The Four Reasons Why Battery Storage Will Gain Traction in MISO and SPP

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Executive Summary

In 2021, front of the meter ("FTM") utility-scale battery storage will continue to grow rapidly in certain states and will begin to make a significant difference in some wholesale markets, most notably the California ISO ("CAISO"). By contrast, even though the interconnection queues for storage have been increasing in size in MISO and SPP, the practical impacts of battery storage are not likely to be reflected in these wholesale markets for the next few years. Energy storage is not cost competitive in MISO and SPP at this time; battery discharge times are insufficient; RTO market participation rules and/or supporting software systems have been delayed; and there has been no driving need for storage, because there has been ample low-cost, dispatchable generation to balance the variability of wind and solar resources. The lack of deployed storage in MISO and SPP to date was supported by client experiences during 22 MCR meetings in late 2019 and throughout 2020. By 2025, however, MISO and SPP will join CAISO in experiencing widespread adoption of storage as several factors take hold, including:

1) **Better-defined market rules and software changes.** Once RTO implementation rules are fully defined and software changes are implemented, consistent with each RTO's compliance filing under FERC Order 841, participants in large-scale storage will gain more clarity on the economic attractiveness and operating rules using storage as a supply resource and/or a transmission-only asset.
2) **Declining battery storage and renewables costs.** MCR forecasts that the low-end cost range of hybrid battery storage (batteries paired with solar) will decline by an average of about 14.3% per year through 2025, making it much more competitive with traditional dispatchable supply resources like combined cycle natural gas.

3) **Longer discharge duration and new battery technology.** Current battery discharge durations are only in the range of two to four hours and have typically applied to lower MW capacity battery systems. This will change in the next few years as battery technologies improve and battery systems get much larger and produce discharge durations of eight hours or more. Long-duration battery storage will play a key role in integrating renewable assets while supporting reliability.

4) **Expanding renewables and decarbonization goals.** Up to this point, most states in MISO and SPP have established modest renewable energy goals. More recently these goals have been made more robust along with regulatory and corporate desires to establish or enhance decarbonization goals and government tax incentives. As hybrid systems become more competitive with the marginal cost of combined-cycle natural gas and coal, the cost of decarbonization will become more palatable to most utilities. As more coal plants and older natural gas plants retire, consistent with decarbonization goals, storage will provide a likely replacement for dispatchable traditional generation to ensure a reliable system.

In MISO and SPP, storage will mainly be used as a supply resource rather than solving a specific transmission issue. A storage facility will not qualify as a transmission-only asset unless it is needed to resolve a discrete, non-routine transmission need. The increase in storage capacity as a supply resource is more likely to complement rather than displace the need for new transmission investment, as a robust transmission system will still be needed to move power and provide ancillary services, especially in times of extended unavailability of non-dispatchable energy. Despite the projected, remarkably high-growth rate of utility-scale battery storage, it will have increasing competition from behind the meter ("BTM") aggregated distributed energy resources ("DERs") bidding into the wholesale market as part of FERC Order 2222. Utilities need to be preparing now for both FTM and BTM storage applications. MCR recommends utilities develop a strategy to:

1) Monitor advancements in storage and hybrid technologies.
2) Participate in the definition of RTO market participation rules for FERC Orders 841 (SPP members only) and 2222 (SPP and MISO members).
3) Determine the resource planning role storage can play in renewables and decarbonization goals for each utility.
4) Examine the wholesale revenue streams and the economic value FTM storage can bring as a supply resource and as a standalone transmission asset.
5) Examine how traditional transmission investment can complement storage investment.
6) Assist customers (or members) in BTM storage applications.
7) As applicable, plan for the retail regulatory treatment (and the profitability impact) of FTM storage.

Once growth starts accelerating in MISO and SPP, it will be very difficult to keep up and meet both the opportunities and challenges that lie ahead if utilities are not prepared.

Storage is Taking Off … but Not Yet in MISO and SPP

The official term used for storage as defined by FERC is an electric storage resource ("ESR"). An ESR is "a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid."[1] FERC stated that this definition applies regardless of their storage medium (e.g., batteries, flywheels, compressed air, and pumped hydro). Additionally, the Commission stated that ESRs located on the interstate transmission system, on a distribution system, or behind the meter fall under this definition. Some ESRs are co-located with renewable energy resources and charge from those resources. Others, however, are sited as stand-alone units and obtain their charge from the grid. The ability of ESRs to inject stored energy into the grid and to follow dispatch instructions quickly and accurately make them capable of resolving reliability problems and acting as an alternative to traditional generation. An ESR such as battery storage can respond instantaneously to grid events to help balance supply and demand and can offer a company several streams of wholesale revenue, as discussed later in this paper.

MCR validated this lack of implemented storage in MISO & SPP through 22 face-to-face and online meetings with various MISO and SPP public power and cooperative clients.

Although the generation interconnection queues in MISO and SPP are growing with proposed battery storage projects, there has been very little FTM battery storage deployed thus far. MCR validated this lack of implemented storage in MISO and SPP through 22 face-to-face and online meetings with various MISO and SPP public power and cooperative clients starting in late 2019 and lasting throughout 2020. Our clients in MISO and SPP confirmed they are seeing little FTM storage deployed in their service territories to date (either as a supply source or a transmission-only asset). Only a couple clients mentioned any storage projects being planned either on their distribution system or BTM. Many clients suggested that two fundamental reasons were driving this current lack of battery projects. First, the MWh discharge duration capacity for batteries is too short (e.g., too little MW capacity with too few hours of power). Second, the cost premium over alternative supply sources was too great for storage projects to be economic.

There was a surge in nationwide storage deployments of 240% in the third quarter of 2020.

This lack of deployed storage in MISO and SPP contrasts with other selected areas of the country, particularly the west and southwest where storage as a supply source (capacity, energy, and ancillary services) is growing exponentially. A report from Wood Mackenzie and the Energy Storage Association says there was a 240% surge in nationwide storage deployments in the third quarter ("Q3") of 2020 as compared to Q3 2019. 230% of the increase was attributable to FTM deployments.[2] Nationwide, FTM (largely utility scale) storage deployments were about 400 MW in Q3 2020 as compared to 75 MW of BTM (both residential and commercial/industrial) deployments. The BTM deployments showed little growth

[1] FERC Order No. 841, 162 FERC ¶ 61,127 at P 29.

[2] "US Energy Storage Market Shatters Records in Q3 2020," *Energy Storage Association*, December 2, 2020.

year-over-year. Through Q3 2020, total new storage deployments were about 750 MW compared to 523 MW for all of 2019. According to Lazard, utility scale storage paired with solar has a two-thirds levelized cost advantage over BTM industrial/large commercial storage paired with distributed solar, which contributes to a disparity in the amount of deployed FTM vs. BTM.[3]

Wood Mackenzie is forecasting storage growth of 42% per year from 2020 to 2025.

Wood Mackenzie forecasts significant growth in the energy storage market (FTM and BTM) will occur in the US between now and 2025. Specifically, they are forecasting an increase from 1,275 MW in 2020 to 7,473 MW in 2025 – a growth rate of 42% per year, resulting in about 26,500 MWh of new discharge capability. This growth will be driven primarily by large-scale utility procurements. Solar-paired battery storage will account for a large majority of these installations, as developers aim to capture value from the federal Investment Tax Credit.[4] Wood Mackenzie forecasts that by 2025, the cumulative battery storage capacity will be 27,500 MW.[5] Building on a breakout 2020 year for U.S. energy storage developers, the storage industry has released a roadmap for the addition of 100,000 MW of new storage resources by 2030. "The role energy storage can and will play in enabling the transition of electricity generation from fossil to renewable sources has come into focus," the U.S. Energy Storage Association said in a report published in August 2020.[6]

As battery prices continue to fall and the penetration of variable wind and solar generation rises, power plant developers across the US are planning or pursuing projects that combine wind or solar generation with onsite batteries, creating hybrid power plants. Storage, when co-located with low-cost generation, can provide an economic energy source for dispatch into an RTO energy market. The U.S. Energy Information Administration ("EIA") reports that the number of hybrid solar and wind generation sites co-located with battery storage systems in the country has increased from 19 paired sites in 2016 to 53 sites in 2019.[7] Data reported for proposed projects suggest that the number of co-located sites may double from 2019 levels by 2023.[8] The benefit of paired resources is the ability

[3] "Levelized Cost of Energy and Levelized Cost of Storage – 2020," *Lazard*, October 19, 2020. See last page entitled Unsubsidized Levelized Cost of Storage ("LCOE") Comparison-Energy ($/MWh); LCOE range for front of the meter storage paired with solar = $81 to $140 per MWh for a 50 MW/200 MWh compared to the LCOE of $247 to $319 per MWh for a 0.5 MW/2MWh C/I storage paired with solar. ($247-$81)/$247 = 62%.

[4] Energy Storage Association, "US Energy Storage Market Shatters Records in Q3 2020," News Release, December 2, 2020. The solar investment tax credit, which was scheduled to drop from 26% to 22% in 2021, will stay at 26% for two more years. The wind industry also received a limited extension of its production tax credit. All market segments (i.e., residential, commercial, industrial, utility-scale) that begin construction in 2021 and 2022 will still be able to receive a tax credit at 26%. All markets will drop to a 22% tax credit in 2023. The residential market will drop to 0% while the commercial and utility markets will sit at a permanent 10% credit beginning in 2024. Source: *Solar Power World*, December 28, 2020.

[5] "US energy storage industry aims to add 100 GW by 2030," *S&P Global Market Intelligence*, August 24, 2020.

[6] Ibid. References the Energy Storage Association report titled, "100 x 30: Enabling the Clean Power Transformation," August 2020.

