Power Asset Monitoring: Renewable Energy Plants Differences Versus Utilities?

by **Dan Roth**

Photo: Dynamic Ratings

It is no secret that energy policy in North America is focused on increasing the availability of renewable energy resources to meet environmental objectives. This policy extends from tax subsidies to encourage construction of utility scale wind and solar sites to federal grants to support transmission infrastructure to deliver this energy from generation to load centers. Policy is also in place to accelerate the deactivation of fossil fuel generation sites. Wind, solar PV, and hybrid generation are projected to be the primary additions to the resource mix over the next 10 years; this leads the continued energy transition as older thermal generators retire [1].

What is surprising is that there are several areas of the country that are projected at High or Elevated risk levels of inadequate electricity supply driven in many ways by this energy transition. Generator retirements and increasing demand are outpacing planned projects to maintain necessary energy reserves [1]. This puts an ever-increasing concern over the availability and reliability of existing installed renewable energy sources.

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When adverse conditions occur from extreme heat and cold temperatures it is critical to the reliability of the bulk energy systems that these generating resources are available. From a plant owner perspective, these times of adverse conditions are also the most profitable to produce energy creating an additional incentive to keep plant online.

These key points above have many owners and operators of renewable energy sites hyper focused on maintaining uptime and providing highly reliable energy to the grid.

These sites are also starting to be deemed as more critical to the overall infrastructure to the grid which is bringing more and more reporting requirements. These reporting requirements can be arduous and costly given the remote nature of many renewable energy sites. There are many elements required in a successful asset management strategy, but online condition monitoring is starting to become the gold standard. Online condition monitoring provides the information needed meeting reporting requirements as well as proactively address asset health conditions before they impact site reliability.

Many wind farms today already have sophisticated monitoring for the mechanical systems in the wind turbines themselves. The problem is this philosophy has not commonly been extended to the balance of the plant and electrical infrastructure needed to deliver generated energy to the grid and more specifically net metering interconnect where revenue is realized. Typically, the plant boundary is where the revenue meter installed on the high voltage bushings

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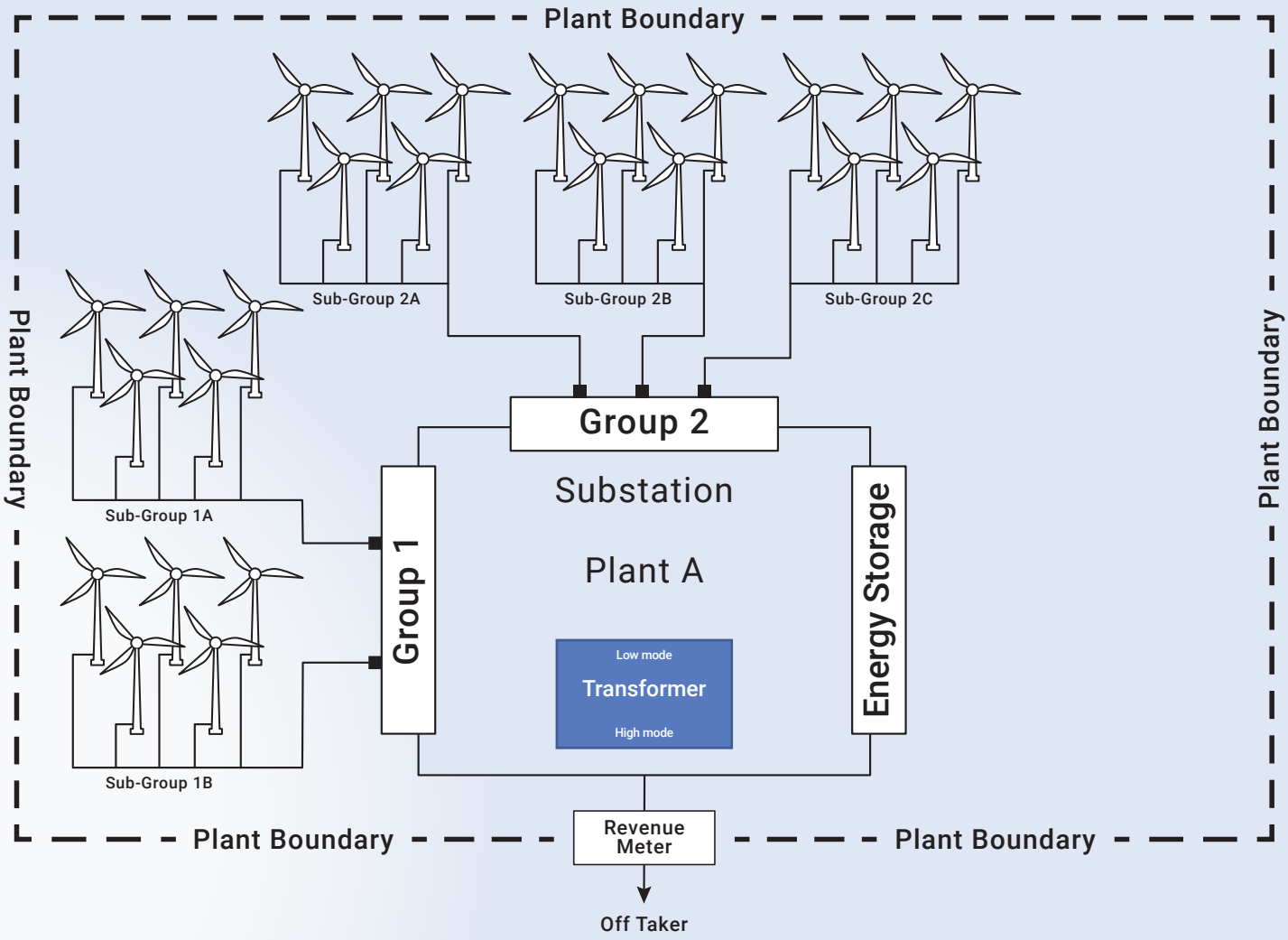
Figure 1: Typical Wind Plant Layout [2]



