MISO Renewable Integration Impact Assessment Report – Summary

I. Purpose, Methodology, and Focus Areas

MISO published its Renewable Integration Impact Assessment (RIIA) report in February 2020. The RIIA is the culmination of 4 years of stakeholder collaboration and intense exploration into the impacts of increasing renewable integration, especially in the MISO region. The primary purpose of the RIIA study is to systematically identify MISO renewable integration inflection points where the underlying grid infrastructure, grid operations, or both need to be significantly modified to reliably achieve up to 50% of renewable deployment. The RIIA evaluates the impacts of increasing amounts of wind and solar resources for MISO to better understand the complexities of renewable integration issues and to examine potential mitigation solutions. The RIIA disclaims that "[it] is policy and pace agnostic: generation changes in the analysis are assumed to occur regardless of external drivers and timelines. As a technical impact assessment, RIIA does not directly recommend any changes to the existing electrical power system or construction of any new resources. That said, this body of work demonstrates that as renewable penetration increases, so does the variety and magnitude of system risk requiring transformational thinking and problem-solving." Therefore, the following five topics are not addressed in the RIIA study:

1. How to cost-effectively address grid reliability and resilience in the transition.
2. How to manage grid operational vulnerability and technology risk.
3. What are the integration and mitigation costs for achieving the 50% renewable penetration?
4. Timing of conventional generation retirements.
5. Recommendations for constructing specific new resource or transmission as normally included in the MISO transmission planning process.

The entire RIIA study focuses on the following three areas:

1. Resource Adequacy: to ensure the system has sufficient resources to reliably serve the load
2. Energy Adequacy: to ensure the system is capable of providing energy continuously in every single operating hour throughout the year
3. Operating Reliability: to ensure the system can be operated to withstand design contingencies defined by current reliability criteria.

II. Key Findings

The MISO RIIA study demonstrates that the challenges related to operating the MISO system beyond 30% system-wide renewable penetration are not insurmountable. It concludes that renewable penetration beyond 50% can be achieved in the MISO region, but MISO does not give a timetable or cost for achieving greater than 50% renewables. When the renewable penetration is lower than 30%, MISO would require transmission expansions and certain changes in current grid operation, market, and planning practices. The system integration complexity increases sharply as the renewable penetration goes beyond 30%. When the renewable penetration is higher than 30% but less than 50%, MISO's region-wide renewable generation availability could surpass 100% of load for a few hours of the year and substantial regional pockets from where the average renewable generation output approaches 100% of the subregional load, indicating significant challenges in system frequency control and system stability. When the renewable penetration goes above 50%, MISO requires additional coordinated actions among participants regarding renewable resource deployment, related transmission expansion, and sub-regional or local renewable energy policies. This is, in part, due to the fact that renewable growth does not occur uniformly across the MISO footprint or because the development of renewable resources in neighboring interconnected systems occurs fastest in areas with high-quality wind and solar resources, available transmission capacity, and favorable regulatory environments.

The RIIA recognizes that, as more renewable resources are added to the system and more conventional generation resources retire, there are new risks and system needs, including new stability risks, grid stress period changes, energy shortage and flexibility risks, and insufficient transmission and resource capacity. Flexible generation resources, additional transmission capacity, and smart grid technologies are needed to help mitigate these new issues.

The following are the key findings of the RIIA in the three focus areas:

- **Resource Adequacy**
  Resource changes will significantly impact grid performance, especially when the renewable penetration goes above the 30% level. There could be not enough resources for winter and/or late in the evening peak load in the summer. The risk of losing load compresses into a small number of hours, shifts into the evening, and has shorter durations but higher magnitudes, depending on the technology, seasonal mix, and geographic mix.

- **Energy Adequacy**
  The MISO system needs greater magnitudes and variations of ramping capacity, especially when the renewable penetration level goes above 40%. The system could be simply unable to flexibly generate enough energy under stressed conditions. High renewable penetration requires a quite different operation for the conventional generators than they do currently. The generation's response to the changes in load and renewable output would be further limited by transmission and generation constraints. The energy adequacy issue then becomes very complex if measured by the effort to develop the transmission needed to maintain and deliver renewable energy every hour in a year.

  MISO's current transmission infrastructure is inadequate to support the full access by the diverse resources across the MISO footprint. Advanced grid technologies and integrated system planning methodologies are needed as renewable penetration increases. Energy storage, paired with renewables or used as non-wire transmission alternatives, can help optimize energy delivery.