[7] Energy Information Administration, *Battery Storage in the United States: An Update on Market Trends*, July 2020, page 27.

[8] Ibid., page 27.

to take advantage of common onsite infrastructure to store renewable-generated energy produced during periods of low electricity prices and low demand, and later supply that stored energy to the grid when both demand and electricity prices are higher.

So where is this growth in storage taking place? Below we discuss some key states that are driving the deployment of large-scale storage.

California

Most of the recent utility scale deployments of storage have been in California and are designed to take advantage of the large amount of excess, low-cost solar generated during the day[9] that can be stored for discharge as the sun sets, thereby meeting peak demand and capitalizing on higher prices in the evening. Average CAISO prices are relatively high,[10] partly due to frequent demand peaks, making the economics of battery installations more attractive. An example of one large California project is the 300-MW Moss Landing battery storage project in Monterey that went in-service in January 2021. The 100-MW second phase is under construction and will be operational by August 2021. The project is scalable up to 1,500 MW/6,000 MWh (four-hour discharge duration) should "market and economic conditions support it."[11] The battery will store excess electricity from the grid and will make it available during peak hours and when solar power generation is declining, usually early morning and late afternoon. The storage project has secured a long-term resource adequacy contract with PG&E Corp.[12] Southern California Edison recently signed contracts for four projects totaling 590 MW of battery energy storage expected all to be online by August 2023.[13] CAISO expects more than 1,500 MW of storage capacity by the end of 2021. As of November 1, 2020, CAISO had 535 MW of stand-alone or hybrid (i.e., paired, co-located storage with solar/wind resources) battery storage, up from 136 MW at the beginning of 2020. As of early October 2020, more than 4,600 MW of storage was under active development in California, much of it associated with solar farms, according to S&P Global Market Intelligence data.[14] This initial development is part of a much larger pool

As of November 2020, CAISO had 535 MW of stand-alone or hybrid storage, up from 136 MW at the beginning of 2020, and expects more than 1,500 MW by the end of 2021.

[9] CAISO, "Largest battery storage system in US connects to California ISO grid," News Release, July 13, 2020.

[10] Energy Information Administration, *Today in Energy*, https://www.eia.gov/todayinenergy/prices.php (accessed January 7, 2021). It shows CAISO average spot prices of two hubs of $36.87/MWh vs. $29.36/MWh for the Midwest. See also Figure 9 Energy Information Administration, "*FERC State of the Markets*," March 19, 2020, and EIA Electricity Monthly Update, *Regional Wholesale Markets*: October 2020.

[11] "Vistra connects 300-MW battery to grid in California," *S&P Global Market Intelligence*, January 6, 2021.

[12] "Moss Landing Battery Storage Project battery energy storage system ("BESS")," *NS Energy*, https://www.nsenergybusiness.com/projects/moss-landing/ (accessed January 12, 2021). In June 2018, PG&E submitted a proposal to the CPUC for a 20-year energy storage resource adequacy agreement with Vistra Energy for Moss Landing BESS. The CPUC granted approval for the contract in November 2018. Vistra Energy proposed to expand the existing Moss Landing energy storage facility by an additional 100-MW capacity in May 2020. The company entered a ten-year resource adequacy agreement pertaining to the Moss Landing BESS capacity expansion with PG&E in the same month.

[13] "Southern California Edison to add 590 MW of energy storage capacity," *S&P Global Market Intelligence*, December 7, 2020.

[14] Ibid.

of proposed battery storage in the CAISO total interconnection queue over the next several years, including roughly 43,000 MW of photovoltaic solar paired with 35,000 MW of storage, as of November 23, 2020. Storage plays a key role in meeting California's 60% renewables goal by 2030.[15] Batteries can help take the place of natural gas generation by charging during times of oversupply and storing the energy for use during the late afternoon and evening hours.[16] In addition to FTM storage, the need for maintaining power during public safety power supply interruptions are promoting BTM rooftop solar with battery storage.

Nevada

As of August 2020, nearly 4,000 MW of new solar and energy storage resources were expected to be in service in Nevada by 2023,[17] including the proposed massive Pantheon Solar Project with 1,000 MW of solar photovoltaic generating capacity and 1,000 MW of battery energy storage. In addition, EDF Renewables has signed a 22-year power purchase agreement with NV Energy for a 200-MWAC[18] solar project coupled with a 180 MW, four-hour battery storage system (720 MWh).[19] Indeed, in July 2020, NV Energy proposed to construct more than $1 billion of new high-voltage transmission infrastructure — namely, the Greenlink projects that the utility expects to provide pathways for solar and storage development.[20]

Colorado

Regarding the storage market in public power, Moody's pointed to plans by several public power utilities to install "battery storage systems totaling more than 1,300 MW to be paired with renewable energy projects."[21] Colorado Springs Utilities announced that it would power down all its coal-fired power generation by 2030 and add slightly over 400 MW of battery storage.[22] Colorado electric cooperative, Holy Cross, recently announced it has increased its carbon-free power procurement target from 70% to 100% by 2030. Holy Cross suggested that energy storage would be key to achieving 100% carbon-free power, through both "large grid-tied resources" and smaller ones such as

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[15] National Conference of State Legislatures, *State Renewable Portfolio Standards and Goals*, January 4, 2021.

[16] CAISO, "Largest battery storage system in US connects to California ISO grid," News Release, July 13, 2020.

[17] "A look at new solar, energy storage capacity planned in Nevada," *S&P Global Market Intelligence*, August 17, 2020. Since 2018, the NV Energy utilities have contracted for 2,216 MW of solar coupled with 1,016 MW of planned energy storage and another 400 MW of stand-alone solar expected online by 2023, according to S&P Global Market Intelligence data as of July 24, 2020. The company intends to own another 150 MW of solar and 100 MW of storage resources, adding a total of 2,769 MW of solar and 1,116 MW of storage.

[18] Megawatt Alternating Current ("MWAC") is a measure of the power output from a solar installation after the output of the PV panels have been converted to AC via inverter devices.

[19] Per the EIA July 2020 Study, Figure 4, duration is calculated by dividing nameplate energy capacity (in MWh) by maximum discharge rate (in MW), except in cases where the maximum discharge rate is not available, whereby nameplate is used instead. 720 MWh/180 MW = 4 hours.

[20] "Nevada continues to be a mecca for solar, storage project developers," *S&P Global Market Intelligence*, October 14, 2020.

[21] "Moody's Public Power Outlook Report," *Moody's Investor Services*, December 7, 2020.

[22] "Colo. municipal utility to retire all coal-fired power generation by 2030," *S&P Global Market Intelligence*, June 26, 2020.

electric vehicle batteries.[23]

Minnesota

In 2018, Great River Energy ("GRE") committed to supply their member-owner cooperatives with energy that is 50% from renewable resources by 2030. GRE plans to phase out its remaining coal resources, add significant renewable energy, and partner with Form Energy on its grid-scale battery technology.[24] In 2019, Rochester Public Utilities committed to 100% renewable energy by 2030 supplemented by either storage or a gas peaker.[25]

Nebraska and Oklahoma

In the SPP Generation Interconnection queue, Omaha Public Power District has listed 430 MW of battery storage projects and Western Farmers has listed 40 MW of storage, both with in-service dates by 2022.[26] Additionally, on December 17, 2020, Western Farmers, together with a subsidiary of NextEra Energy Resources announced the completion of the first phase of the largest project of its kind in the country that combines wind, solar and storage in the same location. This facility, called the Skeleton Creek Project, began the operation of 250 MW of wind energy on December 16, 2020. Skeleton Creek will add 250 MW of solar energy coupled with 200 MW of 4+ hours of battery storage, expected by the end of 2023.[27]

Other States

Texas, Arizona, New York, and Massachusetts are FTM storage leaders with rapid growth also expected in New Mexico, Colorado, and Oregon.[28] Much of the storage growth in these states is driven by policy actions and mandates. For example, New York has energy storage goals of 1,500 MW by 2025 and 3,000 MW by 2030, as part of its ambitious goal of 70% renewables by 2030 and 100% zero-emissions electricity by 2040.[29] Along with its 35% renewables portfolio standard by 2030, Massachusetts established a 1,000 MWh energy storage target for each electric distribution company to be achieved by December 31, 2025 and is proposing a 45% greenhouse gas emissions reduction by 2030.[30]

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[23] "Colo. co-op ups the ante on green goals, sets 100% by 2030 carbon-free target," *S&P Global Market Intelligence*, December 16, 2020.

[24] "Form Energy Announces Pilot with Great River Energy," *Renewable Energy Magazine*, May 11, 2020.

[25] Rochester Public Utilities, "RPU Board selects 100% renewable energy by 2030 scenarios," News Release, July 23, 2019.

[26] *Southwest Power Pool Generation Interconnection Queue,* SPP, http://opsportal.spp.org/Studies/GIActive (accessed December 23, 2020).

[27] Red River Valley Rural Electric Association, "Largest Combined Wind, Solar & Energy Storage Facilities," News Release, December 17, 2020.

[28] "Utility-scale energy storage industry 'blossoming' in several US states," *Guidehouse*, July 21, 2020. States with energy storage deployment targets requiring utilities to procure energy storage include New York, New Jersey, California, Nevada, Massachusetts, Oregon, and Virginia.

[29] New York State, *Energy Storage*, https://www.nyserda.ny.gov/All%20Programs/Programs/Energy%20Storage (accessed January 12, 2021). See also "New York State Moves to Tackle Grid Decarbonization," *Acadia Center*, July 27, 2020.

[30] State of Massachusetts, *Energy Storage Initiative*, https://www.mass.gov/energy-storage-initiative (accessed January 12, 2021). See also State of Massachusetts, *Request for comment on clean energy and climate plan for 2030*, December 30, 2020,

Why has Storage Not yet Gained Traction in MISO and SPP?

