate targets, help to accelerate cost declines and deployment of advanced clean energy technology.[17]

Final implementation of this policy should consider how decisions will impact the volume of EACs imported into Minnesota (which will represent clean energy buildout in other states, and not drive as much in-state decarbonization) versus the volume of EACs generated and claimed within Minnesota (representing deeper in-state decarbonization and economic investments). The more in-state development and deployment along a path towards 100% hourly decarbonization, the more utilities and customers in Minnesota will be protected from market fluctuations as competition increases for hourly EACs across the region. Planning for 100% hourly decarbonization with tighter deliverability zones will also set utility procurement and planning processes down a process aligned with a more economically optimized decarbonized power grid. Without the requirement to pursue this decarbonized end state of the Minnesota (or regional) grid, deployment of assets and investment in technologies may be less efficient and lead to overbuilding.

Response to comments in opposition of hourly matching

Utility group opposition

Utility opposition to the Department of Commerce proposal largely focuses on a few points:

- Implementation lacks statutory support
- Implementation will increase energy and compliance costs to the point of infeasibility
- Lack of hourly EAC market available for a source of liquid attributes

EnergyTag can speak towards the last two concerns in detail. As described, unbiased analysis from Princeton University demonstrates a number of cost-effective, feasible implementations of this law requiring increasing levels of hourly matching. These results are in stark contrast to claims made by utilities. Without access to their underlying analytical assumptions, it is impossible to say absolutely where they are

[17] Joule, https://www.cell.com/joule/pdfExtended/S2542-4351(24)00544-0.

getting their numbers. However, it can likely be assumed that assumptions around technology costs, optimal deployment of hybrid wind and solar portfolios, and using the highest cost modeling results to make claims of overall infeasibility.

The current lack of hourly, liquid EAC markets is a fair criticism only if high rates of hourly matching were required *today*. The Department of Commerce proposal doesn't require high levels of hourly matching until 2035. As outlined above, there are numerous tools and resources being deployed to support the rapid evolution of existing registries to be able to issue tradable granular EACs. The added market pressure of this policy implementation combined with hourly matching regulations in the 45V hydrogen production tax credit and potentially the Greenhouse Gas Protocol Scope 2 guidance will put pressure on US registries to modernize their systems more quickly.

Additionally, some utilities including Xcel Energy are arguing for national boundaries from which to procure RECs to comply with this law. This should not be considered under any circumstances. While some critiques around deliverability requirements as proposed by Department of Commerce center around the idea that true deliverability is difficult to prove and impacted by congestion can have some merit, a tighter deliverability region that at least attempts to mimic true power market delivery is a far better system than the status quo. A recommendation to source credits from anywhere in the country flies in the face of a high integrity climate policy like this one. It would provide an offramp for utilities in Minnesota to buy cheap RECs from anywhere to avoid investing in clean energy in the state or encouraging clean energy deployment in a more realistic deliverability boundary. This recommendation seeks to continue the disreality of claims made for clean energy consumption and how electricity actually works.

Brattle Group study

The Brattle Group put together a study funded by Great River Energy in which they argue an hourly matched implementation as proposed by the Department of Commerce could potentially lead to higher system emissions and that it is not the most effective metric for measuring greenhouse gas emissions reductions.
There are numerous ways in which this study is flawed and its conclusions are cherry picked to support the perspective of the aligned utilities in Minnesota opposed to the hourly matching implementation. EnergyTag's comment will focus on a few key flaws in this study.

First, the argument that an hourly matching requirement would not reduce system-wide emissions in the long term is in juxtaposition to the numerous peer reviewed studies that argue the opposite. Research highlighted in Appendix 1 all

point to the need for a granular accounting standard to ensure true systemwide emissions reduction, as opposed to short run, localized emissions reductions from near term deployment and dispatch modeling. This leads to the second significant concern with this study: the use of short run marginal emissions factors to make conclusions. As a National Renewable Energy Laboratory study demonstrates, short run marginal emissions do not effectively capture the impacts of structural changes in the power sector as a result of policy intervention and actions.[18] The integrity of using short run marginal emissions to make their arguments is further undermined by the choice to assume coal is the marginal unit in Minnesota for their illustrative example. This assumption, which is largely untrue—it is nearly always gas or wind, serves to further dramatize short run marginal emissions impacts from shifts in generation dispatch.

