Recommendations for Harmonizing Distributed Generation Interconnection Practices: Technical Review Processes in NY State

Addendum: Includes Initial Consideration for Energy Storage in Screening

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1 Introduction

1.1 Scope and Objectives

This report addresses technical review processes for interconnection of distributed generation (DG) to the public power supply in NY State. The aim is to better harmonize the Investor-owned utilities' (IOU) technical review and reporting related to DG connections larger than 50kW and to make specific recommendations to the NY State's existing technical review processes. It recommends changes in the exiting technical review processes including screening, conduct of studies, and related reporting required for more complicated DG installations. These technical review processes are currently defined in the New York State Standardized Interconnection Requirements (NYSIR, March 2016). ***This report does not constitute any official change to the NYSIR***. It recommends several ideas for consideration in the context of future revisions of the NYSIR. These recommendations address (1) increasing population of DG, (2) harmonizing technical review processes, and (3) emerging requirements, e.g. revisions to IEEE 1547, where DG provides support services to the grid.

In this context the report provides ideas for improving consistency and harmonization in the technical review of interconnection applications. Stakeholders is this process include DG owners, developers, IOUs, the DG industry and rate payers in the state of NY. This work is part of the ongoing effort, led by the NYDPS, to streamline interconnection application processing for DG projects. The three main parts of the report are:

1. General recommendations related to overall NYSIR technical review process
2. Summary of stakeholder's debate and specific recommendations for evolving preliminary and supplemental screens in the NYSIR
3. Discussion and approach for carrying out, and reporting on, application-specific Coordinated Electrical System Interconnection Review (CESIR) studies that may be required for more complex interconnection applications.

Also, the following are provided as Appendices to the report:

A. Summary of screening recommendations from this report
B. Report Templates for Supplemental Screening and CESIRs

1.2 Background

The New York State Standardized Interconnection Requirements (NYSIR) were established in 1999—and most recently updated in March 2016—and provide a framework for processing applications to interconnect distributed generation systems. The NYSIR covers both the application management[1] and the technical review processes for making new DG connections to the electric power grid up to 5 MW. Applicable to the state's IOUs, the NYSIR lays out 6-step and 11-step procedures by which utilities are mandated to process interconnection applications. The 6-step procedure is intended to facilitate expedited application processing for DG systems 50 kW or less, while the 11-step approach provides a more detailed application processing arrangement for larger systems (from 50 kW to multi-MW).

The March 2016 SIR introduced screening tests as an additional step for reviewing DG applications above 50kW. Failing preliminary screening leads to an option for either a supplemental screening procedure or a CESIR study. This document addresses the current technical review process and recommends changes in the SIR to further define and extend the use of technical screening methods and related steps leading up to grid connection. CESIR reporting practices are also addressed. With the aim of more consistency and harmonization of reporting, this work is one of several tasks assigned to EPRI, and sponsored by NYSERDA and the NYDPS[2]. The overall effort is aimed at "Harmonizing DG Interconnection Practices in NY State.

Currently the NYSIR technical review comprises:

- an initial review that verifies the application's completeness and general feasibility,
- a series of technical screening for larger installations, and
- (if necessary) a Coordinated Electrical System Interconnection Review (CESIR) for relatively large DG connections that may require power system upgrades.

The technical requirements for the initial review are specified in section II of the SIR. These confirm the availability of service, transformer size, type of DG to be installed, submittals if required, certification (such as a listing to meet interconnection and safety requirements) performance verification, and metering

[1] Development of online portals in development by NY utilities is enhancing consistency and enabling more automation of application management activities.

[2] Other tasks include "A NY State Utility Readiness Assessment" completed and published as NYSERDA Report Number 15-28 in September 2015. Also a "Specification of Interconnection Online Application Portal (IOAP) Functions and Timetable," completed and distributed by NY Department of Public Service in August 2016.

requirements. Smaller DG (<50kW) are generally expedited to approval after the initial review. Larger systems (> 50kW) are screened with different levels of detail depending on plant rating, location and interconnection type. Required screening currently includes checks for: DG certification, connection type, aggregate penetration levels, protection, impact on voltage regulation and potential for causing voltage fluctuations.

If an application doesn't pass any of these technical screens, the applicant is provided with options for more detailed reviews. Options currently include further (supplemental) screening or a CESIR study. In some high penetration cases, a risk of islanding (ROI) study may be required. These are usually done by a third party. The general process is shown in Figure 1.

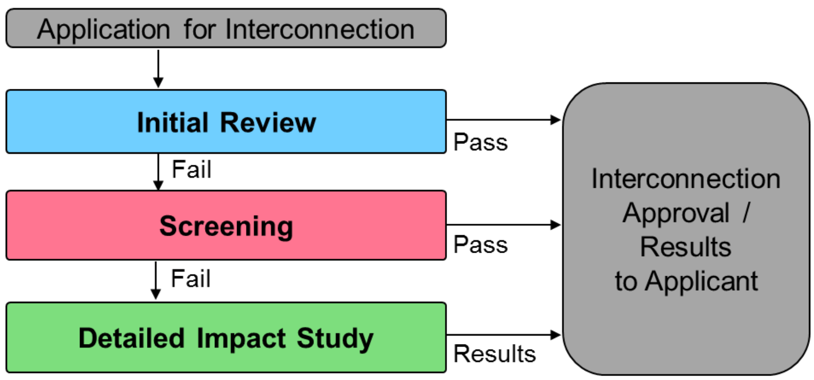


Figure 1. Overview of Existing SIR Interconnection Application Technical Review Process

Screening specific applications that do not pass the initial review and expedited connection process can serve two important functions:

1. Defining for all parties the specific criterion and tests required for connection approval, and considering unique DER, point of connection and feeder characteristics.

2. Identifying any the specific issues needing further review.

Preliminary screening enables a review and approval path for any system meeting the criterion without additional cost or time to carry our engineering reviews and studies. Linking preliminary screening criterion to readily available data and look up tables is one may enable future automate this step in the future. Failing the preliminary screening leads to a decision point to request supplemental screening with engineering reviews or a CESIR study. Either way, more system data is likely required, as well as engineering judgement, and may require electrical power flow simulations common in the CESIR.

In NY, the 2016 implementation of preliminary technical screening has created a more efficient and consistent technical review process. Improving screens is an ongoing effort and should evolve with experience and changing conditions. For example, the need for supplemental screening, with site- and feeder-specific analysis, is expected to increase with higher penetration levels. Revisions to interconnection standards such as IEEE 1547, and DG grid support options will affect grid hosting capacity and DG connection practices. Also, with growing experience in making DG connections, IOU staff and developers are identifying specific ways to improve the overall technical review process. The next section of this report highlights several of these opportunities with recommendations to further improve the screening review process.

