Rakon Energy Comments on Otter Tail Power Corporation

2019 Integrated Distribution Planning (IDP)

Background and Motivation

Rakon Energy background - Rao Konidena found Rakon Energy LLC because Rao is passionate about connecting clients to cost-effective solutions in energy consulting, storage, distributed energy resources, and electricity policy. Rao likes helping clients with his expertise in electricity policymaking, and U.S. energy markets.

Most recently, Rao was with Midcontinent ISO (MISO) as Principal Advisor for Policy Studies, working on energy storage and distributed energy resources. At MISO, Rao worked in management and non-management roles around resource adequacy, economic planning, business management, and policy functions.

The motivation behind these comments – In submitting these comments, Rakon Energy is not representing any client organization. Rakon Energy appreciates this opportunity to submit public comments on Otter Tail Power's 2019 Integrated Distribution planning (IDP) document.

The specific focus of these comments is on the Energy Storage System (ESS) cost estimates. Rakon Energy does not believe energy storage costs are $600,000 per MWh. Here are some data points on why the energy storage costs are lower than $600 per kWh.

1. Massachusetts Clean Energy Center (MassCEC) costs received via Information Request – Rakon Energy submitted an information request[1] to obtain one of the project cost information, for projects

[1] This is the wording used, " Hi, I want to know the cost of the energy storage system for the use case - Investor-Owned Utility (IOU) Grid Mod Asset, mentioned here - https://www.masscec.com/advancing-commonwealth-energy-storage-aces . The location is Shirley, MA. It's a National Grid project. I ask because I intend to verify this cost with cost estimates thrown around in Minnesota Integrated Distribution Plan (IDP) dockets.
Please specify clearly if I cannot use the cost values you have provided to me, if I am submitting my comments to MN Public Utilities Commission (PUC). In that case, I will specify to MN PUC that, "interested stakeholders can put in a request like I did and gather values for themselves". Thanks for your help! Rao

awarded under the Advancing Commonwealth Energy Storage. For a 500 kW/3,000 kWh, Vanadium Redox Flow battery, based on the cost data obtained, I get $315 per kWh considering the battery equipment and installation costs of $945,000 for a 3,000-kWh battery. If we include the costs for site preparation ($180,000), interconnection ($175,000), permits and engineering ($25,000), and education and outreach ($27,000), then the total cost per kWh is $450 per kWh, not $600 per kWh. See attached data received.

2. Lazard's costs – Please include and understand what most industry stakeholders are using these days for energy storage system costs. I am explicitly referring to Lazard's Levelized Cost of Energy and Levelized Cost of Storage 2019, released November 7, 2019[2]. Please also note the footnote (1) in public facing cost estimates for behind-the-meter applications. Lazard's is only estimating 25 cycles per year.
3. Independent costs estimate from Rakon Energy – I had personally interviewed six energy storage integrators and installers for the grid-scale system. Out of which, five have consented to release my notes with their names masked. These companies are referred to as Company A-E. Here are my notes; you will notice that energy storage costs range in the lower than $500 per kWh. And I am sure you would agree that distribution interconnection costs are less than transmission interconnection costs. Hence, energy storage connected at the distribution level should have a lower cost estimate.

Company	Answers
Company A	Cost – This depends on size and requirements, but we have sold projects between $400~800/kWh. (Battery cell is $100-150/kWh, Module is 30% of battery cell costs, Battery management system BMS is $25-50/kWh, Inverter is $25-50/kWh, and Balance of System BOS is $50/kWh)

[2] https://www.lazard.com/perspective/lcoe2019

	When we say, in the next 5 years – battery costs will fall, that cost decreases is seen in cells, module and BMS. Not in inverter and BOS. Battery cell costs are 90% of the time due to the active cathode made of Lithium. 2. The cycle life of a battery is totally dependent on the quality of the manufacturer. But overall, we have noticed a big difference between lithium-ion chemistries. NMC[3] typically gets 1500-2000 cycles before we have to replace or augment the project and LFP[4] typically gets to 3000-4000 cycles. We almost always suggest LFP chemistry on all of our projects. Project life is 15-20 years because with 1 cycle/day, you get more than 10 years. They add a new battery stack after 10 years, as part of the augmentation plan. Their BMS prioritizes new battery. The suggested SOC ranges from 10% - 90%. The battery life is dependent on C rate (how quickly battery charges and discharges), temperature it operates, and where it sits at C rate (they also suggest discharging the battery atleast once per day or every few days) Solar inverters and battery inverters are different in the sense that, for solar inverters – they are mostly constant current, and voltage varies with sun during the day. With the battery DC-DC inverters, voltage is constant and current changes.
Company B	Cost varies from project to project, it is related to the size, the enclosure type, the outdoor or indoor application, on-grid or off-grid etc. Generally speaking, it varies from $400-$600 and we normally have 20% of the price advantages over other competitors. When client asks for the price, we normally send a project request form and quote based on specific project.
Company C	Our products are all UL 1741 SA compliant. They have "augmentation" plan, so no need to oversize the battery. Samsung/LG are their suppliers for the most part for batteries. They replace out of lifecycle cells every 5 years. Battery life is dependent on degradation curve. We give warranty + performance guarantee for 20 years. Batteries are 60-70% of system costs. Today the prices are less than $400 per kWhr. GTM Research and WoodMac are excellent resources for prices research. Solar PPA doesn't have to be broken for storage, but storage capacity contract can be added on top of it.
Company D	http://newsroom.sdge.com/battery-storage-clean-innovative-reliable/sdge-spurs-energy-storage-innovation-flow-battery "Also, we are planning to launch new electrolyte-based system in 2021 to offer more affordable pricing to customers." Electrolyte and cell stack costs are 70-80% of total system costs. For 2021 in service date, they are taking orders now.