- **Operating Reliability**
  Steady-state analysis, which examines the thermal overload of the transmission system, shows that the resource locations and system conditions cause transmission risk to shift to spring and fall more frequently. Moreover, sensitivity analysis shows transmission risks shift to summer shoulder load periods when solar output is high.

Also, regional energy transfer increases and becomes more variable, leading to a need for extra-high-voltage transfer capabilities, which results in transmission bottlenecks shifting to higher voltage lines.

Dynamic stability analysis, which examines the voltage stability, frequency stability, rotor angle stability, and non-oscillatory behavior of electrical quantities, shows remotely clustered renewable resources and unavailable stable conventional generation are the new challenges. The power delivery from "weak-grid" areas needs transmission technologies equipped with dynamic support capabilities. Small disturbance-caused stability issues increase in severity when renewable penetration reaches 30% and beyond; therefore, power system stabilizers are needed. Frequency response is stable when instantaneous renewable penetration reaches 60%, but maintaining online generation headroom is required. The average critical clearing time for electrical faults improves as large generating units are replaced by renewables; however, local issues emerge.

As for the voltage and converter-driven stability issue, the RIIA demonstrates that as inverter-based resources increase in the system, there is a decrease in the thermal generation capacity, which intensifies reliability challenges.

III. Conclusions

The RIIA demonstrates that the MISO region can reach renewable penetrations of 50% or higher with transformational changes and coordinated actions among participants. Additional work is still needed to transform the way MISO and the power system are planned and operated to maximize the reliability and value creation across the MISO region in a high-renewable system.

Based on the major RIIA insights, MISO recognizes additional work on the following items:

- To ensure the resource adequacy, MISO will develop and implement market solutions to identify issues prior to 30% renewable penetration. MISO will improve the fidelity of renewable forecasts and incentivize resource additions to enhance resource diversity.

- To enhance the energy adequacy, MISO will explore the landscape of system flexibility solutions, fuel delivery risks, market incentives, co-optimization of economic and reliability transmission needs, co-plan and process changes across various MISO planning functions, and application of new grid technologies (FACTS, VSC HVDC lines, and grid-forming inverters).

- To increase the operating reliability, MISO will explore new dispatch assumptions and develop tools and processes to capture the changing risks in transmission planning in order to develop long-range, cost-effective, and least-regret transmission expansion plans. MISO will also explore and determine options to monitor and commit power system stabilizers to address "weak-grid" issues; such options might include new inverter technology, increased operation visibility, integrated transmission planning, battery storage, and new protection techniques and tools.

QUANTA TECHNOLOGY

Technical Comments on MISO's Renewable Integration Impact Assessment

March 9, 2021

I. Introduction

The rapid introduction of renewable technologies is a bold step taken by the bulk electric system and power markets to respond to climate change. However, if a regional generation fleet relies too quickly on intermittent resources, the entire bulk electric system could become vulnerable due to the nature of uncertainty in electric generation. Extreme care must be taken so that the adoption of new technologies and the shift in fuel mixes do not undermine the reliability and resilience of the electric grid.

To provide insight, MISO published the Renewable Integration Impact Assessment (RIIA) report. The RIIA is the culmination of 4 years of stakeholder collaboration and intense exploration into the impacts of increasing renewable integration in the MISO region. The RIIA report calls for co-optimization among various solution options to solve emerging grid needs along with new technology deployments (e.g., FACTS, HVDC lines, grid-forming inverters, etc.). Challenges and risks abound: building transmission is costly, uncertain, and takes a long time; and new technologies need time to mature to become effective and reliable tools in system operations. By strategically deferring and delaying thermal retirements, we could not only allow the time for the new transmission technologies to mature, but also enable increased level of renewable integration with minimum reliability and financial risks to the consumers. Quanta Technology applauds MISO for performing this comprehensive assessment work. We appreciate the opportunity to reflect on the report and provide our feedback.

Identified technical risks and mitigation measures by the RIIA notwithstanding, there are key issues that have not been explicitly addressed – (1) how, in the short term, the power grid can pragmatically and cost-effectively manage the transition and address the reliability and resiliency ramifications of the evolving resource mix on the trajectory towards the 50% renewable penetration; (2) grid operational vulnerability as the system is heading in two directions at once: major HVDC overlays to accommodate generation shortfalls in regional AC grids and the regional AC grids being adjusted with incoming distributed energy resources (DERs); and (3) cost of integrating and operating renewable resources going forward. Of particular concern is the schedule and timing of conventional generation retirements and replacement technology installations is not sufficiently assessed to provide a likely roadmap.