Battery storage has not yet taken off in MISO and SPP due to the higher cost of batteries vs. alternatives, delayed market participation rules/software changes, limited battery capacity/duration and plentiful lower cost dispatchable generation.

Despite the growth of storage in some areas of the country, there has been very little deployed battery storage in MISO and SPP.[31] Battery storage has not yet taken off in MISO and SPP due to the higher cost of batteries vs. alternatives, delayed market participation rules and/or related software changes, limited battery discharge capacity and duration, and plentiful levels of lower cost dispatchable generation to complement the variability of wind and solar power. Each of these obstacles is discussed below and shown in Figure 1 on the next page.

High Cost of Battery Storage Relative to Market Prices

Although many states in the MISO and SPP footprints have renewables goals, these goals are generally modest[32] and there are currently more cost-competitive alternatives than battery storage to meet these goals (e.g., wind backed up by system-wide combined cycle units). A recent analysis by Lazard is instructive. Lazard's calculation of the levelized cost of energy ("LCOE") for a utility-scale solar project paired with 50-MW battery storage with a four-hour discharge capability is $81/MWh to $140/MWh.[33] This compares with the much lower unsubsidized levelized onshore wind cost of only about $26/MWh to $54/MWh and the unsubsidized marginal cost for a gas combined cycle unit of $23/MWh to $32/MWh[34] (assuming gas price of $3.45/MMBtu). Given that the current natural gas price in the Midwest is about $2.65,[35] the marginal cost advantage to a combined cycle unit is even more pronounced.

The low cost of output from existing combined cycle natural gas units and wind turbines are reflected in the low market prices in SPP and MISO. In fact, SPP had the lowest 2019 average wholesale power spot price in the country of

[31] As of the end of 2018 (last available year of EIA data), there was only 39 MW of large-scale battery capacity installed in MISO and none in SPP as of the end of 2018. Source: Energy Information Administration, *Battery Storage in the United States: An Update on Market Trends*, July 2020, page 2. Large-scale refers to systems that are grid connected and have a nameplate power capacity greater than 1 MW. Note, these include BTM applications. The EIA battery storage report does not show any large-scale battery storage in SPP. Also see "2021 US Renewable Energy Outlook," *S&P Global Market Intelligence*, January 2021, page 18 showing very little in-service storage in MISO and SPP.

[32] "State Renewable Portfolio Standards and Goals," *National Conference of State Legislatures*, December 11, 2020. Many MISO and SPP states have renewable portfolio goals of 10% to 15%; Minnesota is the exception with a renewables goal of at least 25%.

[33] "Levelized Cost of Energy and Levelized Cost of Storage – 2020", *Lazard*, October 19, 2020, Version 14.0, see page entitled, "Levelized Cost of Energy Comparison—Unsubsidized Analysis and Unsubsidized Levelized Cost of Storage Comparison (Energy $/MWh)." Industry LCOE cost comparisons can vary depending on assumptions related to capacity factors, discharge duration, geography, charging costs, O&M, equipment technology, taxes, tax incentives, equity percentage, return, service life, and inflation. Lazard's analysis determines the LCOE on a $/MWh basis that provides an after-tax IRR to equity holders equal to an assumed cost of equity capital. Assumes 60% debt financing at 8% interest rate and 40% equity at 12% equity cost. Also see "Lazard's Levelized Cost of Energy Analysis—Version 14.0," *Lazard,* October 2020, pages 14, 20.

[34] "Levelized Cost of Energy and Levelized Cost of Storage – 2020", *Lazard*, October 19, 2020, Version 14.0, see page entitled "LCOE Comparison—Renewable Energy vs. Marginal Cost of Selected Existing Conventional Generation."

[35] Energy Information Administration, *Today in Energy*, https://www.eia.gov/todayinenergy/prices.php (accessed January 18, 2021).

Figure 1
Obstacles to Storage Gaining Traction in MISO and SPP

<table>
<tr><th>Obstacle</th><th colspan="2">Description/Comments</th></tr>
<tr><td>1. High Cost of Battery Storage Relative to Market Prices</td><td colspan="2">● Low marginal cost of combined cycle natural gas.
● Little/no wholesale revenue stream in SPP until storage rules in place.</td></tr>
<tr><td>2. Delayed Market Participation Rules and/or Related Software Changes</td><td><u>MISO</u>
● Storage-related software changes.
● Other major market and reliability software enhancements MISO currently faces (e.g., related to short-term reserve market).</td><td><u>SPP</u>
● Teams working through 37+ issues related to storage implementation.
● Storage-related software changes.
● Need to address storage as a transmission-only asset first.
● Tariff revision process and Section 205 filings are required for any changes to baseline tariff to address FERC Order 841 compliance.</td></tr>
<tr><td>3. Limited Battery Discharge Capacity and Duration</td><td colspan="2">● At this point, most in-service battery discharges are only up to two hours, with up to 50 MW capacity.
● Current discharge durations are not sufficient to reliably meet peak demand.</td></tr>
<tr><td>4. Ample Lower Cost Dispatchable Generation to Support Variable Renewables</td><td colspan="2">● The ready availability of low-cost, dispatchable generation in SPP and MISO to date has made the economics and reliability of storage less attractive.</td></tr>
</table>

$30.43/MWh, with MISO close by at $31.23/MWh (MISO Indiana Hub).[36] The averages of independent purchase power deals in the third quarter of 2020 were $28.10/MWh for SPP and $31.20/MWh for MISO,[37] much lower than building a new battery storage system paired with solar. It is currently more economically beneficial for market participants to purchase RTO energy or negotiate a purchase power energy deal rather than build new storage as a supply source. As a result of its relatively high levelized cost of energy, battery storage is more

[36] SPP, "Report: SPP had lowest average wholesale electricity prices nationwide in 2019," News Release, June 16, 2020. By contrast, the average of the two California hubs was $38.55.

[37] "Solar PPA prices in the US rise for the second consecutive quarter — after 18 months of decline," *PV Magazine*, October 16, 2020. Original source: LevelTen Energy's Q3 2020 PPA Price Index report.

As a result of its relatively high levelized cost of energy, battery storage at this time is more likely to be used in MISO and SPP as a proxy supply peaker.

likely to be used in MISO and SPP in the near term as a proxy supply peaker. According to Lazard, gas peakers have a levelized cost of $151/MWh to $198/MWh,[38] higher than hybrid electric storage units.

Most battery systems installed up to this point, however, have had limited discharge duration and MW capacity, which creates both operational and financial challenges in comparison to gas peakers that can run 24/7. The operational challenges of battery storage meeting peak requirements for a sustained period were echoed by many MCR clients, who said the limited discharge duration of storage currently makes them impractical to consistently meet demand spikes.

Keep in mind, however, when evaluating the financial attractiveness of battery storage, one must also look beyond levelized cost and consider the potential wholesale revenue streams from storage, once the market participation rules (see discussion below) are implemented. These revenue streams can include:

- Energy arbitrage – storage of inexpensive electricity to sell at a higher price later. For example, storing energy from paired wind/solar or taking energy from the grid when prices are low or negative at night, and selling it back to the market during the day when prices are higher.
- Resource adequacy – capacity to meet generation requirements at peak load in a region.
- Demand response – managing high wholesale prices, congestion or emergency conditions (if managing congestion is allowed under the RTO market power rules).
- Frequency regulation – immediate power to maintain supply-load balance.
- Spin/non-spin reserve – maintenance of electricity output during unexpected contingency event immediately (spin) or on short notice (non-spin).[39]

Battery storage has been slowed down in SPP and MISO due to delays in development of market participation rules and/or related software changes.

Delayed Market Participation Rules and/or Related Software Changes

In addition to its relatively high levelized cost, battery storage has been slowed down in SPP and MISO due to delays in the development of market participation rules and related software (in SPP) and extensive delays related to software changes in MISO. In February 2018, FERC issued Order No. 841,[40] requiring system operators to remove barriers to the participation of electric storage

[38] "Levelized Cost of Energy and Levelized Cost of Storage – 2020", *Lazard*, October 19, 2020, Version 14.0, see page entitled "Levelized Cost of Energy Comparison—Unsubsidized Analysis."

[39] Excerpted from Lazard "Levelized Cost of Energy and Levelized Cost of Storage," *Lazard*, November 2018, Version 4.0, page 17.

[40] Order No. 841 requires each RTO/ISO to revise its tariff to establish a participation model for electric storage resources consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, will help facilitate their participation in the RTO/ISO markets. Specifically, for each RTO/ISO, the tariff provisions for the participation model for electric storage resources must: (1) ensure that a resource using the participation model is eligible to provide all capacity, energy, and ancillary services that it is technically capable of providing in the RTO/ISO markets; (2) ensure that a resource using the participation model can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer consistent with existing market rules that govern when a resource can set the wholesale price; (3) account for the physical and operational characteristics of electric storage resources through bidding parameters or other means; and (4) establish a minimum size requirement for…

resources in the capacity, energy, and ancillary services markets ("supply resources"), finding that storage will enhance competition.[41] Each ISO/RTO under FERC jurisdiction was required to revise its tariff to include market rules that recognize the physical and operational characteristics of storage resources on the transmission system and to implement the revisions upon FERC's approval of the compliance tariff.

