Comments on the Solar Alliance Proposal for Changes to New Jersey Interconnection Rules

Submitted to New Jersey Board of Public Utilities

By Qado Energy Power Engineering Team

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In comments dated April 29, 2011, the Solar Alliance (SA) proposed changes to New Jersey's Interconnection Rules (IC Rules). The New Jersey Administrative Code (NJAC) currently defines the screening criteria for three levels of distributed renewable energy sources, in NJAC 14:8-5.4 through 5.6. Solar already receives preferential treatment in the IC Rules. In addition to streamlining processes, the SA proposes these increases in solar generation to be accepted without review:

- Aggregate solar nameplate capacity up to 23% of the circuit peak load. Currently, the limit is 15% for solar and 10% for other sources.
- For additional non-exporting solar generation using reverse power relays, accept aggregate nameplate capacity up to 50% of the circuit peak load.
- When real-time load monitoring is available, accept aggregate nameplate capacity up to 75% of the actual circuit's minimum load between the hours of 10 a.m. and 3 p.m.

None of these proposals should be accepted as no-study criteria. It is recommended that circuit-level monitoring and analysis be considered to maximize renewable energy penetration levels, possibly with per-MW charges to interconnect on "advanced" circuits.

Figure 1 below illustrates two radial circuits which include a variety of renewable energy sources, shown in **green**. Most of the renewable sources in Figure 1 are photovoltaic (PV), but the circuits may also include combined heat and power (CHP), wind, fuel cells, landfill gas (LFG), and other types not shown. The circuits are segmented by circuit breakers, automatic reclosers, and fuses, shown in **red**. The circuits also include voltage regulators and switched capacitors, shown in **blue**.

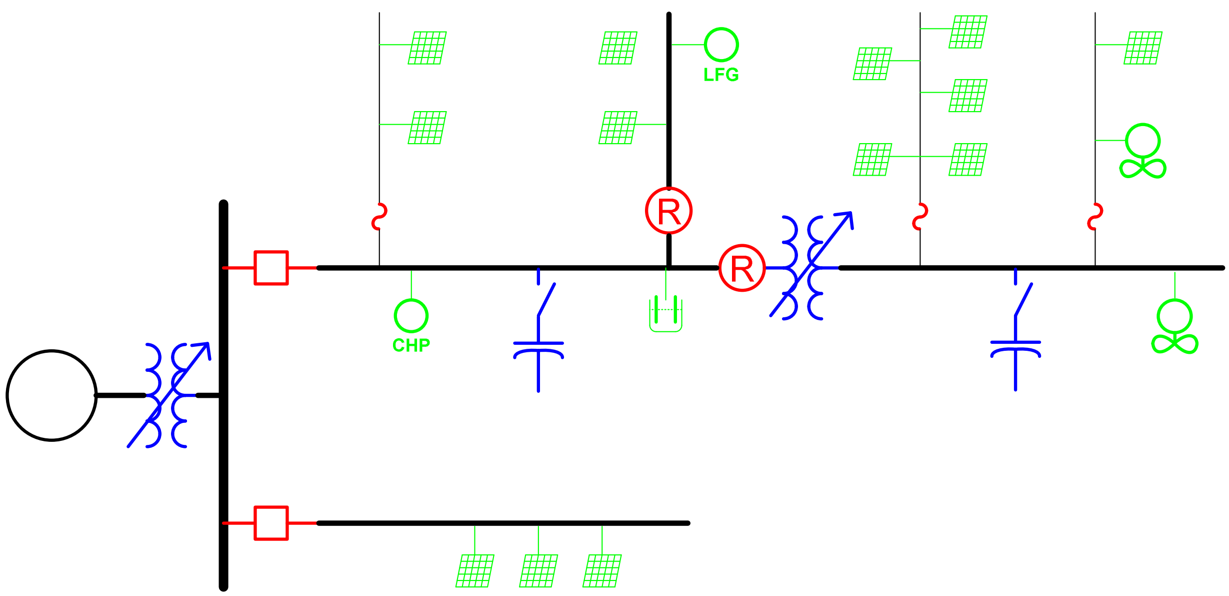

Figure 1 - Segmented Radial Circuits with a Variety of Distributed Generation

Figure 1 illustrates two key factors overlooked in the SA proposal:

1. Solar is not the only renewable energy source contemplated or allowed in New Jersey. The other sources follow different time profiles than solar, and changes to the screening levels must not be based on solar time profiles alone. The SA proposal does not account for up to 10% of peak load in non-solar sources that may be connected to the circuit.