The RIIA report noted a critical myth on page 106, "During these periods of high instantaneous renewable penetration, conventional units, particularly relatively closer to load centers, are displaced by low-cost renewable energy. This displacement introduces new reliability risk periods, which are no longer aligned with the traditional risk-period (peak load) and represents new periods of stress on the transmission [thermal, voltage and stability performances]." Here, not only is the adaptive planning process essential to recognize the grid operating risks as the states adopting renewable targets but, similarly essential, is the need to pragmatically choose the mitigation measures cost-effectively. A simple call for "updat[ing] dispatch assumptions used in the MTEP reliability process" is not enough because once the thermal generation is retired there will not be enough dispatchable capacity around when needed. Rather, there is a need for retaining thermal generation until after cost-effective facilities are built and operating.

While the RIIA legitimately focused on reliability performance under standard design conditions, the increasing risks and impacts from low-probability/high-impact disturbances such as extreme weather events, cyber-threats, etc. were not explicitly addressed to show how resilient the MISO system would be in the future. The RIIA did identify the high-risk period when the solar output reduces to zero during and after sunset with high solar penetration scenarios, however, it failed to recognize the no-wind or too high wind period, or frozen turbine situations under extreme cold weather conditions. These types of uncertainty in "fuel supply" for renewable generation should not pose wide blackout risks for a reliable and resilient power grid.

Resiliency is the ability of the electric system to withstand and recover from unexpected events outside the design conditions. Simply put, the level of resilience reflects the extent of redundancy and readiness in both generation and transmission systems beyond what the design criteria or design conditions require. It would be valuable if MISO's RIIA study could include a comparison between the current level of resilience and the resilience during the transition to a 50% renewable penetration future. Currently, thermal generation is key to maintaining transmission security and system resilience. As such, what effect would the loss of such generation have on reliability and resilience during the transition? Could the system withstand such a loss prior to establishing sufficient mitigation measures? The recommended comparison would help address these questions.

Also, important to consider are the different fuel sources for thermal generation including the availability of each fuel. For instance, gas-fired generation typically has little-to-no on-site fuel storage; nuclear and coal-fired generation, in contrast, have significant on-site fuel stores so that fuel transportation issues during a cold snap pose much less of a risk to generation. Coal and nuclear facilities, which typically have weeks or months of on-site fuel, demonstrated much better performance under extreme weather conditions. At present, nuclear and coal plants, as well as gas-fired power plants with firm natural gas contracts[1], are critical to system resilience and have been for many years. In fact, many of the existing transmission systems have been built to deliver the energy from these thermal power plants to the loads. Until such a time equally reliable and resilient options are available, retiring such assets presents serious risks to bulk electric system reliability and resiliency.

In the comments below, we discuss a few of the challenges that we believe are hindering cost-effective renewable integration and may be easily misconstrued in the RIIA report.

II. Planning to Ensure Resource Adequacy

Regarding resource adequacy, there are significant challenges related to the change in the resource planning paradigm. Specifically:

1. When the "Risk of losing load compresses and shifts into evening" per the RIIA Inflection Point curve, the "adequacy of the resource fleet is one of the most acute problems that needs to be solved".[2]

[1] It is noted that firm contracts or no, gas-fired plants still are susceptible to supply interruptions, and, hence, not as reliable/resilient as coal/nuclear that always have plenty of fuel on site.

[2] P.14 of the RIIA report.

While operating reserves during evening hours is indeed an issue, the bigger issue is when the long term installed capacity reserve, or the planning reserve is not properly or overly optimistically set with too heavily relying on intermittent resources. For example, the no-wind or wind generation not available under extremely cold conditions mentioned above can lead to situations of insufficient planning reserves situations. From a resource adequacy perspective, the over reliance on a single type of resource or a single primary fuel would magnify the risk of a single of failure in the resource adequacy planning.

MISO's Dispatchable Intermittent Resource (DIR) market product, which has been proven to be effective for grid operators to manage reliability risk, should be considered in the planning reserve to avoid over relying on resources that are operationally non-deliverable. That is, transmission constraints should be included in the assessment of resource adequacy.

2. "Increased solar capacity in the siting sensitivity creates a new stressed operating point during the shoulder load periods, which may need further review in Operating Reliability."[3] Balancing the load presents challenges not only on an hourly basis in system operation but also in terms of seasonal resource adequacy.