Each ISO/RTO must develop a model to integrate larger (greater than 100 kW) electric storage in wholesale markets, including its impact on energy, capacity, and ancillary market services. Order 841 covers ESRs located on either the transmission or distribution system. MISO defines ESRs as a resource capable of receiving energy from the transmission system and storing it for later injection of energy back to the transmission system. It also includes a process for an ESR on the distribution system to deliver its energy to the transmission system. Order 841 does not lay out the requirements for storage as a transmission-only asset ("SATOA") as FERC decided to allow each RTO to request its own handling of SATOAs.[42] A SATOA is operating not to provide energy but to provide reliability. Further, a SATOA is held by a transmission owner, not a market participant.

Each ISO/RTO must develop a model to integrate larger (greater than 100 kW) electric storage in wholesale markets.

Delayed SPP Market Participation Rules. FERC approved SPP's baseline storage tariff to address Order 841 compliance in October 2020 but granted SPP a delay in implementing its participation rules due to SPP's ongoing delays in the development of a new market and transmission settlement system, as well as software changes associated with the FERC order. SPP argued that the requested deferral would not materially impact the ability of ESRs to participate in SPP's markets, since nearly all ESRs seeking to interconnect to its transmission system are undergoing generator interconnection ("GI") studies not expected to be complete until the beginning of 2022. A GI study determines the transmission upgrades needed to connect new generation, including ESRs, to the electric grid. In accepting SPP's deferral request, FERC ordered a new effective date of August 5, 2021, for SPP's Order 841 tariff changes.[43]

In July 2019, SPP's board of directors approved a recommendation from their Holistic Integrated Tariff Team to draft a white paper to help the organization

…participation in the RTO/ISO markets that does not exceed 100 kW. Additionally, each RTO/ISO must specify that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale locational marginal price.

[41] Examples of electric storage resources are all technologies and/or storage mediums, including but not limited to, batteries, flywheels, compressed air, and pumped hydro resources. The rule also establishes a small utility opt-in. Specifically, it prohibits grid operators from accepting bids from the aggregation of customers of small utilities whose electric output was 4 million megawatt-hours or less in the preceding fiscal year, unless the relevant retail regulatory authority for a small utility allows such participation. The rule explains that state and local authorities remain responsible for the interconnection of individual DERs for the purpose of participating in wholesale markets through a DER aggregation.

[42] FERC Order 841, 162 FERC ¶ 61,127 at PP 329, 331 (finding that issues protesters raised with respect to compensation or cost recovery under the 2017 Policy Statement are out of scope). See also MISO SATOA order, MISO Docket ER20-588, August 10, 2020, page 67.

[43] "FERC Permits SPP to Delay Implementing Storage Resource Participation Rules Until August 2021," *Washington Energy Report*, March 10, 2020.

further understand ESRs, their expected role and impact, and how SPP can plan for and utilize storage moving forward. The January 2020 SPP storage white paper laid out a whopping 37 issues to be addressed. These issues include, for example, cost allocation and cost recovery for energy and capacity facilities vs. transmission-only storage; the MW capacity that hybrid facilities, such as solar paired with battery storage, should be able to inject into the grid (i.e., only the storage MW amount or both the solar and storage MW); and the technical voltage/stability impact of injecting storage into the system. Teams have been working on the higher priority issues and identified several additional issues, while deferring the multi-use ESR issues.

The January 2020 SPP storage white paper laid out a whopping 37 storage-related issues to be addressed.

Multi-use issues involve how a storage resource can act both as a transmission asset and a supply resource (e.g., energy and capacity). SPP has deferred these multi-use issues as they first must determine how to handle the transmission-only assets, i.e., the SATOAs. A SPP Steering Committee will decide early in 2021 whether to address multi-use storage facilities at all and if so, the timing of when the issues will be addressed. Up to this point, no RTO/ISO has an approved a tariff for addressing multi-use storage facilities, so much work remains. SPP has also seen an uptick in SATOA studies (as part of the transmission planning process), but these projects have generally not been more beneficial than more traditional alternatives to solve transmission issues.

It will take well into 2021 for SPP to address the nearly 40 storage issues. As the issues are addressed, they will work through the SPP stakeholder process and will eventually have associated SPP revision requests to the tariff, prompting potential changes to the approved baseline storage tariff and thus requiring an additional corresponding FERC Section 205 filing(s).

Delayed MISO Software Changes. On November 21, 2019, FERC approved MISO's initial compliance filing to address Order 841 requirements regarding storage as a supply resource with an effective date of June 6, 2022, as requested.[44] FERC ruled that MISO's filing complies "with the requirements of Order No. 841 because it encompasses electric storage resources capable of receiving electric energy from the grid and storing it for later injection back to the grid, regardless of their storage medium. MISO's filing includes electric storage resources located on the interstate transmission system, on a distribution system, or behind the meter."[45] On October 29, 2020, MISO finalized the compliance filings and FERC approved the storage tariff changes and the June 6, 2022 implementation date.[46] FERC consented to the delay and agreed with MISO's statement that it must re-plan the development and implementation of the ESR-related systems and software, given the delays in obtaining approval on the compliance filing and other major market and reliability enhancements it currently faces, such as the short term reserve market. MISO's 841 filing was based on its previous Storage Energy Resource ("SER") – Type II filing approved by FERC in 2018 (Docket ER17-1376) in response to a complaint from

[44] FERC Order on MISO 841 Compliance Filing, FERC Docket ER19-465, November 21, 2019.
[45] Ibid., page 32.
[46] FERC Docket ER19-465, approved by letter order on December 2, 2020.

Indianapolis Power & Light, which argued the MISO tariff did not adequately accommodate and compensate battery storage. MISO's Order 841 compliance filing expanded on its SER filing, which prompted changes to its business practices manuals. MISO argued that its much-delayed effective date of June 2022 would not harm the storage participants that emerge from the interconnection queue that wanted to go active prior to that time, because they could use the SER Type II tariff. Thus, MISO has largely already defined its market participation rules for Order 841, but still must design and implement extensive software changes.

Separate from these filings that address storage as a supply resource, MISO submitted a SATOA filing in December 2019, which was approved by FERC effective August 11, 2020.[47] These changes to the MISO tariff provide for some types of storage to be treated as transmission-only assets for transmission planning and project selection. In other words, certain battery storage projects will now be able to participate as a non-wires solution to transmission issues[48] by rapidly discharging energy or even reactive power to bolster areas with low voltage. The anticipated fast discharge capability of SATOA make them uniquely positioned to reduce voltage instabilities and cascading events, and the resulting hours at risk for load loss. A SATOA may be operated by MISO to avoid load shedding in declared emergency conditions. Per the MISO filing, storage facilities must meet certain criteria to be approved as a SATOA:

In MISO, a storage facility will not qualify as a SATOA unless it is needed to resolve a discrete, non-routine transmission need.

- A storage facility will not qualify as a SATOA under the tariff unless it is needed "to resolve a discrete, non-routine transmission need (such as N-2 or voltage stability issue) that only can be addressed by an asset under MISO's functional control, and not by a [supply] resource operating in MISO's markets."[49]
- "(A) SATOA will generally be selected to address lower probability, more infrequent contingencies (i.e., non-N-1 contingencies) or stability issues"[50] rather than, for example, the re-dispatching of market resources used to address N-1 thermal issues.

A MISO transmission owner that develops a SATOA will need to make a Section 205 filing to update its Attachment O with a line item to ensure any revenues or expenses associated with the discharging and charging of the SATOA are treated in a manner consistent with the treatment of costs associated with the project category in transmission rates, such as a Baseline Reliability Project, an "Other" Project, etc.[51] A transmission-only facility recovers its costs with an

[47] MISO SATOA Compliance Filing, Docket ER20-588, August 10, 2020. FERC approved the filing on November 5, 2020 via letter order.

[48] A transmission issue is defined in the MISO tariff as a reason to improve, expand or modify the Transmission System, e.g., address NERC violations or transmission owner reliability standards.

[49] The N-1 criterion is a minimum system security measure that the System Operator should model the transmission network to address redundancy avoiding potential power interruptions and/or system failure. For the N-2 (or N-1-1) criterion, two component outages are applied sequentially rather than simultaneously. It is defined based on the North American Electric Reliability Corporation ("NERC") guidelines where there is loss of one component followed by the loss of a second component. N-0 is normal operations.

[50] MISO SATOA Compliance Filing, Docket ER20-588, August 10, 2020, page 97.

[51] Ibid., page 21.

annual transmission revenue requirement ("ATRR").

MISO is currently the only RTO with an approved SATOA tariff.[52] Now that the Commission approved MISO's SATOA proposal, MISO can include SATOA projects in the MISO Transmission Expansion Plan ("MTEP"), allowing battery storage to participate in MISO's transmission planning process.[53] The number of SATOA projects are likely to be limited, however, as the tariff reserves SATOA projects as those addressing N-2 contingencies. All single contingency events to relieve congestion or the overloading of transmission lines will be addressed through market solutions, such as the re-dispatching of generation rather than SATOAs. Thus, it is likely that MISO and FERC's narrow SATOA definition (i.e., addressing only non-routine transmission problems) will lead to few storage projects qualifying as SATOAs in MISO. It is likely that many other RTOs, including SPP, will pattern their SATOA tariff based on the MISO tariff.

The limited battery discharge duration of existing in-service batteries does not meet the needs for the vast majority of utilities.

Limited Battery Discharge Capacity and Duration

The vast majority of batteries in-service through 2018 in MISO have up to two hours of discharge duration.[54] These batteries might provide some ability to shave peak demand for some industrial/large commercial customers, but the limited battery discharge duration of existing in-service batteries does not meet the needs for the vast majority of utilities. "Most utilities seem to want much longer-duration storage systems, with 6 to 12 hours discharge, to do serious load-shaping over the day," suggests an analyst at a U.S. energy think tank.[55] Further, up to this time, most battery systems have been of limited MW capacity.[56] Similarly, as discussed previously, many MCR clients cited the small MWh discharge times as a deal killer when it comes to relying on storage for peaking capacity.

