INTEGRATING SMALL SOLAR FARMS

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The construction of small solar farms is running ahead of grid integration rules in many areas, and that can be a problem for utilities. In states where there is nothing like California's trendsetting Rule 21 in place to oversee the process – and FERC rules do not apply – utilities are finding the best way to manage this solar flood is to "smarten" their transmission and distribution grids.

By embracing the smart grid, utilities are not only mitigating the technical difficulties associated with integrating solar farms, they are also putting themselves in a position to benefit from the enhanced stability and reliability renewable generation can provide. On a broader level, investment in a smarter grid can directly benefit ratepayers – through the use of the most economic technologies, designs, and operating practices – while also helping states meet their renewable portfolio standard goals.

YES, SOLAR IS DIFFERENT

Until very recently, when distributed generation was added to distribution systems, it was fossil-fueled, synchronous, and exhibited familiar electrical characteristics. Not so with today's solar inverter-based generation.

When presented with applications for the integration of small solar farms, utility engineers are finding they must deal with an entirely new set of issues, not the least of which is whether they want to control or just monitor these solar facilities.

It's important to mention that utilities often lack control over when and where solar farms are sited. As such, distributed generators are often clustered, resulting in a higher-than-average penetration on individual distribution feeders. This means that the connection of solar farms to the distribution grid can have a massive impact on existing equipment, especially distribution transformers – an impact that can be obscured in the rush to go green.

MINIMIZING THE IMPACT

The integration process generally begins when the solar developer submits an interconnection study describing the project in detail. This report will include generation and control equipment as well as interconnection points, whether such equipment is "certified," and whether the generator will connect using the utility's equipment (cables, transformers, switches, etc.) – even if that equipment is behind the meter. If the developer intends to use utility equipment, an "added-facilities" contract may be required, and that could give the utility additional control over the project. At that point, the utility begins its own due diligence. This includes analyzing the site and modeling various generating scenarios to determine the impacts on their grid.

Once the interconnection study has been analyzed and modeling completed, utility engineers can begin to answer initial questions. As noted earlier, one of the first things utilities need to consider when integrating small solar farms is not just how they are going to connect to them but also how they are going to isolate them when necessary. Many times power from renewables will go to one or more transformers before it's distributed. It's far better to aggregate the power and then bring it onto the network through a single transformer, so it can be controlled and isolated more effectively. If you don't do it this way, you'll have a lot of issues with power factor and power quality.

Further, if the utility can affect the choice of inverters used on small solar farms, it's better to use string inverters and aggregate power at one node. String inverter technology has improved dramatically in the last four or five years.

Next, it is critical for utility engineers to determine – among other things – whether their distribution transformers, feeders, and other equipment have sufficient capacity to accommodate the additional generation from these small solar farms.

Make no mistake, integration issues increase with the size of the solar farm. If we're dealing with a 1 MW farm, the whole network is affected, and utilities should be concerned with system-wide protection schemes, coordination, SCADA, etc. But smaller farms, those adding a few kW of power to the grid, will generally not cause significant disruptions.

The ideal approach is to modularize the solar farm, building it in increments, and adding string inverters as you go along to get the voltage you want.

But no matter how the solar farm is developed, one of the biggest challenges is the high learning curve utilities face when they take over. How is it going to respond to loads? How will the utility handle intermittency? How much to reduce power output and for how long? When to take or dump power? All these things need to be discussed and planned.

ENSURING INTEROPERABILITY

Interoperability is the ability of grid components to communicate to one another through common protocols and standards-based application program interfaces (API). When it comes to integrating DER, new systems and components must be interoperable – not only with each other but also with legacy systems and components. Ideally, utilities should be able to integrate DER – including solar, wind, and energy storage – in varying sizes, in numerous

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locations, and from a variety of vendors with their advanced distribution management systems (ADMS) and supervisory control and data acquisition (SCADA) systems.

But clearly, this is easier said than done. According to EPRI's "Common Functions for Smart Inverters, Version 3" report, utilities face two slightly different issues: No common, standards-based protocols that allow multiple vendors to be integrated, and therefore no interoperability; and no common view of the specific functionality, or services, that these products would provide.

ENERGY STORAGE WILL BE INDISPENSABLE

Of all the issues involved in integrating small solar farms, intermittency – and the problems it creates for grid stability, reliability, and safety – is often paramount.

That makes energy storage an important next step in the evolution of the smart grid. While energy storage isn't a critical element at the grid level just yet. It is becoming increasingly important. The New York Public Service Commission takes it one step further, asserting that, increased use of load control, smart devices, and energy storage will make renewable resources more economically efficient.

In the Northeast, for example, states are seeking protection from future megastorms like Hurricane Sandy, which ravaged power systems in 2012. In California, where solar generation is king, the state has mandated that investor-owned utilities install 1.3 GW of storage by 2020.

Utilities are realizing that to maximize the value of energy storage, it has to be an integral part of their networks, not just something that's bolted on to meet a local need. An energy storage management system (ESMS) that determines when a storage system should be used – and then employs it for the greatest benefit at any given time – is the key to helping utilities achieve peak performance on their distribution grid.

CONCLUSION: A SMARTER GRID FOR GREATER CONTROL

Clearly, the pressure on utilities to integrate small solar farms is increasing at the same time society is demanding more reliable, higher-quality power for everything from advanced manufacturing to communications to data centers.

To get out in front of these potentially conflicting demands, utilities and regulators are increasingly moving toward grid modernization. This trend is based on the fact that smart grids not only help utilities manage the impacts of DERs at the local feeder level but also at the transmission and centralized generation level.

Smart grids do this by monitoring transmission and distribution systems in real time to anticipate problems – and then reacting to resolve those issues within a fraction of a second, even isolating grid segments when necessary.

Further, they will do so whether such problems are caused by equipment failure, human error, terrorist attack, or solar intermittency. But smart grids are much more than problem-solvers.

Planned and built properly, smart grids will also optimize networks and provide utilities a new level of commercial benefit and operational control – even over small solar farms.

ABOUT THE AUTHOR

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Gary has been with ABB for more than 25 years. Gary is past chair of NEMA's Smart Grid Council and member of DistribuTECH Advisory Committee, US Department of Commerce Renewable Energy and Energy Efficiency Advisory Committee, and IEC Smart Energy Systems Committee.

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tronics can be embedded within a structural material. Such capabilities promise to revolutionize the electronics industry by allowing for smaller, lighter, more efficient and more customized products.

Nano metal based conductive inks are critical to the growth of the printed electronics industry because they enable the use of inkjet printing technologies, which are digital, faster, cheaper, simpler and more versatile than conventional printing technologies.

Because the technology is non-touch, there is no significant impact on the substrate, and as the inks can be sintered at low temperatures, they allow the use of flexible, temperature sensitive (but inexpensive) substrates made of plastic or even paper.

Moreover digital printing technologies allow printing on non-flat surfaces and 3D printing.

LEAP INTO THE FUTURE

PV Nano Cell's Sicrys™ inks are slated to become the catalyst for this leap into the future. The conductive inks deliver enhanced performance characterized by a unique combination of low cost, high conductivity, long shelf life, low sintering temperature, robust printing and low viscosity, placing them well ahead of competing products.

PV Nano Cell recently signed a Memorandum of Understanding with a leading manufacturer of printed circuit boards, creating the first mass production printing of PCBs using a digital conductive ink printing process. Sicrys™ conductive

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