   "Shifting Flexibility Risk": As solar resources meet a larger share of mid-day generation needs, non-solar resources are needed to ramp down in the morning and ramp up in the evening to balance the solar pattern. Similarly, non-wind resources will ramp up and down to balance wind patterns, which change daily. To address this shifting risk, overall resource adequacy and flexibility needs to increase and align with the periods in which they are required.

   The effects or actual occurrences of the phenomenon could, in fact, occur sooner if Behind-the-Meter (B-t-M) DERs are considered. It is known that MISO does not have much visibility for many of the B-t-M DERs. As such, the magnitude of the risk impact can be much higher than what is shown in Figure RA-1 of the RIIA. Again, thermal generation, when not retired yet, can be a cost-effective mitigation measure during the risky periods identified in the RIIA report.

3. The Effective Load Carrying Capability (ELCC) for a combined wind and solar scenario declines and eventually plateaus as the renewable installed capacity increases (Figure RA-3 of the RIIA). However, we struggled to concur with the following statement, "The ELCC of MISO renewables is higher when these resources are used to meet load across a large portion of the Eastern Interconnection (MISO, PJM, SPP, SERC), compared to when meeting only MISO load,"[4] as well as the ELCC of 25.2% based on the whole Eastern Interconnect net-load peaks at 19:00 Central Time (shown in "Eastern Interconnection Net Load Profile", Figure RA-12). The Eastern Interconnect includes about two-thirds of North America, so the peaks of the load and renewable generation for each state or province can occur at different times. For resource adequacy, we caution against states setting and procuring adequate statewide resources based on the overly optimistic high value of ELCC at 25.2%. While we agree that "renewable's performance is significantly better when meeting MISO's peak net-load than when meeting only the non-coincident peak net-loads of each individual LRZ," the analysis has likely

[3] Ibid, p.86
[4] Ibid, p.34

assumed local renewable capacity can contribute to the resource needs remotely in the other regions with enough transmission transfer capability. Certainly, this conclusion should not form the basis for people to hastily retire thermal generation, which we believe would greatly increase the risk of inadequate reserves and, hence, rolling blackouts.

4. "Insufficient Transmission Capacity" is especially true if renewables are concentrated in one part of the footprint while serving load in another. Without added transmission, power flow across the footprint is hindered. The variable supply from the renewables would, therefore, become much more challenging to manage, resulting in increased curtailment and markedly different operation of the remaining generators. The installed capacity may not be able to produce the needed energy when the system is operated under stressed conditions.

   Added to the complexity of managing the variable supply is the "Large regional pockets of inverter-based generation need strong reinforcement to maintain system stability, due to these resources' inability to maintain a stable voltage when concentrated in large numbers. Traditional transmission solutions, such as synchronous condensers and Flexible AC Transmission System (FACTS) devices, help stabilize the local system; however, the large magnitude of the need for these solutions causes additional challenges. Two viable solutions are presented: high-voltage direct current (HVDC) lines to isolate a portion of the new renewable resources and connect them to a stronger part of the system; and the commercialization of advanced technology such as grid-forming inverters."[5] However, the definition of "stronger part of the system" means the part of the power grid where more balanced resource mixes exist to make up for wind and solar unavailability during these periods, leading to a lowering of capacity value for wind and solar in the resource adequacy planning.

Without abundant caution, uneven renewable growth in locations could create unrealistic expectations on renewable capacity in planning the resource adequacy. Renewable growth occurs fastest in areas with high-quality wind and solar resources, available transmission capacity, and favorable regulatory environments. For example, when MISO reaches 30% renewable energy penetration, some Local Resource Zones are likely to be approaching 100% renewable energy penetration. The "MISO Futures Whitepaper[6]" demonstrates the 30% milestone could occur as soon as 2026. It is imperative that the cost and risk implications embedded in the planning process be understood by the stakeholders and policy-makers while "Develop[ing] and implement[ing] market solutions to identify issues prior to the system reaching 30% wind and solar penetration (Market Redefinition)"[7].