2 Recommendations for NYSIR Technical Review Processes

EPRI has completed an assessment of the technical review processes applied by NY investor-owned utilities. At the same time, interconnection practices in the State have evolved via the interconnection technical working group (ITWG, which includes DG industry, developers and utilities) and actions of the NY Joint Utilities (JU), and along with the broader group of developers and other stakeholders. These efforts have identified opportunities to improve SIR technical review requirements and to provide clarity in these requirements. Working with NYSERDA, the NYDPS and the ITWG, this report identifies several challenges and opportunities:

Challenges:

- Preliminary screens need improvement to better clarify their objectives and to quantify each test, enhancing their use and effectiveness
- Future preliminary screening needs to consider the potential for automation.
- The supplemental screening option is not getting much practical use, and needs to be better defined and reinforced with an aim to reduce the need for CESIRs.
- CESIRs are currently not consistent in approach, level of detail and reporting.

Opportunities:

- Address differences among utility systems and queue sizes.
- Take deliberate steps toward more automation of the initial review and preliminary screening steps.
- Employ, and make best use of, growing industry and utility in-house interconnection experience and expertise, e.g. more informed developer applications and more readily available engineering knowledge specific to DER interconnects.
- Bring in new consensus and progress from the ongoing ITWG process, such as the JU anti-islanding criteria and related protection practices (Version 1.2 dated 2-9-2017).
- Require more consistent scope and reporting of SIR screenings and studies.

Considering these identified challenges and opportunities, EPRI has evaluated existing the technical review processes leading to recommendations in this report. Evaluations included review of existing screens, as well as supplemental and CESIR reports provided by each of the IOUs. Also considered in the recommendations are written comments from IOU and developers as well as detailed technical discussions within the NY State ITWG and NY JU workshops and review meetings.

Recommendations are aimed to better harmonize both the technical review, screening and study processes in future updates to the NY SIR. The findings and recommendations are summarized here. Specific discussions regarding individual screens are provided in chapter 3. Ideas for better harmonizing and reporting of CESIR studies are covered in chapter 4.

2.1 Recommendation 1: Modify SIR preliminary screens to simplify review and approval

The general purpose the preliminary set of screens is that interconnection of some larger systems may be fast-tracked to connection in cases when the power system is relatively robust and all screens are passed. By the same token, more problematic interconnections likely fail preliminary screening. Beyond initial review, preliminary screens are aimed to check a few critical factors related to the connection without a lot of analysis and site engineering.

One reason for modifying the 2016 SIR *preliminary* screens has been to remove the need for engineering with more specific tests that can be made using available data. This is expected to speed up, and to allow technician-level, decision making. Further, clarifying the data required and the criterion to pass are expected to reduce the need for site-specific engineering judgement and analysis. For example, including a rationale, purpose, method and expected outcome for each screen is expected to make their application more consistent.

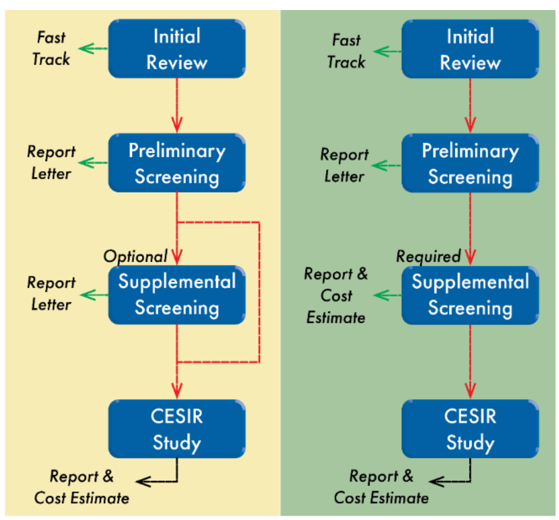
There are also several issues related to simplifying preliminary screening in a wide range of circumstances. Some specific site circumstances, like distance from substation, needs engineering review. All connection approvals must include an engineering review to confirm documentation/drawings. Growing penetration levels and limits in hosting capacity in some parts of the grid will need to be addressed with engineering judgement, improved circuit data, and new analytical tools.

2.2 Recommendation 2: Recast SIR supplemental screens for clarity, and to increased use

Since introduction of screens in the 2016 SIR, the supplemental screening option has been used very little. New screens that may take advantage of growing interconnection experience, increased feeder data availability and engineering judgement need to be tested. If proven out, supplement screening, as an option to more detailed studies, has the potential to expedite review and approval in specific cases. The rationale for recasting supplemental screens in the existing SIR is to extend effective screening to include higher penetration cases, feeder protection, voltage quality, and methods for network accommodation of DG. There is also the need to better define and coordinate supplemental screening with changes in the preliminary screens. Overall, these changes are expected to encourage use of supplemental screens as an alternative to CESIR studies.

The opportunity to apply engineering judgement, screen by screen, can be effective when closer inspection is needed to account for location-specific considerations. Screens involving calculations will usually require feeder- and site-specific data that is readily available to plug in. Missing circuit information requires further data gathering and/or engineering review. Requirements for DG-related feeder protection coordination needs to be included in the supplemental review. And, the outcome of a supplemental review should be documented and delivered in a site-specific report.

Looking ahead, and with a lot more experience in supplemental screening, this step may be considered as required rather than optional. A comparison is illustrated in Figure 2. The current process is shown on the left, in yellow.



Rationale for considering a future change is as follows:

- Provide another level of review before a detailed CESIR study for more complex projects on limited capacity feeders with expectation of reducing the number of CESIR studies performed.
- Take advantage of growing experience and in-house engineering as well as improved system data for planning tools that may be applied to confirm hosting capacity without study.

- Enable specification of protection requirements already defined in JU practices and policy, e.g. unintentional islanding, without CESIR.
- Better define and reduce the scope of CESIR studies, when they are required.

With the ongoing deployment of DER in NY State, there are plenty of opportunities to test drive revisions in supplemental screens, and as an alternative to jumping straight to the CESIR studies. In the ITWG process there was consensus in utility and developer comments to consider more advanced screens on selected new interconnection requests. That is, to experiment before adopting, and to get experience while improving availability of power system data.

Meantime, the consensus was also clear that supplemental screening remains as an option, and not a required step before employing a CESIR study. Feedback from both utility and developers is they are not ready to require supplemental screening. Therefore, requiring supplemental screening is recommended as a target rather than a near-term goal.

2.3 Recommendation 3: Adopt more uniform criterion to scope and report *CESIR* studies

CESIR studies play a significant role in NY DG deployment. The process, as shown in Figure 3, includes data through March 2017. Roughly 80% of DG generation MW capacity required screening, with most needing study, or are in the queue to be studied. At the same time the majority of application, by number, are not required to be screened or studied. These were <50kW, certified and inverter-connected represent about 20% of the MWs either installed and in the queue.