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[52] MISO SATOA Compliance Filing, Docket ER20-588, September 23, 2020, PDF page 253. The MISO SATOA tariff says MISO will evaluate SATOA devices as solutions to transmission issues comparably to any other transmission (wires) solution. Considerations may include: 1) ability to address the transmission issue (e.g., loading, voltage, stability); 2) assurance of sufficient energy and/or reactive capability (MWh/MVar) to maintain injection capacity; 3) expected availability (forced outage rates) compared to alternatives; 4) life-cycle cost and 5) other considerations (e.g., lead-time, right of way or substation impacts, expandability, operational flexibility, and system capacity). Examples of specific SATOA applications: 1) automatically dispatched to control voltage and thermal violations after the second N-1 event and/or 2) fills a need for fast-acting energy storage to provide rapid injections pre- or post-contingency events to maintain reliability of the transmission system and to reduce congestion on key lines or interfaces.

[53] MTEP19 identified the Waupaca Area Storage Project as a SATOA project, prompting the FERC filing. The Waupaca Area Storage Project (2.5 MW) was approved in the 2019 MISO Transmission Expansion Plan. This project is a transmission-only project, classified as proposed by ATC. The project has an estimated $8 million capital cost, and the currently proposed in-service date is December 31, 2021.

[54] Energy Information Administration, *Battery Storage in the United States: An Update on Market Trends*, July 2020, Figure 4. Report provides 2018 data. EIA does not report SPP figures.

[55] "Long-duration energy storage makes progress but regulation lags technology," *PV Magazine*, August 27, 2020.

[56] Note that many existing battery storage systems are relatively small. Per the EIA July 2020 Battery Storage Study, the average MW capacity of a storage facility in CAISO is only 6 MW.

Ample Lower Cost Dispatchable Generation to Support Variable Renewables

SPP has seen major swings in the supply of wind energy. For example, in a single day in December 2019, SPP's wind supply had a swing of 16,200 MW, initially serving 51% of load and 21 hours later dipping down to 6% of load.[57] The ample availability of low-cost dispatchable combined cycle natural gas and coal provides sufficient back-up to ensure reliability. In 2019, for example, SPP combined cycle units comprised about 26% of energy production and coal covered about 35%.[58] To date, the ready availability of low cost dispatchable generation in SPP has made the economics and reliability benefits of storage less competitive and less relevant.

The ready availability of low cost dispatchable generation in SPP has made the economics and reliability benefits of storage less competitive and less relevant.

Significant Amount of Storage in the Interconnection Queues

Despite its slow start in MISO and SPP, storage will be needed for peakers and for periods when low cost, non-dispatchable renewable resources are not sufficient to meet consumer demand. Storage can also contribute ancillary service to the grid. Over the last few years, MISO and SPP have seen a substantial increase in the number of requested standalone or hybrid storage projects to be studied in their interconnection queues. Although storage and hybrid units will account for a relatively small part of total demand, they will nevertheless begin to account for a more significant portion of the incremental required resources.[59]

MISO and SPP have seen a substantial increase in the number of requested standalone or hybrid storage projects to be studied in their interconnection queues.

As of the end of 2020, there are 98 active battery storage and hybrid projects totaling 7,650 MW in the interconnection queue in MISO. To put these numbers in context, the current total MISO interconnection queue of all projects totals about 93,896 MW of summer rating across 634 projects. Thus, storage and hybrids are about 8% of the total MW in the interconnection queue (see Figure 2 on the next page). Of course, not all projects in the queue will be implemented, but it provides a good directional indicator of what the resource mix will be. MISO forecasts an increase of in-service standalone battery and hybrid units from 0% today to a projected 2% and 3%, respectively, by 2025 for a combined 5% of total nameplate MW capacity in MISO.[60] Considering MISO's assumption of 9,283 MW of retired capacity resources over the next five years, this translates into 10,081 MW of battery and hybrids by 2025.[61] MISO has seen increasing momentum in fleet development to "greater levels of renewables and new levels of battery storage based on public interest and support for less reliance on fossil

[57] SPP, *101 Presentation An introduction to Southwest Power Pool*, October 2020, pages 127 and 129.

[58] Ibid, page 35.

[59] For example, see MISO, *MTEP20*, December 2020, Figure 2.5-1: MTEP20 Futures - Resource additions and retirements by 2033.

[60] MISO, *MTEP20*, December 2020, Figure 2.6-4: 2025 and 2030 OMS-MISO Survey Fleet Mix by Nameplate MW.

[61] Ibid., page 2, MISO currently has generation capacity of 198,600 MW. On page 4 of the 2020 OMS-MISO Survey Results report, MISO is forecasting an addition of 12,300 MW in installed capacity by the end of 2025. MISO identifies 9,283 MW of capacity resources with a potential base retirement in the next five years (see MTEP20 Futures Workshop Unit Retirement Assumptions), leaving the total installed capacity to be approximately 201,617 MW. 5% of this total is 10,081 MW.

Figure 2
Standalone and Hybrid Storage in MISO and SPP Interconnection Queues

RTO	Number of Standalone and Hybrid Projects (Percentage of Total Queue)	Nameplate MW Capacity of Standalone Storage and Hybrid Projects (Percentage of Total Queue)	Total Number of Projects in Interconnection Queue	Total MW Capacity in Interconnection Queue
MISO	98 (15.5%)	7,650 (8.2%)	634	93,896
SPP	91 (17.0%)	10,043 (10.5%)	534	95,744

Better-defined market rules and/or software changes, declining battery and renewable costs, longer discharge times & capacity, and expanding renewables and decarbonization goals are the four reasons storage will take hold by 2025 in MISO and SPP.

fuels, and historically low costs of renewables."[62] Many stakeholders noted how new generation could outpace the "Future" scenario bookends within the planning horizon.[63] MISO projections range up to 10,000 MW of battery storage being added over the next 20 years, driven by declining costs.[64]

The impact storage will have on the future in SPP is evident by the increasing amount of battery storage in SPP's generation interconnection queue. As of December 31, 2020, there are 10,043 MW of standalone storage and hybrids in the SPP interconnection queue with 98% of the projects slated to be in-service by 2025.[65] This is about 10.5% of the entire 95,744 MW in the interconnection queue, dominated by wind (45,213 MW) and solar (35,390 MW). "We're seeing more and more storage," says Barbara Sugg, CEO of SPP. "To me, storage has the ability to really change the game once we understand how to treat it, whether we're using it as an energy asset or a transmission asset and helping to assist us in reliability from both wind drop-offs and solar drop-offs."[66]

The Four Reasons Why Storage Will Gain Traction in MISO and SPP by 2025

The factors discussed above that have impeded battery storage from getting a foothold in MISO and SPP are slowly being resolved (see Figure 3 on page 18-19). Better-defined market rules and/or software changes, declining battery and renewable costs, longer discharge times and capacity, and expanding renewables and decarbonization goals are the four reasons storage will take hold by 2025 in MISO and SPP.

[62] Ibid., page 31.

[63] Ibid., page 33.

[64] Ibid., Executive Summary, page 6.

[65] SPP, *GI Active Requests*, http://opsportal.spp.org/Studies/GIActive (accessed December 31, 2020).

[66] "SPP expects wind to return to top of fuel stack, energy storage to emerge," *S&P Global Market Intelligence*, October 13, 2020. Note, FERC subsequently approved the MISO SATOA compliance filing that limits SATOA projects to resolving a non-routine transmission need. This could set the standard for other RTO filings.

1) ***Better-Defined Market Rules and Software Changes.*** Market participation rules and/or software changes for storage as a supply source are scheduled to be completed in SPP and MISO in the next 8 to 18 months as teams work through implementation issues, the tariff and business practices become more fully refined, and GI projects are studied and added to the RTO expansion plans. As the implementation rules become better defined, the market players for large-scale storage will gain more clarity on the economic attractiveness and operating requirements of storage used as a supply resource and/or a transmission-only asset. This will allow them to either commit to their project, decide to postpone, or withdraw entirely from the queue.

Market participation rules and/or software changes for storage are scheduled to be completed in the next 8 to 18 months.

SPP Tariff and Implementation. SPP's baseline filing to address Order 841 for storage as a supply source was approved in October 2020 but delayed for implementation until August 2021. The SPP teams are currently addressing the high-priority issues, thus clearing the way to release the pent-up storage backlog in the SPP interconnection queue. As SPP stated in December 2019, nearly all ESRs seeking to interconnect to its transmission system are undergoing GI studies to be completed in early 2022.[67] Thus, there was about a two-year average lag for recent interconnection requests[68] followed by the construction period. SPP recently instituted new procedures meant to reduce the re-workings of interconnection studies (to determine required network upgrades and cost allocation) when proposed facilities modified their request or withdrew from the queue. The maximum study time has been reduced to about 18 months.[69] Therefore, in-service dates of standalone and hybrid storage in the queue as of the end of 2019 would likely begin to take place in 2023/ 2024, depending on their construction periods. As previously mentioned, SPP has deferred until early 2021 the issue of multi-use storage used as both transmission and supply resources. Even though the 2019 and 2020 SPP Transmission Expansion Plans ("STEP") have no mention of storage as a transmission-only asset, there could be a limited number of additional SATOA projects studied; if economical, these projects could be integrated into the STEP in the next couple of years leading to in-services dates for SATOAs in the 2024-2025 timeframe.

MISO Tariff and Implementation. MISO has also obtained FERC approval for storage as a supply resource under Order 841 but is delaying implementation of the tariff until June 2022 in order to re-plan the development and implementation of the ESR systems and software. Based on the queue, storage projects slated to be in-service in the next two years are relatively few and mostly smaller 50 MW projects. There should, however, be a substantial number of storage GI projects studied and added to the MTEP23 or MTEP24, leading to construction and likely in-service dates in the 2024-2025 timeframe. As shown previously in

[67] FERC Order, Docket No. ER19-460, February 27, 2020, page 6.