III. Transmission Security Considerations

Regarding security considerations, there are significant challenges to power grid operations. Specifically,

5. The RIIA report noted that "as inverter-based resources increase in penetration, there is a corresponding decrease in online conventional generation, which intensifies reliability issues."[8] The

[5] Ibid, p.14–15

[6] https://cdn.misoenergy.org/20200427%20MTEP%20Futures%20Item%2002b%20Futures%20White%20Paper443656.pdf

[7] P.6 of the RIIA report

[8] Ibid, p.110

same phenomenon is also responsible for frequency stability in the study. As the increased penetration of inverter-based generation continues, the number of conventional units available to provide inertia and damping decreases. The result is the potential compromise of the system's ability to arrest a frequency excursion in the timeframe necessary to prevent involuntary load shedding, and, due to the displacement of conventional units with power system stabilizers, the appearance of an Eastern Interconnection (EI)-wide undamped oscillation (also known as an "inter-area small-signal oscillation"). Considering the retirement of thermal generation, the system is losing many of the resources that are critical to system stability. Historically, such resources have provided the bulk electric system with the stabilizing inertia, voltage support, and ramping and regulation under various emergency conditions to maintain system reliability.

Currently, coal and combined-cycle units provide the strong voltage reference point required for the renewable fleet to operate reliably. Enough voltage-support and regulating capability distributed throughout the system are necessary to support stable transmission system operation now and in the future. The RIIA suggests that there will be fewer thermal generators close to loads and more renewable generators remotely located from load centers, requiring longer transmission. Longer transmission paths increase the potential for thermal overloads as most of the existing transmission were not designed for the same level and direction of geographic power transfer to accommodate changing renewable generation. Pilot-programs[9] demonstrating the capability of new technologies (e.g., grid forming inverters) should be pursued to educate electric grid operators, assets owners, and policymakers and familiarize them with the need to speed up the technology adoption in the coming year while the limited amount of thermal generation is still available. As many of the technologies are essentially at the research stage, grid operations will need the existing thermal generation during the transition to maintain reliability and resilience.

6. "New Stability Risk": The grid's ability to maintain stable operation is adversely impacted (primarily) when renewable resources are clustered in one region of the transmission system. As inverter-based resources displace conventional generation, the grid loses the stability contributions of physically spinning conventional units. A combination of multiple technologies – such as high-voltage direct current (HVDC) lines, synchronous condensers, motor-generator sets, and emerging technology such as grid-forming inverters — are needed to provide support, along with operational and market changes to identify and react to this risk as it occurs.

   Concerning voltage and converter-driven stability, the RIIA demonstrates that as inverter-based resources increase in penetration, online thermal generation decreases, which intensifies reliability issues. The inverter-based resources also pose great challenges to the protective relays currently operating in the grid. These challenges are significant because commercially-available inverter-based resources, such as renewables, need strong voltage connections to operate reliably and efficiently, and they do not contribute much to transmission short-circuit current. This study identifies several approaches to address the issues, such as tuning inverter controls, re-dispatching generation, adding synchronous condensers, and using advanced technologies (FACTS, VSC HVDC). However, the frequent (and convenient) generation re-dispatch currently used to maintain reliability and stability

[9] Ibid, p.112

will be scarce, leaving the grid operators in real-time system operations with nascent and unfamiliar technologies.

7. "Small signal stability issues increase in severity after 30% renewable penetration, thereby requiring power system stabilizers. Frequency response is stable up to 60% instantaneous renewable penetration but may require additional planned headroom beyond 60%."[10] Power-system small-signal stability is affected by many factors, including initial operating conditions, the strength of electrical connections among components in the power system, characteristics of various control devices, detailed governor models, etc. The associated oscillations are the characteristic or natural modes of the power grid, the frequency and damping of which generally change with the operating conditions.[11] Since small disturbances are inevitable in power system operation, any power system that is unstable as a result of small-signal stability issues cannot operate in practice. In other words, a power system that is able to operate normally must first be stable in terms of small-signal stability. Hence, the MISO operators need to fully understand the new phenomena during transitioning to the new future.

8. The progress of DER is unlikely to slow in the coming years because electric customers will continue to want such progress. There is likely to be exponential growth as innovation makes these technologies more cost-competitive and capable, and that means power system planners must be ready to enable these technologies. Did RIIA consider B-t-M solar? B-t-M solar can accelerate the risk period when "Solar growth increases intra-hour needs due to its diurnal patterns and unique intra-hour profiles."[12] Retaining existing thermal generation can help maintain reliability by providing the needed ramping services while sufficient mitigation measures (e.g., storage at the customer sites) is developed and installed. This is similar to the existing thermal generation located at "good deliverability" locations to provide the "rampable MWs with lower marginal congestion component (MCC).[13]"