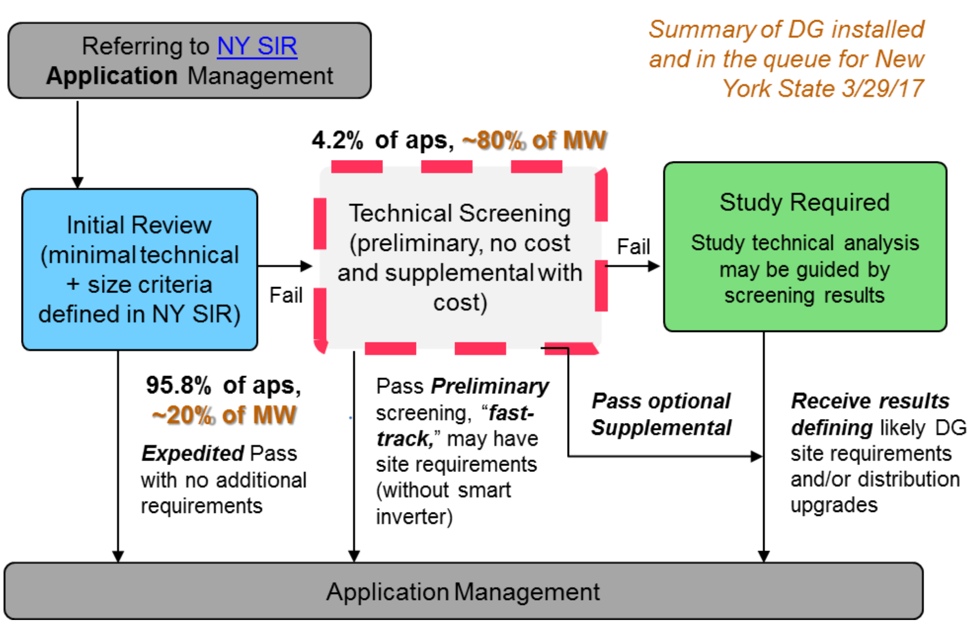


Figure 3. Processing NY interconnection applications; approved and in queue as of March 2017

These studies normally use computer-aided simulations to determine DG system settings as well as site, and feeder upgrade requirements. CESIR studies typically investigate one or more of the following[3] technical questions:

- maintain steady-state overvoltage regulation,
- avoid risk of thermal overload,
- provide protection coordination and compatibility
- require power factor settings, and
- compatible with distribution system grounding

There was strong consensus from the JU and developer discussions and written comments around improving the NY CESIR study definition and reporting processes. Proposed improvements included more visibility in criterion for both scoping and reporting. There were recommendations to streamline CESIR studies based on site-specific conditions. Also discussed was reducing the scope of CESIRs by customizing to address specific issues and application concerns. Related to customizing, the scope of a CESIR study may be informed by the preliminary and supplemental screening results.

From these inputs we propose a balance between uniformity and flexibility in technical studies and reporting. The rationale is follows:

- Improvements in screening can inform CESIR study objectives, scope and the selection of computer-aided modeling and analysis tools. Thus, the scope of CESIR studies would vary depending on screening results and DG interconnection specific needs.
- Given the wide variations in distribution grids, in penetration levels and in readiness for hosting more DG in NY, IOU's will need to balance unique study requirements while addressing more uniformity in the conduct and reporting of CESIR results.
- Future studies will need to consider grid support options for reactive power control, ride-thru requirements and trip settings that are coming in the new IEEE 1547 interconnection standard.

All CESIR studies should identify the scope and process to the applicant in a report describing expected utility system impacts and detailing the proposed DG site and feeder requirements. Chapter 4 of this report addresses harmonizing CESIR studies and reporting. A recommended template based on the current JU practices is provided in Appendix B.

[3] Also to be considered in the future are the options for grid support and the ride thru requirements defined in the upcoming revisions to the IEEE 1547 interconnection standard.

2.4 Recommendation 4: Reinforce the SIR mechanism to address unforeseen site incompatibilities, as well as changes in performance after installation.

With increasing numbers of DG added into the power system there has been reported site incompatibilities and problems. The nature of these problems are often in the general category of electromagnetic compatibility (EMC). These are usually quite unique to the local load, grid wiring and DG interactions, and are not easily predicted. EMC problems and interactions can affect electric service to other end-use customers requiring corrective action. Typical examples requiring follow up are:

- reports of disturbing light flicker,
- cases of high harmonic levels,
- reports of electromagnetic interference, or
- voltage complaints from customers and violations of ANSI voltage range limits.

Given service upset and compatibility issues, the JU emphasized that screens should be designed to identify any predicable site problems before commissioning. Recognizing the difficulty of dealing with unexpected compatibility problems, developers asked for a clearly defined process and to determine root cause. An example of suggested language is provided in an Eversource Energy's Interconnection Service Agreement, Section 6, used in Massachusetts.

The point here was that correcting problems after-the-fact can be difficult and costly. On-the-other-hand, more interconnections and higher penetrations are bound to increase the probably of malfunctions, or simply the number of equipment failures and related incompatibilities.

Balancing these two realities, increasing likelihood and difficulty to resolve, the recommendation is to provide a mechanism in the new SIR to address unforeseen site incompatibilities identified during commissioning or after installation. This may be an item appropriate for the NY IPWG to consider. Rationale is as follows:

- DG certification and testing provides a first level evaluation some assurance that EMC problems are not expected.
- Beyond certification, certain unlikely events may be impractical to screen or predict via studies because unique and varying site conditions would not be well defined.
- It is prudent to make allowance in the SIR for contingency review related to DG malfunctions that may affect electric service to other end-use customers. For example, installing recording devices for monitoring and data analysis.

2.5 Summary of Recommendations

The following are general observations and takeaways related to current SIR technical review and screening procedures:

1. There is significant value to offer more than one level of review, as a hierarchy, with different objectives and tradeoffs. Current the NY example has four review levels; 1) initial review for all systems, many <50kW directly approved, 2) preliminary screening for 50-300kW, 3) supplemental screening option and 4) CESIR study for larger and more complex interconnections, >5MW, go directly to study. Other jurisdictions vary, especially on treatment of expedited and fast track. In the FERC SGIP all applications are screened.
2. In the current NY process both developers and utilities agreed on a need to include reviews and engineering judgement at key steps in the review process. This flexibility should not be given up, or replaced by a fully automated process.
3. The potential for improved power system data and tools to support technical reviews and screening is expected to evolve. Options for grid support from DG are also expected to evolve while penetration levels increase. Therefore, future technical review processes will also have to evolve and to consider these trends. There needs to be trade-offs made between the number and complexity of screens and the ease and data available for their use. At the same time, several relevant standards for interconnection and grounding are changing and will need to be considered in future screening. These include IEEE 1547, 1547.1[4], and ANSI C62.92.6[5].

Building on these, the four specific recommendations in this chapter are intended to support and enhance this hierarchy of screening and analysis in NY's SIR. Recommendations aim is to provide well-defined calculations, approval paths, and off-ramps at each level. Better defined preliminary screens can be effective for approval of installations >50 kW on robust distribution. Supplemental screening, when further developed and proven, may become a good alternative to CESIR studies. Also improving with time are criterion and tools to conduct CESIR studies that address the more complicated cases requiring engineering and computer-aided analysis.

Technical approach and objectives for each level in this hierarchy have been recommended. Automation potential and recommended method of reporting are also defined. Establishing a clear hierarchical

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[4] Institute of Electric and Electronic Engineers, IEEE 1547, Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces and 1547.1 for test procedures.

