The Science and Economics of Repowering

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New multi-megawatt solar installations are growing rapidly, which is great news for the environment and the economy. With that growth comes falling prices, both for power purchase agreements (PPAs) and solar gear including PV modules, inverters and other equipment.

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But what about the people reading this article who got into large scale solar earlier in the game, with PV plants now between five and ten years old, or perhaps even older? How are your PV assets performing now? It's quite likely there is significant untapped potential in those assets that could provide you increased returns on your existing portfolio by boosting yield and decreasing operating costs.

There is sound science behind how you can do so, the application of which will have some very significant economic benefits.

Turning your central inverter into a string inverter

One of the great debates in the solar industry at the moment is the one over central versus string inverters. Settling this debate is beyond the scope of this article. What is in the scope of this article is explaining that one of the arguments string inverter advocates make in favor of their application is their more granular maximum power point tracking or MPPT. For those unfamiliar with this term, MPPT refers to the technique for determining the maximum amount power a PV module can produce.

Central inverters generally offer one maximum power point tracker for the entire PV array that feeds into them. For example, say a 500 KW PV array has 84 strings connected to a central inverter with one MPPT (MPPT can also stand for maximum power point tracker or the software and hardware that actually does the maximum power point tracking). That means the central inverter looks at each string in the array as if they were the same from a power production perspective. The problem, particularly in aged PV plants, is that those strings are anything but the same in this regard. This lack of similarity is called mismatch.

Mismatch can occur on a day to day basis due to issues such as cloud cover or

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uneven panel soiling. Those mismatch issues are typically more pronounced in residential systems i.e. most larger systems are not built in shady places. What can be pronounced in older utility scale systems is mismatch in MPPT characteristics due to uneven degradation that has occurred over the years. Degradation refers to the amount the performance of a solar panel decreases over time.

Uneven degradation, which invariably occurs as panels deteriorate, means over time, those 84 strings we referred to above start to behave very differently and those differences mean you could be leaving a significant amount of energy production "in the array." If you think of harvesting energy as akin to harvesting an agricultural product like corn, you could think of having one MPPT for a field of degraded panels as analogous to leaving quite a bit of overripe or underripe corn in the field after a harvest.

By retrofitting your plant with a string level optimizer, you can mitigate this problem by performing MPPT at the string level. In this way, you will be sure to "optimize" the yield of your plant.

In scientific terms, the best way to describe this effect is to look at the total power produced by adding up the power produced by the individual MPPTs of each string versus the MPPT of the entire array previously controlled by the inverter's single MPPT. When doing so, you see the total power produced is measurably higher, with the more granular MPPT adding anywhere from 5 to 15% more power produced for a plant that is suffering from excessive degradation related mismatch.

The economics of utility scale PV retrofitting

Once you understand the yield benefit, you can quickly determine the economic impact of such an investment in your plant. In understanding the economic impact of an optimizer retrofit, you essentially need to know a few parameters: the incremental value to you of each additional kilowatt hour of energy produced, the amount of additional energy the retrofit will yield and of course the cost of the retrofit, inclusive of installation cost. Based on these factors, you can quickly model the return on investment of such a proposition inclusive of any tax equity considerations such as accelerated depreciation.

What's interesting about PV retrofit opportunities is that they provide the highest ROIs to PV plants whose performance they are best poised to improve. As stated above, older plants suffering from any variety of panel mismatch issues will generally have higher value power purchase agreements and/or other arrangements that create incentives for production. For example, in the U.S. states such as a Massachusetts and New Jersey have very favorable solar renewable energy credit programs (SRECs) which create a strong incentive to produce more power from existing PV assets. In Europe, these incentives come in the form of feed in tariffs. This symbiotic effect clearly makes retrofits on older PV assets a very attractive economic proposition.

O&M advantages

Retrofitting with string level optimization can also provide a number of qualitative benefits beyond just yield improvement. Appropriately equipped string level optimizers can also provide a number operations and maintenance (O&M) benefits. For example, optimizers could be equipped with on-board arc and ground fault detection, which can inject a higher level of safety into a plant. Again, this is more important in older plants where conductors are that much old and more susceptible to such issues. Additionally, if an optimizer is galvanically isolated, it can create a force field of sorts between the PV and the inverter, shielding the inverter from any harmful faults that might occur in the array. String level optimization also generally entails string level monitoring, so plant owners can have much more granular visibility into the performance of their PV plant.

The solar industry has sustainability built into its ethos. Retrofitting existing PV assets would seem an activity decidedly consistent with such a view, though doing so also has a very sound scientific and economic basis.

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