9. "Explore the landscape of system flexibility solutions (e.g., renewables as a solution to variability need and nuclear plant ramping) [14]": Technically and environmentally, nuclear is harder to respond net-load variations than other thermal generation. Figure UC-5 shows the technology breakdown of the incremental solutions modeled to achieve reliable operations at each renewable energy milestone level. The exponential growth of the solution complexity can be seen as MISO transitions from the 10% renewable milestone to the 50% milestone. Although high-voltage transmission lines constitute the largest share of the overall growth of complexity, the diversity of technologies required increases dramatically with penetration level. With a large portion of the current system within a power pool such as MISO being replaced or augmented by HVDC as shown in Figures UC-5 & 12, the characteristics of the grid will change tremendously. The DC and AC coordination alone may present an insurmountable challenge to the MISO grid operators. Additionally, if the large number of HVDC links would indeed work properly within the AC system operations, each of the two ends of an HVDC link

[10] Ibid, p.9
[11] Ibid, p.115-p.134
[12] Ibid, p.97
[13] Ibid, p.98
[14] Ibid, p.7

would constantly require energy and capacity balancing as well as operator interventions under normal and emergency conditions.

The benefits of thermal units during the transition toward ever-higher penetrations of renewable resources are manifold. Thermal units can not only facilitate higher levels of renewable penetration (by providing needed ramping and maintaining system voltage and stability performance),[15] but they are also needed, as the RIIA points out, "when an accelerated pace of thermal unit retirement (as in the high retirements sensitivity), the lack of thermal unit support for system ramping becomes an issue."[16] Additionally, as shown in Table EA-4, the high retirements sensitivity has the lowest penetration and annual renewable production compared to the Phase II-Final model and other sensitivities. The spiking of the system's average LMP during evening hours (Figure EA-51) and daily peak-load hours (Figure EA-52) indicates the reduced thermal capacity available in the system to support ramping.

IV. A Resource Mix with Predominantly Limited Energy Production

There are additional challenges that relate to the nature of intermittent generation and mitigating measures such as energy storage. These types of resources are comparatively energy-limited and less certain in terms of when and how much electricity they can provide while also supporting transmission planning and operations under N-1 and N-1-1 conditions. The following factors may present future challenges:

10. Shifting periods of energy shortage are a risk of not having enough generation to meet demand shifts from the historic times of peak power demand to other periods, specifically hot summer evenings and cold winter mornings, when low availability of wind and solar resources is coincident with high power demand. Therefore, the power grid would need to ensure 1) sufficient visibility of locational risk, and 2) that other energy-supplying resources are available during these new times of need, with adequate transmission to deliver across regions.

    "The flexibility that traditional generation units provide, if dispatched, will need to increase in magnitude and direction. Coupled with this, renewable resources will also need to contribute to system flexibility by dispatching less than their maximum available output during periods of high system change."[17] It will be challenging when the marginal cost among the renewables are all the same (e.g., zero). There will be imparity to limit some renewable generation while there is no guarantee that these renewables will produce from one minute to the next. Besides thermal generation, energy storage may be useful for the daily cycles but subject to whether it has the energy to discharge.

11. Shifting periods of grid stress occur when renewable resources supply most of the energy. During such times, the system becomes more dependent on the stable and predictable conventional generators, increasing the system risk associated with unexpected outages of those generators. As the direction

[15] Ibid, p.85-86
[16] Ibid, p.81
[17] Ibid, p.14

and magnitude of power flows change rapidly due to the variable output of renewable resources (e.g., wind speed, cloud cover, etc.) increased flexibility and innovation in planning and infrastructure are needed to adapt to new and shifting periods of stress. The grid operators tend to prepare for winter and summer peak loads based on historical data, but those forecasts may no longer be as reliable due to climate change. As such, the grid will be running on thin margins and insufficient energy production as the more reliable resources become uncertain and rare. While we are still figuring this out, the existing thermal capacity should provide the reliability and system resilience cushion necessary to maintain acceptable system operation. During this transition, we need to make the best use of the resources available as they are a viable and extant solution to bridge the gap between the grid of the present and the grid of the future.

V. Conclusion

In conclusion, Quanta Technology appreciates MISO's willingness to consider stakeholder feedback on the RIIA study. In the near-term, we urge MISO to examine our proposed solutions to the current planning process to maximize the thermal generation available in order to objectively assess and develop the cost-effective mitigation measures necessary for reliability and resilience. In the long term, MISO should explore (with stakeholders) the adoption of a more pragmatic approach to achieve economic and long-lasting grid reinforcement plans that will realistically and harmoniously accommodate the renewable operation and, at the same time, provide the same reliable and resilient electric services consumers have enjoyed for years.