[5] American National Standards Institute, ANSI, Guide for Application of Neutral Grounding in Electrical Utility Systems.

framework, with contingency coverage, affords New York utilities the opportunity to better harmonize technical review of DG interconnections even with a wide variety of DG sites and circuit conditions. Built-in this approach there needs to be flexibility for accommodating higher DG penetration levels and new DG performance options available with the upcoming revision of IEEE 1547.

3 Preliminary and Supplemental Screens in the NYSIR

The idea of using screens to support fast-track processing of interconnection requests has evolved to be a broadly accepted practice. Interconnection procedures such as the FERC SGIP[6] have suggested initial and supplemental screens to support technical review and fast-track interconnection approvals. New York adopted screening in its Standard Interconnection Requirements in 2016.

As discussed in chapter 2, ongoing efforts to refine and improve the NY SIR screens are underway. Evolving the existing screens is recommended for several reasons. These are; increasing aggregate capacity of DG, changing opportunities for DG and energy storage to provide grid support, increased experience, and better tools for understanding specific grid impacts and mitigations. The same reasons are likely relevant in a number of other jurisdictions in the US.

For comparison, under California Rule 21 fast track eligibility depends the tariff and relative size. <u>All</u> DG and energy storage connections are screened. The FERC SGIP makes recommendations for connection of certified equipment using a "fast track process" that applies from low voltage to 69kV. Also, the SGIP requires technical screening for <u>all</u> DG connections, of any size from 0 to 20MW. The SGIP was originally developed for transmission connected and is being adapted for distribution in many jurisdictions such as in Minnesota.

In NY, the SIR was developed for distribution and screening is required for inverter systems from 50 kW up to 5 MWs and for all non-inverter DG up to 5M. In many ways NY is progressive in its efforts to review and update screening beyond those recommended in several revisions in CA rule 21 and in the FERC SGIP.

Currently the NYSIR includes two sets of screens as follows:

- Six required "preliminary" screens[7]

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[6] Federal Energy Regulatory Commission, FERC, Doc No. RM13-2-000**,** May 12, 2005, *Standardization of Small (<20 MW) Generator Interconnection Agreements and Procedures.* Under FERC jurisdiction, this docket also provided suggested procedures for DG in distribution.

[7] It should be noted that the NY SIR preliminary screens for fast track are less prescriptive than either the FERC SGIP recommendations (9 initial screens) or the CA Rule 21 (13 initial screens) for fast track.

1. Networked Secondary Connection?
2. Certified DG Equipment Used?
3. EPS Rating Exceeded?
4. Line Configuration Compatible?
5. Simplified Penetration Test.
6. Simplified Voltage Change Test.

- Three optional "supplemental" screens[8]

    1. Line Section Penetration Test including Aggregate DG
    2. Power Quality and Voltage Tests referring to IEEE Standards
    3. Assessment of Safety and Reliability Impacts

In this chapter we address the ITWG's ongoing efforts aimed to improve application, effectiveness and confidence in technical screening. For several of the existing screens there is no change recommended at this time. Other screening improvements are discussed, but may require feeder data that is not currently available uniformly across the state. As NY is currently considering the technical review requirements for energy storage, it is also discussed relative to future screening requirements. Following the convention of the IEEE 1547 when referring to both DG and energy storage the term Distribution Energy Resources (DER) is used.

Generally, including energy storage adds to the complexity of the interconnection decision. Some specific issues are swings from fully charging to fully discharging with generation. Ramp rates may increase depending on capacity of the storage and its inverter. There will be significant difference in case of combined DG and storage and if the combination is dc or ac coupled. Compared to PV, storage can operate any time and not just daytime hours. Storage modes need to be considered. If storage operation is restricted, such as no grid charging, no grid back feed compared to unrestricted changing and back feed, will affect screening outcomes. Also, peak shaving using storage may also affect screening outcomes. Choice of tariff likely plays a bigger role in how to screen and metering requirement with energy storage. And control options will impact technical screening with storage.

[8] An applicant, upon failing one of the preliminary screens may currently elect to apply supplemental screens in lieu of a CESIR study. If the results of the supplemental screening are unsatisfactory, a CESIR still may be required for approval of the interconnection.

For recommended changes to preliminary screens the technical basis and intended purpose of each screen is clarified. Also, comments and discussions for any proposed modification to existing screens are provided. This includes input from discussions with IOUs and developers as well as EPRI's observations and suggestions. One of the difficult questions has been, can a few selected screening tests be sufficient to approve medium-size DER connections without significant engineering review or study? Depending on circumstances, relevance of any particular screen will change with site conditions and also with changing deployment penetration.

A key point, to set the stage on the screening discussion that follows, we find screening is a process without a single correct solution and where there are necessary tradeoffs. For example, preliminary screens will tend to be conservative to enable simplicity. On the other hand, a supplemental screen can be complicated to enable specific applications and avoid further study. The following screening discussions and recommendations aim to inform the art of screening rather than resolve it.

Given this background the following documents some clearly different views from developers and utilities on the pro and cons for changing specific screens. In general, utilities want to beef them up and expand coverage of these screens while developers rather argue to keep it simple. One step to compromise is the opportunity to migrate the more complex and less defined assessments to the next level. That is from preliminary to supplemental and from supplemental screening to studies. This idea can be seen in several recommended changes below.

3.1 Technical Review of Preliminary Screening

Preliminary screening is required in the SIR application process, Step 4, and applies to any inverter connected DER, from 50 kW up to 5 MWs, and for all non-inverter DG up to 5 MW. The result of each screen, pass or fail, are to be provided in a written response to the applicant. If a preliminary screen is failed, the written response includes the technical reasons for failure, as well as any data and analysis that support the screening tests. To support this reporting requirement a technical basis, or rationale, and the specific purpose for each screen are recommended in this report. The format here used here is to define the existing screen, to provide discussion from developers, utilities and EPRI, and then to make a recommendation with technical basis and purpose of the screen.

Existing Screen A: Is the PCC on a Networked Secondary System? Does the proposed system connect to a secondary network system? If yes (fail), If no (pass), continue to Screen B.

Discussion: There were not directed comments or recommendations regarding changes to this screen. For future consideration, we note that the FERC SGIP allows limited inverter based DER to be considered for fast-track screening on a network connection. The main condition for connection is an aggregate total less than 5% of maximum load or less than 50kW. SGIP does not distinguish between LV and MV networks. Spot networks are called out in some jurisdictions.

Recommendation: Keep this screen as is for the near term. This screen is a straight-forward pass/fail that may be automated with a yes or no. In the future consider a relative-size criterion for fast tracking network-connected DER. This may be supported by ongoing efforts to improve analytical methods for network hosting, such as proposed in ConEd's pilot projects. Also, network equipment and protection schemes are expected to evolve and to better accommodate DER in networks. Including energy storage in network connections will increase operating options, and may ease back feed concerns. Storage mode control, charging or discharging, will be critical allowing interconnection. Although adding storage will make network connection more interesting, it won't change the result of screen A.

