Resource Reliability in a Changing Environment

Thomas J. Butz

10710 Town Square Drive NE Suite 201

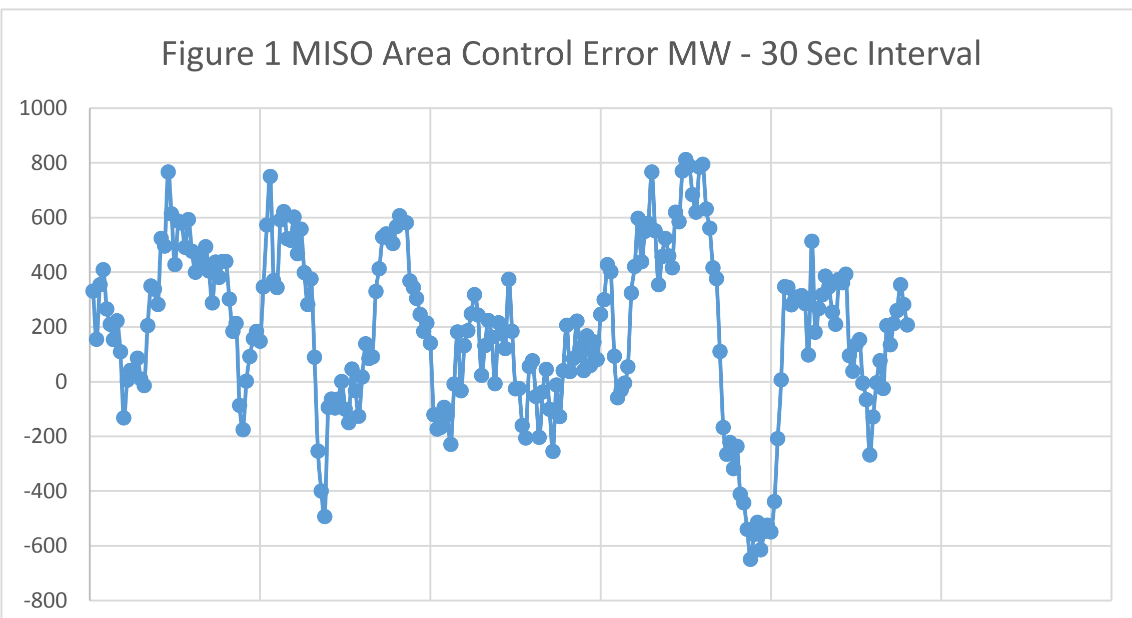
Minneapolis, MN 55449

612-961-9495

It is safe to say that everyone agrees that electric reliability is important, and there are measures in place to evaluate the reliability of the electric system. The most common metric for evaluating electric reliability is to compare the peak MW load including planning reserves with the capacity available on the system. There are a number of variations on how this has been implemented in individual NERC planning areas, and currently in the MISO RTO, there is a defined approach defined in Business Practice Manual (BPM) number 11. The current version is r15 dated 9/1/2015. BPM-011 provides the full description of how MISO currently maintains and evaluates electric system reliability. The approach is complete and adequate for our current configuration of electric resources and usage, but will certainly need to be changed in the future with expected changes of higher saturation of renewable resources, and Distributed Energy Resources.

The purpose of this paper is to touch a number of topics seeking to compare today's approach with what may be needed in the future. The process of changing a reliability approach and a BPM is extremely compacted and involves a wide range of stakeholders. This paper will not be a template that can simply be plugged into a revised approach, but will provide a snapshot on some of the areas that will need to be reviewed.

Electricity is unique as an energy form in that it is produced, transported, and utilized in virtually the same instant of time. One system metric that provides the indication of this phenomenon is a system frequency measure, where the nominal frequency of 60 cycles/second has actual variance on a moment by moment basis. System operators use the Area Control Error (ACE) variable that tracks how close the system is matching load, generation, inflows and outflows of power on a 5 second interval. The ACE equation has both a MW flow value tracking the balancing of the electricity, and also a term of frequency / MW value, to show the impact of load imbalances on the system frequency. Figure 1 shows a sample of MISO MW ACE value for the real time – 30 second intervals - September 19, 2016.



Another system design indicator of the balancing of load and generation, inflows and outflows of power is the underfrequency load shedding that is designed into the electric grid. When there isn't enough generation to serve the load, the frequency drops. The underfrequency load shedding requirements are designed to provide protection to the system when there isn't enough generation to shed the load to avoid a total system collapse. The NERC Standard design is to shed 10% of the load in three discrete steps of lower frequency. The first step is 59.3 hz, the second is 59.0 hz, and the third is 58.7 hz.

