Supplementary Written Materials for the July 17, 2012 Technical Conference on the Review of Small Generator Interconnection Agreements and Procedures.

Respectfully Submitted by:

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The existing Small Generator Interconnection Rules and Procedures (SGIP) established in Order No. 2006 provides the opportunity for a proposed interconnection to be expedited through a Fast Track Process if the technical screens included in the SGIP are met. The Solar Energy Industry Association (SEIA) has recently requested that one of the technical screens (the 15% Screen included in Section 2.2.1.2 of the SGIP) be modified to allow more applications to qualify for the Fast Track Process. The following discussion explains that the existing 15% Screen is still valid and that the proposed modification poses several risks to the safety and reliability of the electric grid.

The purpose of the technical screens included in the SGIP is to determine whether a proposed interconnection can be approved in an expedited manner or if additional study is required to evaluate the potential impacts of the proposed interconnection on the safety and reliability of the system. The Study Process may yield concerns or it may not; however, without the Study Process any potential concerns will certainly not be discovered. Therefore it is prudent to ensure that the screens are sufficiently conservative to allow the Study Process to be implemented if there is any reasonable doubt as to the ability of the existing system safely and reliably to accommodate the interconnection. If an interconnection application does not qualify for the Fast Track Process because it does not pass all of the technical screens, it does not mean that the interconnection cannot be accommodated. It simply means that due diligence is required to study the interconnection request.

The Existing 15% Screen Is Still Valid

The existing 15% Screen included in the SGIP states "For interconnection of a proposed Small Generation Facility to a radial distribution circuit, the aggregated generation, including the proposed Small Generating Facility, on the circuit shall not exceed 15% of the line section annual peak load as most recently measured at the substation. A line section is that portion of a Transmission Provider's electric system connected to a customer bounded by automatic sectionalizing devices or the end of the distribution line."

This screen has to-date successfully allowed utilities to interconnect thousands of small photovoltaic (PV) systems without further study. It has also permitted utilities to identify those proposed interconnections that could negatively impact the safety and reliability of the system, allowing them to initiate a more thorough Study Process to identify and present solutions to overcome any safety or reliability issues that may be discovered. The existing 15% Screen has proven to be valid in a decade of practice. It has shown itself to be sufficiently conservative such that PV that has been interconnected on an expedited basis because it passes the screen has not proven to cause harm to the system. It has also shown itself not to be overly conservative in that it has permitted the expedited interconnection of thousands of PV systems. The existing 15% Screen continues to be valid, even after a decade because nothing material has changed in PV system design, distribution system design, or distribution system operations in the interim that would justify or require a change to the screen.

The specified 15% of line section annual peak load reasonably assures that the aggregate generation installed will not:

1. Create reverse power flows across the system
2. Negatively impact steady-state voltage regulation
3. Negatively impact power quality
4. Allow for the formation of an island

It is important to understand why the above issues are such a concern to utilities. When generation output approaches and then exceeds the load present, several known technical issues are immediately encountered:

1. During times when the aggregate generation capacity of all installed generation facilities exceeds local load, reverse power flows will occur on the primary distribution system. Reverse power flows through equipment can have unintended consequences, especially with protective devices and voltage regulators. Proper study is required to identify devices that may encounter reverse power flows and develop solutions to mitigate negative consequences through appropriate equipment upgrades and programming of microprocessor-based controls that have the capability to sense reverse power flow conditions and operate accordingly.

2. Once the aggregate generation output exceeds load, steady-state voltage rise can become an issue during periods of light loading and high generation output. This is especially applicable to feeders that are comprised of predominantly residential load, as loads may be lightest during the day when solar output will be the highest. Many utilities have a residential load profile that resembles a camel, where load peaks in the morning as homeowners rise and prepare to leave the house for school and work, drop off in late morning and early afternoon when solar energy is most abundant, and then rise again in the evening as people return home after solar has peaked and dropped off. In particular, situations where large penetrations of solar generation resources are located close to the end of the line, steady-state voltage rise may occur during light loading periods. This concern is exacerbated with rural utility lines that are typically longer and have lighter loading levels, which leads to higher impedance lines and more prevalent

steady-state and transient voltage issues. Proper study is required any time generation output approaches minimum load to determine the extent of any unacceptable levels of steady-state voltage rise and appropriate solutions.

3. Islanding occurs when generation facilities continue to keep a portion of the utility distribution system energized when the normal source is lost. IEEE 1547 requires that generation facilities disconnect from the utility system within two seconds after the normal utility source is lost. Most interconnection protection schemes of small distributed generation systems accomplish this with passive and/or active means. Passive means commonly include over/under voltage and frequency relaying. Active means check for an island by attempting to change voltage and/or frequency levels; if an island is present a voltage or frequency shift will occur and is thus detected. Active detection methods offer a more reliable means of detecting an island, but in large numbers, active detection methods may interact with each other and interfere with the detection scheme. Additionally, a large number of these systems may impact power quality as they attempt to check for an island. The closer that the aggregate generation capacity is to the load, the greater the risk of an island being formed and potential interference or power quality concerns from active anti-islanding schemes.

In addition to the issues noted above, as aggregate generation capacity approaches load, certain risks are increased and must be evaluated for the specific interconnection application and situation.

1. Individual small generation units suddenly coming online or dropping offline will likely not cause any appreciable abrupt voltage change on the system. However, large numbers of small units operating together due to a common event have the potential to create voltage sags and swells of large enough magnitude to affect other consumers. This is of particular concern considering that the majority of small generation facilities will be programmed with similar protective settings. Thus, conditions that would require each individual generation facility to trip offline would create a potential voltage sag if enough units trip offline at once. Conversely, these same generation facilities coming online suddenly after all conditions have been met to allow for safe reconnection could cause a voltage surge on the system. Cloud cover and rapid changes in wind may also affect many generation facilities at once, causing rapid change in generation output and thus voltage sags and swells.