Revised Screen A: Is the PCC on a Networked Secondary System?

Does the proposed system connect to a secondary network system? If yes (fails preliminary screening), If no (pass), continue to Screen B.

Technical Basis: Protective devices in network systems are currently not designed for reverse power. Detection of reverse power may cause an outage for network served end users.

Purpose of Screen: Requires a supplemental review or study for all network connections.

Existing Screen B: Is Certified Equipment Used? Does the Interconnection Request propose to use equipment that has been listed to meet safety standards such as UL1741 (Inverters, Converters and Charge Controllers for Use in Independent Power Systems) and by a nationally recognized testing laboratory? If no (fail), If yes (pass), continue to Screen C.

Discussion: With the new IEEE 1547 standard (likely approved by 1/2018), it is expected that certifications will define different grid support functions. For example, certified to provide a particular voltage support function like volt/var, with performance settings and ranges. Also, non-inverter DG are expected to begin receiving certifications, when they contain required relay functions and grid response capabilities. Note that relay packages, added to a DER installation as part of the plant, may be separately certified for grid connected applications.

NY currently maintains two lists for inverters certified before, and after, 2011. In the future, and with changes in UL 1741, a third list may be needed to address inverters meeting the new IEEE standard. Collaborating with UL and/or other states may be effective for keeping up the certification lists. This will need to address non-inverter connected DG that receive certifications from listing organizations in the future.

Recommendation: Keep this screen as is. Note that, when NY adopts the new IEEE Standard 1547, additional listing categories will be needed to cover smart inverters as well as non-inverter certified equipment. This includes energy storage inverters, which normally will have to have capabilities and options of smart inverters and will be certified for these operations. Future automation of this screen should be straightforward.

Revised Screen B: Is Certified Equipment Used?

Does the connection request propose to use equipment that has been listed to meet safety standards such as UL1741 (Inverters, Converters and Charge Controllers for Use in Independent Power Systems) and by a nationally recognized testing laboratory? If no (fails preliminary screening), If yes (pass), continue to Screen C.

Technical Basis: Electrical equipment on premises, and in many utility applications, are required to have a safety listing or certification for the intended purpose.

Purpose of Screen: Check for appropriate DER listing and certification.

Existing Screen C: Is the Electric Power System (EPS) Rating Exceeded? Does the maximum aggregated Gross Ratings for all the Generating Facilities connected to an EPS exceed any EPS rating, modified per established Distribution Provider practice, absent any Generating Facilities? If yes (fail), If no (pass), continue to Screen D.

Discussion: The existing language, to consider “aggregated” capacity in determination if any rating is exceeded in the EPS, was supported by both the JU and developers. A related point was to clarify inclusion of all generation in a queue when determining “aggregate” generation on EPS. Note that EPS, and related terms, are defined in IEEE 1547. Depending on location of the PCC this may include the service transformer. A possible simplification discussed was to look at only the rating of the DG transformer and secondary service drop. However, this was not accepted because it would necessarily require some other screens to check if ratings were exceeded further upstream. In addition, medium voltage feeders are sometimes tapered downstream and along the route. Therefore, location of the DG on the feeder, not just local transformer rating, may be a limiting factor. Engineering judgement is needed to complete this screen.

Note a FERC SGIP preliminary screen limit DG, in aggregate, not to exceed 87.5% of the short circuit interrupting capability of protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers). Another SGIP screen limits the DG, in aggregation with other generation, not to contribute more than 10% of the distribution circuit's maximum fault current at the point on the high voltage (primary) level nearest the proposed point of change of ownership.

Regarding rating limits in general, the concept of considering load was discussed. The requirement that generation shouldn't exceed the thermal rating of wire or substation equipment is clear, however, it is not clear how to account for load (especially in urban areas). For example, a 12MW feeder with 3MW of min load may have 15MW of allowable generation depending on location (based on thermal limits). Although a valid consideration, bringing in load was considered a complicating factor for review and automation and better addressed in a supplemental review.

Recommendations: To further clarify the existing screen C, define "aggregated gross rating" to include both existing generation and storage as well as all DER approved to be installed in the electric power system. Replace the terms "Generating Facilities" with DER. In the future, when better feeder data are available, consider accounting for load effects on generation, when calculating if ratings are exceeded. Furthermore, when energy storage is included, then depending on operating mode and control the ES may either add to, or reduce, back feed capacity. For example, adding a back feed prevention relay will reduce the DER generation capacity to be considered. Also, from additional loading point of view, three modes may be considered; no grid charging, peak shaving and unrestricted charging mode. In the future this screen may be modified to consider some of these restricted operating modes. Otherwise, storage capacity is simply additive to the screen for both increased generation and increased loading. Adding load will likely require supplemental screening or added load study. With or without load effects, to automate this test detailed feeder load data, computer-aided tools or engineering judgement will be needed.

Revised Screen C: Are Electric Power System (EPS) Ratings Exceeded?

Does the maximum aggregated DER generation or loading capacity connected to an EPS (existing, approved and being considered) exceed any EPS ratings (modified per established Distribution Provider practice)? If yes (fails preliminary screening), If no (pass), continue to Screen D.

Technical Basis: Exceeding ratings of the medium voltage distribution system may be unsafe or contribute to reduction in power quality or outage. This screen is designed to consider worst case conditions. Identifying possible grid changes, or DER changes, to avoid overloads is beyond the scope of preliminary screening.

Purpose of Screen: To check for potential overload in the medium-voltage distribution system with all the aggregate DER operating. (application of reverse power limiting relays or effective load reduction via generation are not considered at this time)

Existing Screen D: Is the Line Configuration Compatible with the Interconnection Type? Line Configuration Screen: Identify primary distribution line configuration that will serve the Generating Facility. Based on the type of Interconnection to be used for the Generating Facility, determine from the table below if the proposed Generating Facility passes the Screen. If no (fail). If yes (pass), continue to Screen E.

Primary Distribution Line Type	Type of Interconnection to Primary Distribution Line	Result / Criteria
Three-phase, three wire, > 5 kV	3-phase	Pass
Three-phase, four wire, >5 kV	Effectively-grounded 3 phase	Pass
All	Single phase, phase-phase, or ineffectively grounded sources or transformers	Fail

Table 1. Line Configuration Criterion, taken from the March 2016 SIR.

Discussion: The origin of this table is SGIP preliminary screening to address DG back-feed related overvoltage after a sustained high side ground fault and opening of high side circuit between the DG and substation. The concern is ground fault overvoltage, or GFO, if the DG continues generating into the faulted primary. As currently written it's not clear how to pass if the feeder voltage is < 5kV. It is not clear how to define "effectively grounded" for inverter based DG.

Note that the new ANSI C62.92.6 standard is now available to address transformer connection and evaluation of effective distribution system grounding with inverter-based sources. For purposes of NY screening process, more complex questions related to effective grounding, multi-grounded wye systems, and related protection are best covered as supplemental screening or in a CESIR study. These issues can lead to special grounding and connection requirements.