[3] Nickel Manganese Cobalt
[4] Lithium Iron Phosphate

Company E	The cheapest "All-in cost" is $250/kWh. Upper range can be as high as $2,000/kWh. Battery costs are typically $200-220 per kWh, Power conditioning System PCS at $30-100 / kW, controls are $10-15 / Kwhr, and Engineering, Procurement and Construction (EPC) is $30-300 /KWhr. The wide range for the last one because of, installation, commissioning, construction, permitting, site remediation, de-watering sites, regrading landscape. You also must figure out electricity consumption needs for station power, maintenance, warranty. You can use the inverter array to add new batteries. Regarding Lazards report on storage costs, some of the costs are higher because of smaller cycles like 50. If you are using the battery only for one service, then the costs are higher. ITC for storage reduces the paperwork for each storage unit. Otherwise, you have to ask IRS ruling for each storage project individually.

4. NREL costs – National Renewable Energy Laboratories has energy storage system costs with and without solar. That report might provide additional data points. Wesley Cole and A. Will Frazier authored a report titled, "Cost Projections for Utility-Scale Battery Storage", June 2019 found here[5]. This sentence in the Executive Summary caught my eye, "*the overall capital cost for a 4-hour battery system based on those projections, with storage costs of $124/kWh, $207/kWh, and $338/kWh in 2030 and $76/kWh, $156/kWh, and $258/kWh in 2050*[6]".
5. Xcel – Colorado costs – Xcel Energy did an all-resource solicitation that is much discussed in the industry. The costs for energy storage with solar here are much lower than expected according to industry sources. Does it make sense to compare notes with Xcel in Colorado?
6. Moon Island Energy Storage Costs – DNV GL prepared a report for The Massachusetts Clean Energy Center and the Boston Fire Department, released on September 26, 2018. This report is titled "Moon Island Energy Storage Design Feasibility Study." A copy of this report and other energy

[5] https://www.nrel.gov/docs/fy19osti/73222.pdf
[6] ibid

storage systems can be found here[7]. This report is cited because detailed costs are provided for each equipment into an energy storage system.

7. San Diego Gas & Electric (SDG&E) – SDG&E Emerging Technology Program department co-authored a report with Information & Energy Services, Inc, titled, "*Behind the Meter Battery Energy Storage System M&V Study, Study Results Report with Addendum 1*". This report was released August 1, 2019[8]. If it is OTP's concern that there is a lack of proper storage data – this SDG&E report contains a lot of operational data. Perhaps it is worth spending some time with SDG&E folks sharing notes on energy storage and thermal storage costs and functional details.
8. Connexus Energy costs – It is not clear to Rakon Energy if Connexus Energy was consulted, in terms of their energy storage system costs. Connexus has two 5 MW storage systems active in Minnesota.
9. Energy Storage Technology Assessment, Prepared for Public Service Company of New Mexico – This report prepared by HDR released on November 7, 2017, shows costs for energy storage in a transparent manner[9]. This report is the HDR Report No. 10060535-0ZP-C1001. This report focuses on both battery storage and other forms of energy storage. Perhaps it is worth spending some time with Public Service Company of New Mexico team who received this report.
10. PacificCorp DNV GL Energy Storage study – This report prepared by DNV GL[10] cites energy storage system costs in 2016 values. Industry stakeholders know the costs are much lower now compared to 2016. But the report shows all the cost components for various battery chemistries.

In light of the above sources of cost information, OTP needs a comprehensive framework to keep track of industry trends and transparently procure cost data. There are some examples in the industry today.

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[7] https://www.masscec.com/moon-island
[8] The report can be found here when searched for SDG&E, https://www.etcc-ca.com/reports/search
[9] Found here, https://www.pnm.com/documents/396023/1506047/11-06-17+PNM+Energy+Storage+Report+-+Draft+-+RevC.pdf/04ca7143-1dbe-79e1-8549-294be656f4ca
[10] DNV GL – Document No.: 128197#-P-01-A, Date of Issue: August 22, 2016. You can also find it here, https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2017-irp/2017-irp-support-and-studies/10018304_R-01-D_PacifiCorp_Battery_Energy_Storage_Study.pdf

1. Edison Electric Institute (EEI) – Otter Tail Power Company is listed as a member of EEI[11]. There are different resources available to OTP as a member of EEI, specifically on energy storage[12]. Shouldn't OTP leverage those resources and cost data, for the benefit of OTP's stakeholders?
2. Emerging Technologies Coordinating Council (ETCC) – If there is pushback to the EEI idea since it's a national association of IOUs and other electric utilities, how about forming a coordinating council for emerging technologies in Minnesota along the lines of ETCC in California? Please see the details provided here[13].

In conclusion, Rakon Energy appreciates this opportunity to provide comments on Otter Tail Power's 2019 Integrated Distribution Plan (IDP). Energy Storage costs are a cause for concern. However, it is possible to exchange cost information with other Minnesota utilities using an idea similar to ETCC.

[11] https://www.eei.org/about/members/uselectriccompanies/Pages/default.aspx
[12] https://www.eei.org/issuesandpolicy/Pages/EnergyStorage.aspx
[13] https://www.etcc-ca.com/