2. Small generation facilities are typically single-phase systems. Therefore, imbalance stemming from unequal amounts of generation output on each phase is a valid concern. This is especially true with utility feeders that have a significant amount of single-phase lines present. Voltage unbalance on utility four-wire feeders can lead to a variety of issues such as unacceptable levels of neutral-earth voltages, increased losses, increased voltage drop or rise, and increased contribution to negative sequence voltage levels. Utilities have little control over where generation facilities choose to locate, leaving them to attempt to manage voltage unbalance through load shifts across the feeder.

The Proposed Modifications to the 15% Screen Pose Several Risks to Safety and Reliability

SEIA has proposed to supplement the existing 15% Screen with a screen that that would permit expedited interconnection of PV provided that aggregate generation capacity on the circuit does not exceed 100% of minimum daytime load. The proposal poses several risks to system operations.

1. First, the proposal is far more liberal, meaning far less protective of safety and reliability than the screens adopted anywhere in the country. Although the proposal resembles the California Electric Rule 21 on its surface, it is not the same. Rule 21 provides that if a proposed interconnection fails the 15% Screen, the 100% of minimum daytime load screen is applied along with several additional screens to evaluate power quality, voltage, safety and reliability, and only if all of these supplemental screens are passed, will the proposed interconnection qualify for the Fast Track Process.

2. Even if the Rule 21 supplemental power quality, voltage, safety and reliability screens are adopted with the 100% of minimum load screen, the proposal is still too liberal given the previously noted concerns when aggregate generation capacity approaches and then exceeds load. Applying a supplemental screen that uses 100% of minimum daytime load as its threshold not only allows for no margin of safety but crosses the line because many of the problems discussed above arise as 100% of minimum daytime load is approached, even if that level is not exceeded. Were the screen applied more broadly than SEIA has requested to cover proposed interconnections other than solar generation resources, it is possible that the aggregate generation capacity could be greater than minimum load during night time hours. Utility system planners study the system and create plans to safely and reliably design and operate the system such that it is not normally operating near its limits. Implementing a technical screen that allows the system to be operated at or beyond the threshold of when problems are known to occur without allowing for a step to study the possible issues is not good utility planning and undermines the utility's planning processes. Reasonable margins of safety need to be present in the technical screens to allow utilities the opportunity to review the potential impacts and develop solutions to any concerns found.

3. Another significant challenge to implementing a supplemental screen that uses minimum load is being able to accurately determine what the minimum load on a line section[1] actually is. Peak load information is maintained by utilities due to its importance in planning processes; however, minimum load is seldom of any value and therefore not determined. The term "minimum load" in itself is difficult to define given that changes in minimum load due to load shifts, maintenance, decreased customer usage or customer closings are real possibilities to be dealt with.

[1] Note that applying a screen based on minimum circuit load is orders of magnitude worse than applying a screen based on minimum line section load, as there could very easily be reverse power flows, local voltage and/or power quality concerns and islanding concerns present in certain areas of the circuit.

There are two primary methods to determine the minimum load on a line section:

1) Collect actual data from the field from deployed Supervisory Control and Data Acquisition (SCADA) systems and intelligent electronic devices, or

2) Estimate minimum load based on a power flow model of the system

Method #1 above for determining minimum load is the preferred method, but is not available if a SCADA system and/or intelligent electronic devices are not installed in the field. In today's world with all of the promises of the "Smart Grid", one might casually be misled into thinking that this technology is widely deployed; the reality, though, is that many (if not most) utilities do not have the devices and systems installed in the field to collect actual minimum load data across their entire system, particularly smaller utilities serving rural areas.

Method #2 above for determining minimum load is similar to what most utilities use to determine peak load on a line section. An engineering model of the system is created and power flow analysis conducted to determine how measured peak loads at substations and other critical locations on the system is spread out, or allocated, across each line section. One might then think that this method could easily be adapted to determining minimum load on each line section; however, loading characteristics are much different during times of minimum load than peak load. The types of loads and diversity among loads are different during times of minimum load than during times of peak load. The utility industry has developed numerous valid methodologies for allocating peak loading across the system using commonly available information. Not nearly as much time has been devoted to accurately allocating minimum load across the system. Using customer class load profiles is one way to potentially develop methods to allocate minimum load; however, not all utilities maintain this information, particularly smaller utilities. Again, there are many other uncertainties associated with load shifts, maintenance, decreased customer usage and/or customer closings that would need to be addressed as well.

Given the effort required to accurately determine minimum load for each line section across a utility's distribution system, and then apply the supplemental screens proposed, the technical screening process becomes much more involved and begins to rival a detailed review included as part of the Study Process. It would seem that a wiser strategy would be to devote the time and effort into actually studying the proposed interconnection through the Study Process and producing real value rather than spending significant time and effort trying to avoid performing the studies.

<u>There Are Better Alternatives to the Existing Proposal to Modify the 15% Screen</u>

Two active working groups of industry experts and peers are presently engaged through the Institute of Electrical and Electronics Engineers (IEEE) to evaluate similar issues relating to high penetrations of distributed resource interconnections and the Study Process. One group (P147.7) is working to

determine the appropriate technical basis for the preliminary review of system impact studies for proposed distributed resource interconnections. The other group (P1547.8) is evaluating how the IEEE 1547 standard may need to be modified to accommodate high penetrations of distributed resources. The technical experts working on these issues are in the best position to determine whether the existing SGIP screens are effective, or whether they should be changed or supplementary screens added. The Commission, the industry and consumers will benefit from allowing these IEEE working groups to complete their evaluation before considering any changes to the SGIP.