We proposed to modify this screen and to remove the table because it is generally not being used. IOU's confirmed that decisions about an existing or new transformer connection, and configuration compatibility (voltage compatibility, phase matching, phase balance, and grounding coordination) can be evaluated without this table. Another factor considered is likelihood of islanding after a fault. In order to pass preliminary screening aggregate DER are limited to 15% of peak load and or otherwise less than expected feeder minimum load, see Screen E. Give these factors the consensus taken from the ITWG is that the screen can be simplified to only include configuration compatibility. Note that configuration compatibility may also be combined as part of screen C.

Recommendation: Revise this screen to address basic service configuration compatibility checks including voltage rating, phase matching, phase balance, and grounding coordination. These checks can be applied in case the DER is energy storage or generation.

Revised Screen D: Is DER Compatible with the Power Service at PCC?

Identify primary distribution line configuration that will serve the distributed generation or energy storage. Based on the type of DER interconnection, determine if it is compatibility with the electric power service, including voltage rating, phase balance, line and grounding configuration. If yes (pass), continue to Screen E. If no (fails preliminary screening).

Technical Basis for Compatibility Screen: Mismatch in voltage rating, such as 240V on a 208 service or unintended grounding such as Y-Y can be problematic. Large imbalances with 1-phase DER connected to three- phase service, or 120V DER on 240V secondary service need to be looked at. Also, imbalanced services such as 3-phase open-delta, single-phase open-wye, and 240V split-phase delta may also be problematic and need to be considered for compatibility.

Purpose: Confirm compatible DER configuration with the available or planned power service at PCC.

Existing Screen E: Simplified Penetration Test. Is the aggregate Generating facility capacity on the Line Section less than 15% of the annual peak load for all Line Sections bounded by automatic sectionalizing devices? If yes (pass), continue to Screen F. If no (fail), Supplemental Review is required, continue to Screen F.

Discussion: This is an important screen to provide a simplified penetration-level check for medium voltage issues. There was agreement that "aggregate" generation capacity means to include all DG approved in the queue.

Other discussion on screen E related to lack of availability of feeder load data and on how to define, and track, annual peak load. Without better data the screen is necessary conservative. Developers suggested if data are available showing that minimum load is higher than 15% it should be used. They also argued that passing this screen should be sufficient to cover voltage rise and ΔV concerns (see screen F). They cite HI, MA and CA screening to support this point.

In the future, feeder-specific data in specific cases may enable greater certainty on 15% of peak load or on expected minimum load to be greater than 15%. Currently there are many cases where supplementary screening or studies allow greater than 15% peak load for aggregate DER. These options are noted in proposed revisions to screen E. Also, feeder-specific analyses are included in supplemental screening or in a CESIR study. Computer-aided analysis tools that calculate available hosting capacity, with up to date feeder data, may be the best future way to address penetration limits.

Regarding application of screen E, the reference to feeder line-segments implies only medium voltage. It has not been applied at low voltage. Given this understanding, the term generating "facility" capacity was identified as causing some confusion on applicability at the PCC and at an end-user secondary. For this MV screen the term "facility" should be removed for clarity.

There was discussion about the need for a LV screen, in case of multiple DER connected on shared secondary's. Note that two secondary voltage screens are included in the FERC SGIP commonly used in other jurisdictions. These include a kW limit for single-phase DER on a shared secondary (limited to 20kW or alternatively, 65% of the service transformer rating) and a limit on unbalance between the two sides of a center-tapped 240V service (limited to 20% of the service transformer rating). One difference in the NYSIR is that preliminary screening doesn't apply to inverter connected <50kW, but it is possible in urban area cases such as shared service in a strip mall, see screen F

Recommendations: To further clarify the existing screen, drop the term "facility" and state that aggregate includes installed as well as any DER approved in the queue to be installed, including both DG and energy storage. Confirm this screen is for medium voltage. Consider a different screen to include specific checks for end-user shared secondary voltage issues in the initial feasibility review (for single phase) and as a new preliminary screen for three phase. Feeder-specific data may allow automation of this screen in the future.

Revised Screen E: Does Aggregate DER Pass Simplified Penetration Test?

Is the aggregate DER capacity on any medium voltage Line Section less than 15% of the annual peak load for all Line Sections bounded by automatic sectionalizing devices? If no, consider if feeder data are available that show aggregate DER will not exceed a minimum load. If yes (pass), continue to Screen F. If no. (fails preliminary screening), supplemental review or study is required and continue to Screen F.

Technical Basis: Assuming feeder peak-load data is more readily available than minimum load data, this screen provides 15% of peak load as the calibration for expected minimum load. In case minimum load data are available than higher than 15% may be approved. Also, in case some storage capacity can be applied be prevent or reduce back feed than higher than 15% may be approved. This screen allows interconnect applications that are relatively small compared to the feeder's available capacity to pass. It covers all upstream line segments. There is an assumption that protection impacts may not need to be addressed if passing this preliminary screen. Questions for larger DG and storage, or relatively large aggregate DER, are beyond the scope of preliminary screening.

As a sidebar, the following provide insight on where this arbitrary, and frequently used, 15% limit came from:

> *The 15% number originated from studies by Roger Dugan at Cooper Power Systems and at Electrotek Concepts in the 1980's, early 1990's. It was later adopted in the FERC SGIP screens. The basis came from results of distribution studies (medium voltage and without consideration of secondary voltage effects) with various combinations of single and 3-phase DG, inverters and synchronous generators, and including various 12kV distribution mains and single-phase lateral configurations. These studies showed that at ~30% of peak-load issues began to appear. To be conservative, 15% was selected as the limit. This become a useful fast-track or preliminary screen. More detailed, feeder-specific studies are likely to yield higher limits for feeder hosting capacities.*

Purpose: Provide a simple check on the relative capacity and loading of the upstream feeder compared to the aggregate DER along the feeder.

Existing Screen F: Simplified Voltage Fluctuation Test. In aggregate with existing generation on the Line Section - Can the Generating Facility parallel with the Distribution Provider's Distribution System without causing a voltage fluctuation at the PCC greater than 5% of the prevailing voltage level of the Distribution System at the PCC? If yes (pass), Preliminary Screening Analysis is complete. If no (fail), additional review is required.

Discussion: There is ongoing and significant discussion about the technical basis of a voltage fluctuation screen. The term "fluctuation" has more than one possible meaning, and implies changes without providing clarity on the rate of change or the frequency of change. The PCC may be at a secondary or primary voltage level, which will affect the appropriate voltage change limit.

Differing views on the purpose of this screen include; concerns for starting (inrush), tripping of generation, variable output (resulting in voltage variations for utility and customer equipment), and perception of visible light flicker (due to rapid power output changes and resulting voltage changes). None of these issues are very common or easy to screen in one test. The rationale and purpose of this screen needs to be clarified in order to gain consensus. Weighing in the concerns and inputs from both the JU and the developers provides some direction.