[68] SPP, *Three Phase Interconnection Study Process Education*, September 19, 2020, page 42.

[69] Ibid., pages 62-70.

Figure 3
Reasons Why Storage Will Gain Traction in MISO and SPP by 2025

<table>
<tr><th>Reason</th><th colspan="2">Description</th></tr>
<tr><td>1. Better-Defined Market Rules and Software Changes</td><td><u>MISO</u>
● Storage-related and other higher priority software changes expected to be completed mid-2022.
● Construction of storage and hybrid facilities (if not yet built) takes another 12-18 months[70] after the interconnection study is complete, cost allocation is known, and the interconnection contract signed.</td><td><u>SPP</u>
● Teams will have worked through storage issues by about Q2/Q3 2021; potential revisions to tariff will then work through the stakeholder review process.
● Section 205 filing for any changes to baseline tariff likely approved by late 2021/early 2022; longer if further compliance filings required.
● SPP stated that interconnection studies for interconnection requests in the queue as of December 2019 will be complete in early 2022.
● Construction of storage and hybrid facilities (if not yet built) takes another 12-18 months after interconnection request is complete and cost allocation is known, and interconnection contract signed.</td></tr>
<tr><td>2. Declining Battery and Renewable Costs</td><td colspan="2">● MCR forecasts the levelized costs of hybrid storage paired with utility-scale solar will decline an average of 14.6% per year through 2025,[71] making paired storage increasingly competitive with combined cycle.</td></tr>
<tr><td>3. Longer Discharge Duration and New Battery Technology</td><td colspan="2">● Existing and new battery technologies will increase battery discharge times to 8 hours and beyond. This, combined with larger MW capacity battery systems, make battery storage more practical to meet peak demand.
● Battery technology is more reliable and safer than in recent years.</td></tr>
</table>

[70] Storage systems typically take about one year to complete, and hybrid timelines are driven by the generation and whether the generation already exists. Assuming the paired generation does not already exist, paired systems could take another six months with some activities running in parallel.

[71] See discussion on page 19 and 20 under Declining Battery and Renewable Costs.

Figure 3
Reasons Why Storage Will Gain Traction in MISO and SPP by 2025 (continued)

Reason	Description
4. Expanding Renewables & Decarbonization Goals	● Storage will begin to displace fossil fuels as a dispatchable resource as states, utilities and corporations set more aggressive renewables and decarbonization goals. ● There is increasing scrutiny by stakeholders of resource plans, desiring more attractive non-wires solutions (such as storage) or DER alternatives. ● IOUs owning renewables and storage is consistent with building new rate base to increase earnings and retiring fossil fuel generation (which reduces fuel adjustment revenue but has no earnings impact.) ● The investment community is pressuring companies to decarbonize. ● There are government tax incentives and DOE investment in technology to lower storage costs and scale up battery production.

Figure 2, at the end of 2020, there were 98 active battery storage and hybrid projects totaling 7,650 MW in the interconnection queue in MISO. However, there is only one approved SATOA project in the MTEP.[72] The MISO tariff does not currently address multi-use storage, used for both transmission asset and supply resources.

Battery storage paired with solar will be increasingly competitive with gas and coal.

2) ***Declining Battery and Renewable Costs.*** The cost of storage-only systems and the cost of hybrid storage paired with solar will continue to decline. Wood Mackenzie forecasts the median asset cost of standalone 4-hour discharge FTM battery systems will decline by about 13% from $1,950/kW to $1,700/kW from 2020 to 2022.[73] As technology improves and per unit battery costs decline, the average MW size of a battery system will also increase. Further, Lazard reports that the average unsubsidized levelized cost per MWh of utility-scale solar dropped 11% per year since 2015.[74] As these longer-term declining cost trends continue, hybrid battery storage paired with solar will be increasingly

[72] MISO, "MTEP20 Executive Summary," page 6, the Waupaca Area Storage as Transmission Project.

[73] "Energy Storage Monitor: 2nd Quarter U.S. Energy Storage Review," *U.S. Energy Storage Association,* June 17, 2020, page 13.

[74] "Levelized Cost of Energy and Levelized Cost of Storage – 2020," *Lazard*, October 19, 2020, Version 14.0. Moreover, Lazard's latest (October 2020) annual Levelized Cost of Storage Analysis (LCOS 6.0) shows that storage costs have declined across most use cases and technologies, particularly for shorter-duration applications, in part driven by evolving preferences in the industry regarding battery chemistry. In Lazard's 2018 study, the low-end of the thermal solar tower paired with storage was $98/MWh compared to the $81/MWh low-end cost in 2020, or a cost reduction of about 17% over the two-year period.

competitive (particularly with tax incentives) with gas and coal, thereby making the cost of decarbonization more palatable to most utilities. Despite a recent uptick in prices of hybrid systems that reflects COVID-19 obstacles, tariffs on solar panels, increased battery duration and size, and increased demand for renewables,[75] MCR forecasts that four-hour battery storage paired with solar will fall from the current unsubsidized Lazard estimate of $81/MWh to $140/MWh to an estimated range of about $37/MWh to $64/MWh by 2025 (a compounded annual decline of 14.6%).[76]

3) ***Longer Discharge Duration and New Battery Technology.*** Battery system discharge times, currently about two to four hours, have been progressing[77] and safety records are improving. After first debuting with short-duration functions, like frequency regulation, new lithium-ion battery systems now typically offer four hours of discharge, and recently have edged up to eight hours in one AES project in Hawaii.[78]

   Eight-hour discharge capability with larger MW battery systems[79] makes battery storage much more practical for peaker use for many utilities. Eight hours of battery storage will most likely be the norm within the next several years as battery technology continues to improve. On average, existing co-located hybrid projects have a renewable nameplate capacity to battery power capacity ratio of 6:1, whereas planned projects have a power capacity ratio of 2:1, with increasing battery capacity and duration of planned storage projects.[80] Decarbonizing California's electric grid to meet state targets is expected to require the addition of 2,000 MW to 11,000 MW of long-duration energy storage by 2030 and between 45,000 MW and 55,000 MW to achieve a carbon-free power system by 2045, according to a report released by the California Energy Storage Alliance.[81]

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[75] "Falling US solar-plus-storage prices start to level as batteries supersize," *S&P Global Market Intelligence*, February 20, 2020.

[76] MCR analysis based on 2020 Lazard 50 MW/200 MWh estimate in "Levelized Cost of Storage Analysis – Version 6.0" and International Renewable Energy Agency "Renewable Power Generation Costs in 2019." MCR's levelized cost of energy estimate does not adjust for inflation and does not include subsidies that may range from $2-$12 per MWh. Prices include Hawaii projects which are substantially more costly than other areas. Note that purchased power agreement prices will be lower, reflecting competitive markets with a different technology geographic mix.

[77] Energy Information Administration, *Battery Storage in the United States: An Update on Market Trends*, July 2020, page 11. For example, in 2018 most MISO battery systems in service were for two hours. In CAISO, however, large-scale battery storage installations had an average power capacity of 6 MW and duration of 3.5 hours. This is an increase in the average duration of 3.2 hours in CAISO in 2017. Most recently announced storage facilities have a discharge duration of four hours with a typical capacity of 50 MW.

[78] "New Battery Stations to Further Displace Gas Peakers, Fluence Executive Says," *S&P Global Market Intelligence*, June 17, 2020.

[79] Ibid.

[80] Energy Information Administration, *Battery Storage in the United States: An Update on Market Trends*, July 2020, page 27.

[81] "Up to 55 GW of long-duration storage needed to decarbonize Calif. grid – report," *Electric Transmission Week*, December 14, 2020, page 2. Report produced by Strategen Consulting LLC.

Given the rise of renewable portfolio standard and decarbonization goals (see discussion below), long-duration energy storage will play a key role in integrating renewable assets while supporting reliability. In fact, procurement of long-duration storage has picked up in recent months. For instance, in October 2020, eight community choice aggregators in California issued a call for 500 MW of energy storage with at least eight hours of discharge to come online by 2026.[82] The technologies vying for a share of emerging demand for long-duration storage include conventional lithium-ion batteries, zinc-based batteries, flow batteries, compressed air, cryogenic storage,[83] pumped hydroelectric storage and hydrogen produced from renewable energy (increasingly referred to as "green hydrogen").[84]

Given the rise of renewable portfolio standard and decarbonization goals, long-duration energy storage will play a key role in integrating renewable assets while supporting reliability.

In addition to improving discharge durations, the safety record of battery installations has improved. In the last couple of years, there were some high-profile cases of lithium batteries catching fire, including the April 2019 fire and explosion of the Arizona Public Service ("APS") storage facility, but the probability of recurrence of those incidents has declined as adjustments have been made and battery technology continues to improve. Battery makers have engineered systems to detect and remove dangerous gases to help ensure they do not build up and explode. They also addressed the layout of battery cells, so that if one heats up, the problem does not spread.[85] Despite the APS fire and explosion, battery storage has experienced meteoric growth in the last couple of years, indicating the inherent strength of the storage market.

4) ***Expanding Renewables and Decarbonization Goals.*** States that have begun requiring utilities to include storage in integrated resource plans include Arizona, California, Connecticut, Colorado, Florida, Indiana, Kentucky, Massachusetts, New Mexico, North Carolina, Oregon, Utah, Virginia, and Washington. In addition, New York and Vermont include storage in their state energy plans.[86] Batteries are widely seen as an important strategy for managing rising amounts of renewable energy on electricity grids. In the last 10 years, MISO has experienced 17,500 MW of coal retirements. Even utilities in fossil-rich states, such as Indiana (including utilities such as NIPSCO, IPL and Hoosier Energy), are

[82] Ibid.