2. The IC Rules currently apply screening levels only to the feeder breakers in Figure 1. In fact, the circuits are segmented into switched sections, which may not have uniform distributions of renewable sources. For example, one fused single-phase lateral in Figure 1 has significantly more PV than the other two. Screening should actually be applied segment-by-segment.

Basis of 10% or 15% Screening Rules

The purpose of a screening rule, on percentage capacity, is to conservatively rule out the possibility of unintentional electrical islanding for more than 2 seconds. Such islands are likely to cause damaging overvoltages and frequency excursions. According to IEEE 1547 and 1547.2, one way to rule out islands is to ensure that distributed generation (DG) is no more than 1/3 of the minimum load in a "Local EPS". In terms of Figure 1, this applies to each segment delineated by **red** switching devices, any of which might open (or melt) to create the island. The 1/3 minimum load criteria comes from a 1987 IEEE paper by Gish, Feero, and Greuel, which found that under lighter loads than that, ferroresonance can sustain islands with induction or synchronous generators. Ferroresonance is a non-linear phenomenon, which is difficult to analyze for each case, but the screening rule is based on both laboratory tests and simulations.

One might argue that PV inverters would behave differently than rotating machines, but in the absence of published studies and adequate inverter models, the IEEE 1547 working groups have not contemplated changing the 1/3 minimum load criteria. One might also argue that PV inverters can use the UL 1741 test as a means of islanding detection, but this doesn't help other types of DG that may be connected to the circuit.

IEEE 1547 and 1547.2 go on to describe that for some circuits, it may be appropriate to assume the minimum load is ½ of the peak load. But for most electric distribution companies (EDC), the typical circuit minimum load is 35-40% of the circuit peak load. In any case, the SA proposal should state that the "safety factor" is 3x, not 2x, while the rule-of-thumb ratio of peak to minimum load is still 3:1.

In general, 10% would be an appropriate and conservative screening threshold for any type of DG, and the IC Rules already specify 10% for non-solar. By allowing an extra 5% of solar DG, the IC Rules may already be allowing for time coincidence of solar output and load peaks, and relaxing the 3:1 peak to minimum load ratio. Some jurisdictions apply 15% screening thresholds for all types of DG, but those jurisdictions apply the screen to each switched or fused circuit segment.

Non-Exporting Generation

The SA proposal argues that non-exporting generation, if equipped with reverse power relays, can be safely embedded in the circuit beyond the screening threshold. However, reverse power relays only prevent the local DG from islanding. They are one of several islanding detection methods listed in IEEE 1547 and 1547.2, along with the 1/3 minimum load criteria. The reverse power relays don't prevent other DG on the circuit from islanding.

For example, according to the SA proposal, suppose there is 27% non-exporting solar with reverse power relays on the circuit, and another 23% without. The total aggregate solar capacity would be 50% of circuit peak load. During an island condition, the 27% non-exporting solar would not produce reverse power flow, and would stay on line. The other 23% solar DG units actually see 50% aggregate solar on the circuit, and not the intended 23%. The screening criteria would be violated for that first 23% of non-exporting solar that was approved for the circuit.

Use of Monitored Load Data

The SA proposal suggests that more solar can be accommodated on circuits with historic load data. This is a good idea. In fact, most if not all EDCs have feeder-level load data, typically at 15-minute intervals, monitored at feeder breakers within the substation. However, very few EDCs have such data from reclosers, sectionalizers, and fuses out on the circuit. In terms of Figure 1, this means that minimum loads are not monitored within each segment. That argues against the aggressive upper limit at 75% of monitored minimum load, from 10 a.m. to 3 p.m., which SA proposes.

Role of Impact Studies

The SA proposal requests guidance and specification on the scope of impact studies, when required. The IC Rules already mention load flow, transient stability, and short-circuit protection. For variable power sources like solar and wind, the following topics are of special interest:

1. Voltage fluctuations, voltage regulation, reactive power control, and the possible increase in numbers of tap changes and capacitor switching operations.
2.
3. Islanding and temporary overvoltages. The solar vendors could help in this area by providing better models and more data on the behavior of their products under islanding and back-feed conditions. The UL 1741 standard currently tests only one device in isolation with matched load, but on actual circuits there are many devices of different size, type, and manufacture.