This study further uses a 50/50 wind and solar portfolio split to evaluate hourly matching costs and benefits: “we have not attempted to fully optimize on these dimensions and instead adopted in our study design a simplified 50/50 wind and solar resource mix located away from the demand center.” Without any attempt at optimization, the results of this study are immediately skewed and will represent higher cost estimates than one using an optimized portfolio (like one that can be found using a capacity expansion model as Princeton’s Zero Lab does, or even found by using a basic spreadsheet model). The 50/50 portfolio approach seems to be intentionally avoiding a more realistic optimization one might use to optimize for hourly matched consumption.

Additionally, the fact that this study only evaluates the costs of 100% hourly matching serves to generate the perception that hourly matching in general is prohibitively expensive. As explained previously in this comment, the vast majority of these costs come at the very end of the approach to 100% hourly matched clean energy. These costs can therefore be both unrepresentative of actual costs necessary to achieve significant hourly matched decarbonization (in the 80-90% range) and are subject to greater assumptions about costs of technologies like storage and clean firm which are necessary at scale to achieve 100% hourly matching levels.

Finally, this study admits that it does not give proper evaluation and analysis to how the entire market system and deployment decisions would change under an hourly REC market scenario: "If a large number of buyers competed for time-stamped RECs, prices could surge during scarcity hours. At the same time, in that scenario, market forces would likely drive investment in additional resources to increase REC supply. We do not capture these market dynamics in our analysis."

[18] PNAS, https://www.pnas.org/doi/10.1073/pnas.2211624119.

Support for other comments

EnergyTag supports some specific comments made in this docket from the following organizations.

Carbon Solutions Group

Carbon Solutions Group makes the correct points that, "A forward contract for hourly RECs would not only reduce administrative strain for utility buyers but the approach should also de-risk hourly REC procurement by stabilizing against price volatility." This hedging co-benefit of highly correlated hourly matching clean energy procurement has been studied, and the risk mitigation strategy of aligning hourly load with procured clean electricity on an hourly basis is one utilities should consider to meet obligations under hourly implementation of this law.[19]

EnergyTag also echoes the comment made regarding tighter deliverability zones driving greater decarbonization impacts, especially within Minnesota.

Center for Resource Solutions (CRS)

Similar to Carbon Solutions Group, CRS argues that Energy Attribute Certificates (EACs), which can exist in the form of Renewable Energy Certificates (RECs) are necessary for high integrity tracking and matching. EnergyTag agrees with this sentiment and encourages the use of its standards to support the interoperability of hourly EAC markets as they develop in parallel around the US.

Google

Google has communicated the importance of the PUC requiring hourly matching analyses in future Integrated Resource Plans. EnergyTag supports this proposal as a bare minimum for effective resource planning going forward.

Appendix 1

Institution	Studies
MIT	The influence of additionality and time-matching requirements on the emissions from grid-connected hydrogen production

[19] Eurelectric, https://www.eurelectric.org/news/247-hedging/.

Institution	Studies
Princeton University	"System-level Impacts of Voluntary Carbon-free Electricity Procurement Strategies Enabling grid-based hydrogen production with low embodied emissions in the United States System-level Impacts of 24/7 Carbon-free Electricity Procurement Electricity System and Market Impacts of Time-based Attribute Trading and 24/7 Carbon-free Electricity Procurement Short-run marginal emission factors neglect impactful phenomena and are unsuitable for assessing the power sector emissions impacts of hydrogen electrolysis
TU Berlin	Spatio-temporal load shifting for truly clean computing On the means, costs, and system-level impacts of 24/7 carbon-free energy procurement The value of space-time load-shifting flexibility for 24/7 carbon-free electricity procurement System-level impacts of 24/7 carbon-free electricity procurement in Europe Hourly versus annually matched renewable supply for electrolytic hydrogen
Denmark Technical University	Does the purchase of voluntary renewable energy certificates lead to emission reductions? A review of studies quantifying the impact
EPRI	Impacts of IRA's 45V Clean Hydrogen Production Tax Credit
International Energy Agency	Advancing Decarbonisation through Clean Electricity Procurement
Florence School of Regulation	Green hydrogen: - how grey can it be?