ACE is provided for each balancing authority, which at one time before MISO offered ancillary services, there were more balancing authority boundaries on the electric grid. MISO provides a real time indicator of the system ACE, which is a metric on the system being balanced, and how real time variations of load and generation cause the system frequency to vary, up and down. Whether the electric system is an interconnected grid, such as the eastern interconnect in the US, or a small island, the real time delivery of electricity matching generation and load at virtually the same instant of time is a reality for both sitatuations.

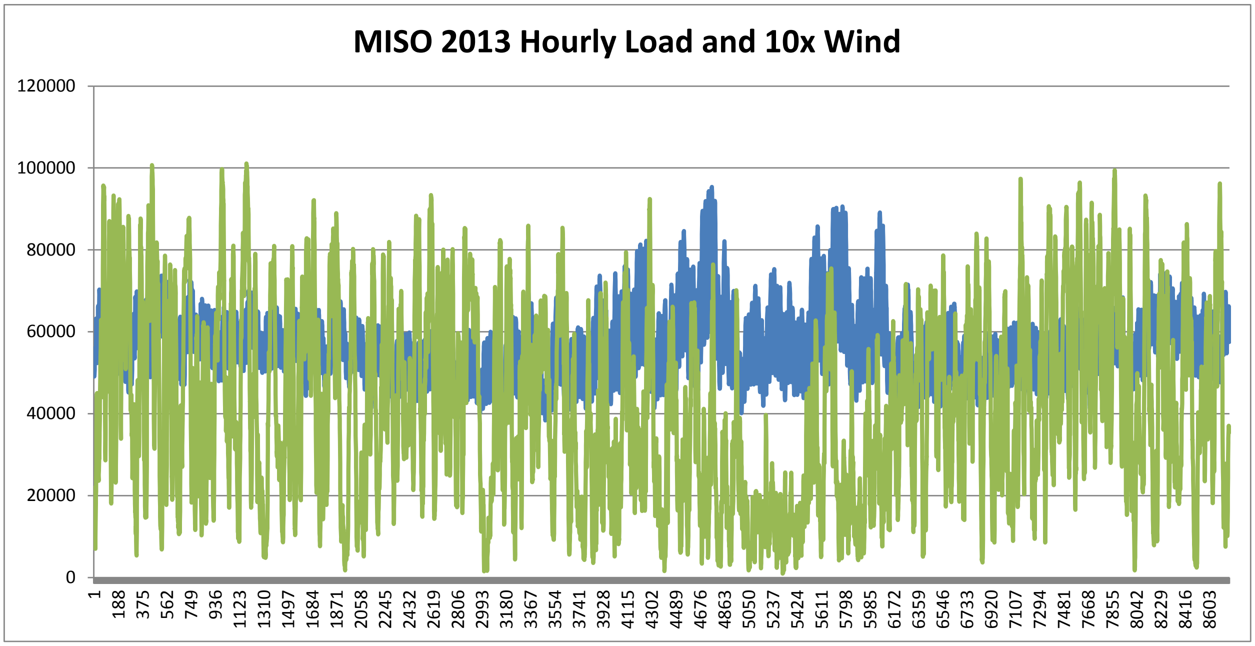
Reliability is an attribute of the electric delivery system that is commonly agreed upon of its importance. The impact of power outages moved from an inconvenience for shorter outages to having higher levels of impact for larger outages, or longer outages, such as hurricanes or tornadoes. It is useful to break down the outages by the facilities that are causing the outages. In a central station electric grid, it is much more common for outages to be caused by the distribution and/or the transmission system. As defined in the MSO BPM 11, central station large scale generation has zones defined where there must be adequate generation resources, or the capability to import capacity if needed to meet peak load requirements. The current design allows a seamless provision of capacity across the zone. The likelihood of an outage related to generation resources not being available is much less likely, unless the outage is of such a magnitude that it covers a very large geographical area, such as the 2003 outage. Load serving entities are required to secure enough capacity to meet the peak load requirement within the zone, plus have a planning reserve of 13-15%. The planning reserve is designed to account for forced outages of generation units, and uncertainty in other system conditions. Keep this in mind, when we discuss the move to a Distributed Energy Resource approach, as this must be considered as to what reserves should be maintained, when the likely footprint or zone of providing the sharing of reserves would be much smaller, due to the expected lower capability of the distribution system to move power over larger zones. The distributed resource approach is expected to be a smaller zone to share reserves.

The current resource adequacy requirement for MISO is based on a peak demand and resource capacity. There are provisions for how all types of generation resources can provide system capacity, including both conventional and renewable generation. Resource adequacy provides an evaluation for system reliability by using both a complex evaluation of demands, coincidence of the individual system demand with MISO, and the planning reserve requirements. As an additional analysis, MISO performs an evaluation of making sure that system does not have any more than one day in ten years where the system would not have enough capacity to serve the system. This evaluation is used to set the planning reserve requirements.