[83] "Long-duration energy storage makes progress but regulation lags technology," *PV Magazine*, August 27, 2020. For example, London-based Highview Power uses liquid air to store energy and plans to develop a 50-MW/8-hour energy storage project in northern Vermont. Highview uses off-peak or excess electricity to chill and liquefy air at -320°F, storing the liquid air in insulated, low-pressure tanks. Upon exposure to ambient temperatures, the liquid air rapidly returns to a gas, expands by 700 times its liquid volume and powers turbines to generate electricity. Form Energy, a startup thought to be working with Great River Energy to develop a flow-battery variant is a 1-MW, grid-connected storage system capable of delivering its rated power continuously for 150 hours, an accomplishment assuming it can be commercialized.

[84] "Up to 55 GW of long-duration storage needed to decarbonize Calif. grid – report," *Electric Transmission Week*, December 14, 2020, page 2. Report produced by Strategen Consulting LLC.

[85] "How the Energy Storage Industry Responded to the Arizona Battery Fire," *GTM*, August 18, 2020.

[86] "Utilities are increasingly planning for energy storage," *PV Magazine*, December 7, 2017.

planning to retire coal plants as part of their transition to renewables. MISO expects that an additional 21,000 MW to 41,700 MW of solar and wind will be added by 2025.[87] MISO also states that over the same period there could be another 26,500 MW to 33,500 MW of coal-fired generation retirements.[88] Natural gas retirements of 10,600 MW to 13,900 MW are expected to be nearly balanced with new combined cycle additions.[89] As the construction of fossil fueled generation decreases, renewables will increase. MISO's planning committee's projection of possible additions of battery storage ranged up to 2,000 MW with the most expected in Zone 1 (western Wisconsin to Montana), Zone 7 (Michigan) and Zone 9 (Louisiana and southeast Texas).[90] Battery storage will begin to displace fossil fuels as a dispatchable resource as states, utilities and corporations set more aggressive renewables and decarbonization goals, and the federal government provides research and incentives.[91]

Storage will begin to displace fossil fuels as a dispatchable resource as states, utilities & corporations set more aggressive renewables and decarbonization goals, and government provides research and incentives.

State and Regulatory Goals. Within MISO, Minnesota is one of the more aggressive states with respect to renewables and decarbonization goals, with a renewables goal of 26.5% by 2025 for IOUs. Xcel has a separate stated goal of 31.5% and other Minnesota generation and transmission cooperatives have adopted a 25% goal by 2025. Minnesota also has statutory targets to reduce greenhouse gas ("GHG") emissions 30% below 2005 levels by 2025 and 80% below 2005 levels by 2050. Multiple Minnesota utilities, such as Xcel, Great River Energy, and Allete, have announced coal plant retirements,[92] with Xcel incorporating storage into its plan to meet its renewables and decarbonization goals.[93] Stakeholders are increasingly expecting innovative, less capital-intensive, non-wires alternatives such as storage in utility resource plans.

As the transition from coal and older natural gas generation to renewables takes place, the system vulnerability to the variability of expanding wind and solar will increase. In its December 2020 Long-Term Reliability Assessment, NERC stated to ensure reliability, grid operators "must increasingly balance uncertain loads with uncertain generation and that additional flexible resources are needed to offset variable energy such as wind and solar power." NERC went on to say, "Flexible resources refer to dispatchable conventional as well as dispatchable variable resources, energy storage devices, and dispatchable loads … energy storage

[87] "MISO Planning Committee's Futures Resource Expansion and Siting announcement," *S&P Global Platts*, November 11, 2020.

[88] Ibid.

[89] Ibid.

[90] Ibid.

[91] "State Renewable Portfolio Standards and Goals," *National Conference of State Legislatures*, December 11, 2020.

[92] NRECA, "Great River Energy Announces Transition to Wind, Market Power," News Release, May 7, 2020; Xcel, "Xcel Energy to end all coal use in the Upper Midwest," News Release, May 20, 2019; and "Phasing out: Utilities, cities prepare for the end of coal-fired energy in Minnesota," *MinnPost*, July 20, 2020.

[93] "Xcel Targets $1.4B in Wind and Solar Investments, Outlines Broader Carbon-Reduction Goals," *GTM*, October 30, 2020.

provides important capabilities to maintain grid reliability and stability."[94]

In other words, storage will need to play a key role in moving to net zero carbon emissions goals, as it works in tandem with renewables. Storage provides a partial replacement for dispatchable generation to ensure a more reliable system, both from a supply (energy and capacity) and a transmission (e.g., voltage) perspective. The availability of lower cost, longer duration storage will help defer or replace the need for new natural gas plants or result in utilities being more aggressive in retiring less efficient coal and gas plants, consistent with their renewables and decarbonization goals.

Storage provides a partial replacement for dispatchable generation to ensure a more reliable system.

Utility Goals. With or without aggressive state goals, many utilities are pledging their own more aggressive goals. Pushed by customer groups and a more environmentally-conscious investment community that is increasingly avoiding companies with carbon exposure, 70% of the largest IOUs in the country, including Ameren, CMS, DTE, Duke, Entergy, WEC and Xcel, have established significant decarbonization goals.[95] The increased renewables goals are consistent with building new rate base in an increasingly decarbonized world. Some utilities are contemplating a "Steel for Fuel" strategy of investing in zero fuel renewable generation assets (which increases rate base and earnings) and retiring heavily depreciated fossil fuel generation (which reduces fuel adjustment clause revenue and has no impact on the bottom line). The impact on the customer bill may be neutral. That is, the increase in rate base is offset by the decrease in fuel charges, but the shareholder typically wins with higher earnings.

Some utilities are contemplating a "Steel for Fuel" strategy.

Corporate Goals. In 2017, Google became the first large company to match 100% of global annual electricity use with purchases of renewable energy. Now, Google will go far beyond its previous goal by matching hourly electricity use with locally sourced zero-carbon energy, operating essentially on carbon-free electricity around the clock by 2030.[96] "To meet the needs of Google, we're talking about amounts [of battery storage] that are unprecedented," says Wood Mackenzie's Dan Finn-Foley, head of Energy Storage.[97] Other companies, such as AT&T, Amazon, and Morgan Stanley, have also made decarbonization pledges as part of the environmental, social and governance trend. Bloomberg Green analyzed 187 different climate pledges to be voluntarily fulfilled by 2020 as part of

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[94] "2020 Long-Term Reliability Assessment," *NERC*, December 2020, pages 7, 25, 36. Storage may be used for load shifting and energy arbitrage—the ability to purchase low-cost, off-peak energy and resell during on-peak, high-cost periods. Storage may also provide ancillary services, such as regulation, load following, and contingency reserves. This is true for both bulk storage, which acts in many ways like a central power plant, and distributed storage technologies.

[95] "Path to net zero: 70% of biggest US utilities have deep decarbonization targets," *S&P Global Market Intelligence*, December 9, 2020.

[96] "Google Shows the Path to a Clean Energy Future," *Rocky Mountain Institute*, September 14, 2020.

[97] "Google made clean energy cool for corporations, and it's about to do the same for batteries," *Quartz*, September 17, 2020.

the Obama Administration's 2015 American Business Act on Climate Pledge. 138 out of 187 company pledges have already been met or appear to be on track by year-end, though many goals were modest.[98]

Similarly, the largest pension fund in the U.S. announced plans to decarbonize fully by 2040 and begin a four-year review of its energy sector investments for potential divestment. New York State Comptroller, Thomas DiNapoli, announced the New York State Common Retirement Fund will set interim goals to reach net-zero greenhouse gas emissions for its entire portfolio by 2040. It is also starting a process to identify companies across the fossil fuel sector for potential divestment by 2025.[99]

The Department of Energy is betting on the need for long-duration storage to balance electric grids that increasingly rely on variable renewable energy resources.

Federal Energy Policy Goals. The December COVID-19 relief law contains significant investments for energy storage research, development and demonstration, as well as extended tax incentives for energy storage systems coupled with solar arrays.[100] Separately, the Department of Energy ("DOE") is betting on the need for long-duration storage to balance electric grids that increasingly rely on variable renewable energy resources. Working with industry partners, the DOE plans to invest in storage technology that dramatically lowers cost and scales up production for storage with a duration of more than 10 hours.[101] In addition, a bipartisan energy bill currently in Congress would allow certain resources, including offshore wind and energy storage, to be eligible for an investment tax credit and would extend the production tax credit for solar and onshore wind projects by 10 years.[102] It is expected the Biden Administration will encourage and possibly enact laws that continue to support additional renewables and decarbonization with an eye toward a 100% carbon-free power sector by 2035.

Thus, a number of factors will combine to make storage a major contributor to resource plans in the next several years:

1) State, regulatory and federal government trends to increase renewables and decarbonize;
2) A desire to build new rate base by IOUs owning renewables to increase earnings;
3) The emergence of socially conscious or "green" corporations with large footprints across the country; and
4) Investment community pressure to decarbonize.

[98] "Time's Up on Corporate America's 2020 Climate Goals. Here's the Results," *Bloomberg Green*, December 14, 2020.

[99] "NY pension fund sets 2040 net-zero goal, divestment review plan," *S&P Global Market Intelligence*, December 9, 2020.

[100] "Congress Passes Spending Bill with Solar, Wind Tax Credit Extensions and Energy R&D Package," *Green Tech Media*, December 22, 2020. Also see "What Renewable Energy and Energy Storage Did, and Didn't, Get from Congress This Week," *Green Tech Media*, December 24, 2020.