A main concern expressed by the JU is for maintaining voltage regulation within ANSI limits along the feeder service points. Line section, as used in the current screen F implies medium voltage (5-25kV), where the most vulnerable sections are 5kV laterals and long feeders. On this point JU proposed that systems > 300kW and to be connected in 5kV distribution would fail preliminary screening. JU also identified voltage rise and voltage regulation at the PCC, including rise on end-user shared secondary's (120-600V), as concerns.

Developers suggest that a 15% limit on peak load screen, or a 10% of feeder rating screen can adequately address medium voltage regulation issue. They also acknowledge these screens may not address low voltage, shared secondary connections. Developers addressed many of their comments to what could be worst case voltage drop related to starting DG (in particular a synchronous or induction machine as well as any related transformer inrush). Starting or stopping may cause step changes in voltage at the PCC. Related, developers pointed to differences between inverter- and machine-connected DG and the common practice for inverters to apply ramp rate control and soft-start capabilities.

Developers asked if the application fails screen F than the utility should provide estimate of short circuit-current at the PCC in the preliminary screening feedback report. This may inform a decision on using the SIR supplemental screening option. Developers discussed experiences with voltage rise when the PCC is on shared secondary, and suggested that more complicated questions related to end-user voltage quality should be moved to supplemental screening. Developers also asked that existing feeder voltage regulation equipment be modeled and considered in supplemental screening and studies. They noted that DG capabilities, including reactive power control, will be required in the new 1547 and should also be considered in the future.

How to treat light flicker concerns was one of the most contentious issues. The JU pointed out that evaluating potential for conditions causing light flicker is not easily analyzed prior to installation. A number of assumptions are required to roughly estimate the Pst and Plt thresholds of perception. By the same token, JU considers resolving flicker complains after the fact, using an IEEE 1453 flickermeter as appropriate while potentially difficult and time consuming. Therefore, they support strengthening contractual mechanisms is case of unforeseen flicker issues after installation and JU desired well defined limits, like the GE Flicker Curve, as a simplified evaluation tool prior to installation.

Developers argue that light flicker as defined in IEEE 1453 is an unlikely event for DG and is impractical to study prior to installation. Limits would have to be unnecessarily conservative. They support a process using actual measurements with an IEEE 1453 defined flickermeter. JU and EPRI recommendations also support use of the standard flickermeter to resolve field problems.

Regarding use of simplified flicker limits, like the “GE Flicker Curve” ΔV limits, developers and JU disagree. A number of studies, practices in other states, and standards are referenced in the developers input. The main points are; the GE flicker curve can be inaccurate (lacking shape factors), the percent change limits are unnecessarily strict, and it is not possible to measure in the field. Since 2005, IEEE standards have supported use of the IEC flickermeter approach as a replacement for GE curve.

Given different viewpoints on the application of screen F, we conclude the existing screen implies too many different voltage fluctuation issues, and doesn’t provide a good calibration or test for any one. We propose limiting screen F to address the most common concern, voltage rise, as a preliminary indicator for maintaining voltage within ANSI limits in both secondary and medium voltage. Rapid voltage change, ΔV/V, and voltage regulation are issues for supplemental rather than preliminary screening.

Table 1 summarizes this approach and compares recommendations for NYSIR with other voltage fluctuation limits for several different jurisdictions and proposed changes in the IEEE standard 1547.

	NY SIR[1]	FERC SGIP	Rule 21[2]	1547[2]	Xcel MN[2]
Preliminary					
15% Rule	"C"	yes	"M"3	N/A	yes
ΔkVA/kVA	40/50% "F"	1Φ-20kW	N/A	N/A	20kW/40%
Regulation	N/A	no	Vdrop "C"	N/A	no
Supplemental					
RVC[4], ΔV/V	3%/5% "H"	1453	1453 "O"	3%/5%	1.5/3/5%
Flicker	N/A	1453	1453 "O"	Pst<.35	1453
Min Load	100% "G"	100%	100% "N"	N/A	100%

1. proposed by EPRI (July 2017)
2. currently under review
3. designates which screen
4. RVC is rapid voltage change

Table 1. Proposed voltage fluctuation screening compared to other jurisdictions and IEEE 1547

Less likely issues, such as starting inrush for transformers or synchronous machines, DER equipment malfunctions, and disturbances causing light flicker complaints are not recommended to be covered by screening. The main reason is that these issues will be infrequent and unplanned. They will depend significantly on the PCC, and from a screening point of view, would not likely be predicted.

Recommendation: Modify screen F to a "simplified relative size test at PCC." Include both secondary and medium voltage at the PCC based on voltage level and source capacity at the PCC. Use DER capacity from next upstream voltage regulator to determine aggregate. Compliment this ***preliminary*** screen with a new ***supplemental*** voltage rise calculation screen. Engineering judgement is likely required to determine short circuit capacity the source impedance at the PCC, and to carry out the calculations for these relative size and voltage rise screens. Automating will require more complete feeder data and computer-aided tools.

More detailed considerations for voltage quality, regulation along the feeder, harmonic interactions and rapid voltage change should be covered in supplemental screening. Reference the IEEE 1547 draft standard limits to address these voltage concerns instead of IEEE 519-1992. Remove light flicker (according to IEEE 1453) as an objective from screening, as recommend in the Xcel filing. Note that output variations, that may occur due to DER design or malfunction, are included as a basic requirement in DER certification and related testing.

Consider creating some initial feasibility checks for secondary voltage impacts of DER <50kW. For example, if the proposed DER is to be interconnected on single-phase 240-volt on shared secondary, the aggregate generation on the shared secondary shall not exceed xx% (or a kVA limit) of the nameplate rating of the service transformer. For example, SGIP has two secondary voltage screens that are commonly used in other jurisdictions. These include a kW limit for single-phase DER on a shared secondary (e.g. limited to 20kW or alternatively, 65% of the service transformer rating) and a limit on unbalance between the two sides of a center-tapped 240V service (e.g. limited to 20% of the service transformer rating).

Revised Screen F: Is feeder capacity at PCC adequate for aggregate DG?

The aggregate DER relative to the capacity (available power rating) at the PCC does not exceed 40% at MV and 50% at LV. Aggregate DER includes all DG and energy storage on a line section or LV transformer bus. If not exceeding these limits (pass). Preliminary Screening Analysis is complete. If exceeding (fails preliminary screening), additional supplemental review or study is required.

Technical Basis for Simplified Size Limit at PCC: These limits are conservative relative to a 5% or 3% $\Delta V/V$ limit for both low and medium voltage. The calculation requires engineering judgement to estimate the feeder capacity at the PCC consider feeder size, voltage and distance from the sources. If the PCC is at low voltage, then the service transformer rating may be sufficient information for this test. This preliminary screen addresses voltage rise, and step changes, due to power output variation. The primary concern is DER related voltage changes at the PCC.

Purpose: Determine if the addition of DG is likely to cause excessive steady-state voltage rise or $\Delta V/V$ outside conservative limits.

The follow table supports this technical basis by providing example available capacity based on 3% and 5%, and compared to 40% of medium voltage feeder rating at PCC and 50% of the step down transformer ratings. Note that the aggregate DER power limits for LV, and related voltage drop or rise will depend on the service entrance conductor size and length. Recommendations here assume service drop conductor contribution to rise or drop is <1.5%. Longer or undersized service entrance conductors will further limit aggregate DER.