of plant Generator Step Up (GSU) transformer [2] as shown in Figure 1. If the feeder circuit breakers or GSU transformers fail unexpectantly, the result can be millions of dollars of loss revenue from a single outage.

Today's online monitors are capable of monitoring the condition of circuit breakers, switchgear and GSU transformers from a common platform. This includes the monitoring of electrical, mechanical and insulation systems [3]. This capability allows for needed standardization within a single plant and a common look and feel for plant operations. The benefits of condition monitoring extend beyond just detecting degraded performance and risk mitigation. The monitors themselves can simplify PRC reporting for battery systems and circuit breakers alike by automating the process and eliminating routine inspection requirements. This helps owners reduce their operation and maintenance (O&M) budgets to further

support the deployment of monitoring technology system wide.

Another challenge that extends beyond immediate financial returns of improved reliability and reduced O&M budgets is the availability of replacement assets in the event a problem arises, or when failure does occur. Extending the life of an asset and getting early warning of developing issues is crucial in navigating transformer supply chain environments. Large power transformers are commonly available at five (5) year lead times with very limited availability of spares [4]. Much has been written about transformer supply chains in the last few years, but this is very large and complex issue to resolve. It is important that all renewable plant owners and operators have a resiliency plan in place for these long lead time items.

Many utilities will carry their own inventory of spare transformers, but this practice is not common among renewable energy owners except on the lower MVA distribution class transformers. Another approach is implementing substation design principles to have full redundancy to eliminate single points of failure. This has not commonly been done in the industry because often the original owner during construction and development phase is different than long term owner/operator and there was no total cost of ownership considerations during construction. This makes continuous online condition monitoring a far easier first step to provide a level of risk mitigation while still providing long term benefits.

Once a renewable owner/operator decides to move forward with a balance of plant asset management strategy, the same driving forces creating the need to implement a monitoring system become challenges to overcome in the implementation. Large wind farms can only incur short outage windows and associated loss revenue to install monitoring equipment. The reason for this is the loss revenue can destroy the return on investment of monitoring if outage is extended too long. This creates certain challenges in project management, and commissioning that must not be overlooked. Even short outages can cause significant delays in restarting an entire feeder of connected turbines because of various mechanical and electrical issues associated with restarting turbines.

The best solution is to have a substation design with high redundancy. Substations utilizing a breaker and a half scheme are ideal for installing HV circuit breaker monitoring. This bus configuration allows all breakers to be fully commissioned with monitoring equipment without taking an outage.

Since it is impossible to switch all feeders to adjacent bus because of available fault current, it is more to take outage in original bus configuration. Often the delays in restarting turbines and complications that arise from trying to switch feeders individually undermine efforts to maximize revenue output by segmenting buses. Since the entire bus is being taken down, the breaker

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monitor commissioning should be coordinated with installation of transformer bushing monitoring that also requires an unavoidable outage as part of installation process.

In order to minimize outage windows and the impacts to revenue it is important to have an effective project management team. Project teams need to work closely together to make sure all the appropriate approvals and risks are understood when performing pre-outage work. This includes completing as much work as possible during pre-outage work dates. Cabinets should be hung and conduit run with care in hopes that monitoring will soon be there. To further expedite the time it takes to install sensors, such as bushing & temperature sensors, many sites are preferring armored cable in leu of traditional conduit runs. Miscommunication at this stage can be very costly if the commissioning team is intending to complete work that the site manager denies because of previously uncommunicated concerns. Before outage work begins, proper grounding and safety work practices must all be cleared defined so that work can begin immediately after outage is taken because time truly is money in this case.

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