Expansion of IEEE Standard 1547

The SA proposal suggests that the New Jersey Board of Public Utilities (BPU) relax the requirement for strict adherence to IEEE Std. 1547, particularly in regard to active voltage regulation. Under the admittedly long title, IEEE has already begun a standards development project *"P1547.8 Draft Recommended Practice for Establishing Methods and Procedures that Provide Supplemental Support for Implementation Strategies for Expanded Use of IEEE Standard 1547".* This project is about 1.5 years through its 4-year lifetime. The purpose is to allow for high penetration levels and smart grid applications of DG, including but not limited to:

1. Active voltage regulation
2. Alternative islanding detection and fault detection methods
3. Monitoring and communications
4. DG data requirements
5. Power quality
6. Aggregate capacity up to 20 MW
7. Optimizing grouped behaviors of DG

The standards development process includes semiannual working group meetings, on-line writing group sessions, formal comments, and formal ballots. Representatives from EDCs, vendors, universities, renewable advocates, and consultants all participate. The process should result in a technically sound document, and after final ballot resolution, the BPU could adopt 1547.8 in addition to the base 1547 standard.

Accommodating More Solar Generation

It is desirable to integrate higher levels of renewable energy on distribution circuits, and make it more compatible with integrated volt/var control (**blue** devices in Figure 1) and other smart grid applications. In order to do that safely, a holistic view of the circuit should be taken:

1. Real-time load monitoring of each switched segment, at the **red** locations in Figure 1.
2. Consider time-dependent output profiles of all renewable energy sources actually connected to the circuit.
3. EDCs to provide rapid assembly of up-to-date circuit models to perform impact studies.
4. Vendors to provide adequate models for islanding and overvoltage analysis with multiple DG units connected to the circuit.
5. Possible participation of DG in volt/var control or optimal power dispatch.
6. Allow more DG capacity than the screening thresholds, whenever the circuit parameters and impact study results warrant it.
7. Update the circuit-level impact study as loads change, more DG is added, more smart grid applications are deployed, etc.

Some of these items could be relatively expensive, and the cost might be shared among all DG units that are connected to the circuit.

Proposed solution to the problem

Qado Energy proposes that the New Jersey BPU fund a project that would enable all four NJ Utilities to leverage a centralized “multi-agent” modeling and simulation platform to accelerate and transform the Interconnection application and study process.

We propose that each utility work closely with the platform providers power engineers and software experts in the selection of 12 -15 feeders from their coverage area. The selected feeders should be able to be categorized into 5 class types and they should have different characteristics such as;

- Length
- Overhead or Underground
- Load Levels and Types
- Mix of DG assets
- Number of assets
- …

This classification of feeders will enable the utilities to be able to state they have X percent of feeders with Y characteristics and the corresponding models and behaviors of said classified feeders will provide the utilities and the BPU a firmer basis to set Distributed Generation targets and policy.

The 48 -60 feeders will be modeled and simulated with the Qado Distribution Grid Analytics platform. The feeder data will all be stored in the IEC DCIM standards format and provided back to each utility. Each feeder analysis will answer the following questions:

1. How much solar can be added to the feeder as is?
2. How can more solar generation be added to the feeder?
3. What are the costs of upgrading the feeder to accommodate more solar?

The modeling and simulation of the feeders will also be made available in real time to the utilities and the BPU via a secure website for ongoing review.

As the circuits are updated over time their models can be automatically updated and validated providing each utility a fresh baseline to support decision making. This dynamic library of circuit models will enable the utilities to visualize the static and dynamic states of the feeders as well as analyze other key factors. With on-going load data being provided to the platform, all parties will be able to find answers to the broader set of questions posed by the changing distribution grid and called out in the 7 line items defined in the *"Accommodating More Solar Generation"* section above.

In addition, the on-going use of the platform will enable utilities to automate the analysis of new feeders, creating an every growing library of up to date circuits which will further accelerate the interconnection fulfillment process. This platform approach will help alleviate the expert resource burden and decision bottlenecks being experienced in the Distributed Generation Interconnection process in the State.

Just as importantly it will create a standards based modeling, simulation and monitoring application that all utilities will be able to leverage, bringing consistency and repeatability to the interconnection process statewide. This will offer the utilities, developers and BPU a new level of understanding and transparency in the process of setting policy and targets. If the BPU chooses, the platforms "multi-agent modeling" capabilities may also be extended to model the market impacts of new policies and targets. For example, the platforms library of distribution feeder data could be leveraged to help policy makers model various "costs per kW" charges for interconnections in order to create a fair and balanced fee structure for all concerned parties.

For more information please contact us: information@qadoenergy.com