Although the current resource adequacy is thorough and complex seeking to make sure there is adequate reliability on the system, when the analysis is completed, the only metric that is used to indicate either excess or shortage of capacity is the MW value. There is a thorough methodology to determine the planning reserve capacity based on GE MARS simulation and a maximum loss of load value allowable for the system. The immediate concern about the current method is that there isn't a reflection on the types of capacity that are on the system, where some types of capacity have more flexibility in terms of being available. By the current method, if there are resource additions being made to the system that are less reliable, the need for planning reserves would be expected to be higher, and cause an increase in the number of MW of capacity that need to be added to the system. The concern that needs to be dealt with in the future is that the current method does not provide a metric on the type of capacity being added to the system. Some capacity is economic to run at higher capacity factors, some is most economic at lower capacity factors. There are also some types of capacity that are dependent on the wind or sun, and this results in parameters on how the resource can be dispatched. Treating all MW as the same type of capacity could have issues if the balance of MW is drastically different than the current system.

Electric System Reliability in the future will have a higher dependency on being able to produce adequate energy for all periods of time throughout the year, rather than only having the focus on the system peak hour. Higher penetrations of solar DER installations, and more dependency on energy storage systems will drive the need to evaluate the ability of the system to provide adequate energy. It will also be important to account for energy losses for both the storage and discharge cycles. The evaluation of reliability in a DER environment must be rigorous, and thorough, and cannot be simply expressed in general terms that "storage will allow matching the shape of the production with the load shape".

Historic wind and load profiles can be used to provide a high level assessment of the resource needs in conjunction with higher level of renewable energy. MISO wind capacity for 2013 is reported to be 13,127 MW. For a scaled increase of 10.2 times the wind, the nameplate wind capacity would be over 130,000 MW. The actual loadshape maximum of the scaled wind shape is over 100,000 MW and would provide over 70% of the MISO energy. The following figure shows the MW dispatch of the 10x wind resource against the actual load for 2013.



The remaining amount of energy needs for MISO are surprisingly high, with a need for 84,000 MW of capacity that would need to be dispatched nearly 25% throughout the year in order to match the generation and load. This example is extremely simple, but allows the evaluation of extremely high levels of wind to be shown using the actual wind data from MISO, which does have an inherent amount of diversity within the historic data.

The same analysis of 2013 data can be used to evaluate the impact of an electric storage system. Losses for storing energy are assumed to be 10%, as are the losses to convert the storage to serve the power needs. For the 2013 period, the maximum amount of storage need is 84,000 MW. The scaling factor that would allow to have adequate energy from the wind in order to have enough energy from an electric storage system is in the range of 16 times the current wind. The storage system for MISO would have to produce as much as 84,000 MW of peak energy, and have the capability to store energy for 740 hours.

The implementation of DER, smart grid technologies, demand response programs Distribution System Operator, and many other trends will result in a need for more rigorous and clear indicators of system reliability based on the characteristics of how the system is expected to be operated. Most of the current literature in this arena focusses more on the operation, technologies, and market price indicator aspects on the utility system of the future. There are a number of key decision points and metrics that don't appear to be getting adequate consideration. These points will need to be clarified, and allow parties to make adequate investments in order to be assured that the system will be reliable in the future. It appears that that is a need for additional considerations, including the question of the amount of load serving responsibility that is being provided by the DER needs to be clarified. This might sound like an old fashioned description of what is being proposed to be solved by a more dynamic system of being able to provide resources from DER, demand response programs etc. If the impacts from DER and demand response are two examples that need to be demonstrated to be adequate to displace the need for central station resources and transmission, then the transmission and distribution areas of the system will know what load levels must be included in the planning cycle.

The flexibility that is being purported to be a new operating paradigm cannot be demonstrated to have adequate reliability without showing this in the planning analysis.

In simple terms, if you don't make it clear which resources are needed to serve the load, whether DER, or central station, there is no assurance that the system will be reliable in the realm of real-time operations. If you don't clearly designate the capacity provided at the distribution level that can be shown to relieve the need for system capacity at the central station generation and transmission level, there will not be any savings in capital investment. The planning cycle is defined in terms of years and this is the realm where reliability must be clearly demonstrated. Once the system can be shown as being reliable in the planning cycle, the flexibility and economics can be optimized in the timeframes in the Day Ahead and Real Time operations. Clearly the MISO Resource Adequacy procedure needs to migrate to an approach that properly reflects not only the type of capacity resource being utilized, but also how a system with higher levels of DER will maintain adequate levels of reliability in the future.