[101] "US energy storage strategy targets domestic manufacturing boom," *S&P Market Intelligence*, December 22, 2020.

[102] "Bipartisan US House bill would set national clean electricity standard," *S&P Global Market Intelligence*, December 29, 2020.

As renewables and decarbonization goals accelerate and non-dispatchable resources are added,[103] storage becomes increasingly important to maintain a reliable transmission system.[104]

DER Competition for FTM Storage

Although FTM battery storage will be an important contributor to resources and the transmission system by 2025, it will have competition from small DERs. Issued in September 2020, FERC Order 2222 allows aggregators to combine small DERs (e.g., energy efficiency, load management, distributed generation, electric vehicles, and BTM storage) and bid these aggregated DERs into the wholesale marketplace. Initial compliance filings for Order 2222 are due from each RTO by July 19, 2021, but implementation of Order 2222 may take longer due to sorting out market participation rules and making required software changes. MISO has established the Distributed Energy Resources Task Force ("DERTF") to manage the implementation of all DERs, including battery storage facilities, and had its first meeting on January 4, 2021.[105] Among its responsibilities, the task force has been asked to ensure that batteries do not disrupt efficient operation of competitive markets in the RTO. It will likely be well into 2022 before market participation rules and tariff changes for FERC Order 2222 are approved and take hold in MISO and SPP.

FERC Order 2222 allows aggregators to combine small DERs and bid these aggregated DERs into the wholesale marketplace.

Order 2222 is an outgrowth of its cousin, Order 841. Whereas Order 841 covers larger FTM storage greater than 100 kW, Order 2222 addresses all DERs connected to the distribution system with aggregations of at least 100 kW.[106] Order 2222 allows behind-the-meter storage and other DERs access to wholesale energy markets; the DER aggregator has the flexibility to mix and match resources from various locations. There is no practical limitation on the number of distributed technologies that can be networked together; and combinations of generation and load reduction can be deployed simultaneously into one unified market offering. FERC declined to impose (or permit RTOs to impose) a minimum size requirement on individual DERs.[107]

Instead, Order No. 2222 requires that DER aggregations meet a minimum size of at least 100 kW. The benefit of participating in the wholesale market for an

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[103] Intermittently operating resources whose output cannot generally be controlled when operating. In particular, this refers to wind and solar facilities without energy storage.

[104] CapX2020, "CapX2050 Transmission Vision Report," News Release, March 2020, page 6.

[105] The purpose of the DERTF is to: 1) serve as a focused forum for stakeholders and MISO to address many cross-functional issues associated with MISO's Order 2222 compliance as well as non-Order 2222 DER issues, 2) engage appropriate parties, including regulators, distribution utilities, and other subject matter experts, to develop the coordination framework required by Order 2222, 3) identify potential risks and opportunities stemming from the integration and participation of DERs in the MISO markets, including study of the various services DERs can offer, and (4) recommend approaches and/or solutions to address these risks and opportunities to the Market Subcommittee.

[106] DERs include BTM storage, aggregated rooftop solar, batteries, EV chargers, smart inverters, smart appliances, building controls, grid-responsive water heaters and air conditioners.

[107] FERC Order 2222, "*Participation of Distributed Energy Resource Aggregations in Markets Operated by Regional Transmission Organizations and Independent System Operators*," September 17, 2020, paragraphs 179 and 180.

aggregator with multiple DERs must outweigh the costs of its technical requirements, such as metering and telemetry and interconnection costs.

The concept of DERs participating in the wholesale market is already beginning to take shape now in California. Startup OhmConnect is planning the "largest residential virtual power plant in the world," an artificial intelligence driven 550-MW network of DERs spread across California.[108] OhmConnect is expanding its current base of roughly 150,000 residential customers and will subsidize their purchase of home energy devices, including smart plugs and thermostats, electric-vehicle charging ports, and BTM battery-storage systems. The devices connect to a web-based platform that enables the company to control them at key moments, primarily during early-evening peak power demand as solar declines. OhmConnect then bids aggregated demand-side energy reductions and BTM storage into CAISO and compensates customers for the savings.

As the impacts of Order 2222 kick in, aggregated DERs will see substantial growth and start to become a competitor of larger FTM storage.

Guidehouse forecasts mixed-asset virtual power plant ("VPP") cumulative capacity is expected to grow from 2,800 MW in 2020 to nearly 36,900 MW by 2029 at a compound annual growth rate of 33.1%.[109] "This is going to be a massive market," said John Carrington, CEO of Stem Inc., a California-based developer of artificial intelligence-driven VPPs, in a recent interview. "There is going to be a lot of room for a lot of players."[110]

These DER aggregation mechanisms under Order 2222 present some competition to utility-scale FTM battery storage. As the impacts of Order 2222 kick in, aggregated DERS will see substantial growth and start to become a competitor of larger FTM storage.

Implications of Storage for Transmission Owners and Participants in MISO and SPP

As the RTO market participation rules and software changes for FTM storage are defined and implemented, as costs become more competitive, as battery discharge durations increase, and as decarbonization efforts intensify, FTM storage paired with utility-scale solar and wind will take off, becoming an essential element of the MISO and SPP markets. Given recent trends associated with each of these four areas, MCR anticipates that storage as a supply resource will begin to take hold as a significant part of the resource mix in MISO and SPP in about 2025. The impact of this trend in the near term is clear: transmission owners will need to utilize new transmission technologies and build more transmission infrastructure to accommodate the transition to non-dispatchable resources and the addition of storage onto the grid. Bi-directional flows from the injection and withdrawal of energy from battery storage will require upgrades to the transmission and distribution system.[111] This will take careful planning and

[108] "Builder of 'largest residential virtual power plant in the world' reels in $100M," *S&P Market Intelligence*, December 7, 2020.

[109] "Market Data: Mixed-Asset Virtual Power Plant Models," *Guidehouse Insights*, Q3 2020.

[110] Ibid.

[111] CapX2020, "CapX2050 Transmission Vision Report," News Release, March 2020, page 6 and "The Coming Electrification of the North American Economy," *Brattle Group*, prepared for the WIRES group, March 6, 2019, pages ii, iii, vi of Executive Summary and page 2 of report.

Figure 4
The Call to Action for Utilities to be Prepared for Storage

1) Monitor advancements in storage and hybrid technologies.
2) Participate in the definition of RTO market participation rules for FERC Orders 841 and 2222, as applicable.
3) Determine the resource planning role FTM storage can play as a supply resource and as a standalone transmission asset in renewables and decarbonization goals for your utility.
4) Examine the wholesale revenue streams and the economic value FTM storage can bring as a supply resource and as a standalone transmission asset.
5) Examine how traditional transmission investment can complement your storage investment.
6) Assist customers (or members) in BTM storage applications.
7) As applicable, plan the retail regulatory treatment (and potential profitability) of FTM storage.

preparation. As listed below and shown in Figure 4, market participants in MISO and SPP need to be preparing now for both FTM and BTM storage applications. At a minimum, MCR recommends utilities develop a strategy that includes: (1) monitoring advancements in storage and hybrid technologies, (2) participating in the definition of RTO market participation rules related to FERC Orders 841 (for SPP members only) and Order 2222 (for MISO and SPP members); (3) determining the resource planning role storage can play in renewables and decarbonization goals for your utility, (4) examining the wholesale revenue streams and the economic value FTM storage can bring as a supply resource and as a standalone transmission asset, (5) examining how traditional transmission investment can complement your storage investment, (6) assisting customers (or members) in BTM storage applications, and (7) as applicable, planning for the retail regulatory treatment (and its potential profitability) of FTM storage. Discussions with RTO, state, and customer/member stakeholders will help determine the role FTM and BTM storage plays in each utility's supply portfolio to meet renewable and decarbonization goals, as well as each utility's viability of investing in storage as a transmission asset.

The use of FTM and BTM battery technology will create both opportunities and challenges for utilities. If utilities are not prepared, it will be very difficult to keep up once the growth starts accelerating in MISO and SPP, and even harder to meet the opportunities and challenges that lie ahead. MCR

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"Jim has a way of getting to the core concept; he's able to present it in a way that's understandable. He has a confidence when he's presenting, which is quite valuable." —Transmission Planning Manager, G&T

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"Chris is incredibly responsive and knows what questions to ask." —GM, municipal

About MCR's Transmission Strategy Practice

MCR provides services to members of various RTOs across the country. Our clients, public power, cooperatives and independent transmission developers have a goal of optimizing the value of their current and future investments in electric transmission. We help them realize the full revenue potential from these assets. Our Transmission Strategy practice provides the following services:

Transmission Formula Rate Analysis

- Formula Rate Review for Existing Transmission Owners
- Development of Annual Transmission Revenue Requirements ("ATRR") for New Transmission Owners
- Review/Challenge to Incumbent Formula Rate Costs
- Staff Education Workshops on Formula Rates

FERC Filings

- Section 205 Rate Filings and Testimony
- Transmission Incentive Rate Filings and Testimony
- Cost of Capital Expert Testimony
- Intervention and Settlement Support

Strategic Economic Analysis

- Development of Transmission Business Plans
- Economic Evaluation of New Transmission Projects
- RTO Membership Evaluation
- Analysis of Joint Zone Investment and 7-Factor Tests
- Analysis of the Potential Purchase or Sale of Assets

Transmission Cost/Rate Competitiveness

- Peer Cost Comparison by FERC Account
- Rate Strategy and Transmission Revenue Forecasting
- Transmission Capital Investment and Metric Comparisons

Through our consulting assignments, MCR has created millions of dollars in value for our clients and broken new regulatory ground for our client base with landmark FERC decisions.

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