Aggregate DG Power Limits (MW and kW)

Primary	Conductors	Miles	5% Rise	3% Rise	40% PCC Rating
12.5	350 mcm	4	6.6MW	4MW	3.51MW
12.5	350 mcm	8	3.3	2	3.51
12.5	2/0 mcm	4	2.5	1.5	1.11
12.5	2/0 mcm	8	1.3	0.8	1.11
4.8	4/0 mcm	2	1.2	0.7	0.30
4.8	4/0 mcm	4	0.6	0.4	0.30
Secondary	**Service Size**	**n/a**	**Rating**	**r=1.5-3%**	**50% of Rating**
.480-3Φ	400 amps	n/a	330kVA	330kVA	165kWA
.208-3Φ	200 amps	n/a	72kVA	72kVA	48kW
.240-1Φ	100 amps	n/a	24kVA	24kVA	12kW
.120-1Φ	100 amps	n/a	12kVA	12kVA	6kW

Table 2: Relative Size Limits, compared to 3 and 5% Voltage Rise.

3.2 Technical Review of Supplemental Screening

Supplemental screening is an alternative path to studies when preliminary screening fails. In the SIR, March 2016, the supplemental screenings include objectives on DG penetration, voltage quality, safety and reliability screens. These are similar to the NERC 2013 SGIP and were found to be not very well defined with specific tests to achieve the objectives of safety, quality and reliability. Several alternative supplemental screens have been proposed by JU and developers. Each the exiting SIR supplemental screens is discussed with recommendations on next steps. Note, to pass supplemental screening all the screens must pass, and failing any screen one screen may be required a Coordinated Electric System Interconnection Review (CESIR) process and related mitigations to be connected.

Existing Screen G: Supplemental Penetration Test? Where 12 months of line section minimum load data is available, can be calculated, can be estimated from existing data, or determined from a power flow model, is the aggregate Generating Facility capacity on the Line Section less than 100% of the minimum load for all line sections bounded by automatic sectionalizing devices upstream of the Generating

Facility? If yes (pass), continue to Screen H. • If no (fail), a quick review of the failure may determine the requirements to address the failure; otherwise the Interconnecting Customer may be required go on to the Coordinated Electric System Interconnection Review (CESIR) process. Continue to Screen H.

Discussion: This screen is based on the 2013 update of the FERC SGIP. It usually applies only to inverter-connected DER and is used in a number of other jurisdictions. If aggregate DER exceeds 100% of the minimum load, then the installation fails supplemental screening and further study is recommended. Accurate minimum load data may not be readily available and therefore engineering judgement may be needed to execute this screen. Otherwise this is a simple test that may be automated. The only suggested change to this screen is limit it to-inverter connected DG and replace "Generating Facility" with DG.

Revised Screen G: Does Aggregate DER Pass Supplemental Penetration Test?

Where 12 months of line section minimum load data are available, can be calculated, can be estimated from existing data, or determined from a power flow model, is the aggregate DER capacity on the Line Section less than 100% of the minimum load for all line sections bounded by automatic sectionalizing devices upstream of the DER? If yes (pass), continue to Screen H. • If no (fails supplemental screening), a quick review of the failure may determine the requirements to address the failure; otherwise the Interconnecting Customer may be required go on to the Coordinated Electric System Interconnection Review (CESIR) process. Continue to Screen H.

Technical Basis: If DER exceeds minimum load than there are a number of protection and islanding issues that are beyond the scope of supplemental screening.

Purpose: This screen may allow a relatively high penetration relative to load if other supplemental screens are passed.

Existing Screen H: Power Quality and Voltage Tests. (a) Can it be determined within the Supplemental Review that the voltage regulation on the line section is maintained in compliance with current voltage regulation requirements under all system conditions? (b) Can it be determined within the Supplemental Review that the voltage fluctuation is within acceptable limits as defined by IEEE 1453 or utility practice similar to IEEE1453? (c) Can it be determined within the Supplemental Review that the harmonic levels meet IEEE519 limits at the Point of Common Coupling (PCC)?

Discussion and Recommendation: This is a continuation of the discussion for the voltage fluctuation screen F. Recommendations for the preliminary screen F were to consider the relative size of DER to capacity at PCC test. This supplemental voltage quality screen calculates the magnitude of DER caused voltage change at a likely worst case location of PCC. A simple calculation with engineering judgement can determine the ΔV at the PCC, which is likely worst case. Indirectly, this test provides an indication of rapid voltage changes that may occur due to tripping of DER or coincident start-ups.

A voltage calculation with % change limits, ΔV/V, is recommend to replace the existing voltage quality screen. (see supporting technical discussion in screen F). Voltage change limits in this screen may address the most likely DER related conditions leading to flicker complaints. However, based on difficulty of analysis, this screen is not intended to predict Pst and Plt perception limits of IEEE 1453. Also, regarding concerns for harmonic distortion in voltage at the PCC, and compliance with IEEE 519, all DER should be certified to meet harmonic current distortion limit in 1547. Specific cases, where resonance conditions are suspected, should be flagged for further study. Future computer aided analysis may allow higher penetrations by considering the special distribution of DER, voltage regulators and load in estimating voltage regulation impacts.

New Screen H: Voltage Change and Quality Tests at the PCC.

Individual DER, ramping up to full output, or tripping off line, should not change voltage at the PCC more than 3% of rating (either medium voltage or secondary voltage). Aggregate DER should not change voltage more than 5% at any-point on a line segment. Fluctuating outputs, such as PV with moving clouds should not change the voltage at any regulating device more than 1.5%. If below these limits (pass), continue to Screen I. If exceeding limits (fails supplemental screening), reasons for failure may determine what is required to pass. Also, mitigations may be considered with engineering judgement such as reactive power support from DER as well as specific operating mode limitations for DG or energy storage. Continue to Screen I.

Technical Basis for a Voltage Change Test at PCC: Voltage rise is one of the most common issues with DER. Voltage drop can also occur if DER trips for any reason and prior to load tripping[9]. A calculation of ΔV/V is straight-forward if using the DER power rating times resistance (from the PCC to the primary voltage source) and divided by the rated V^2at PCC, as follows.

[9] Xcel Energy Response to MN Docket No. E002/M-13-867, Transition to 1453, March 30, 2017.

$$\frac{R_{EPS,MAX}}{VLL^2} P_{DG} \times 100 < 3\% \qquad \text{and} \qquad R = \frac{V_{LN}}{I_{3\Phi SC}\sqrt{1+K^2}} \text{x}$$

K = X/R ratio at the PCC.

If failing this screen, utilities should provide developers with the short circuit current at the PCC for reference to consider alternatives.

Purpose: This test indicates if voltage changes are likely to violate ANSI limits by raising or lowing voltage at the PCC. It can apply for both medium and low voltage services. The screen considers the DER location on a feeder or service.

Screen I: Existing Safety and Reliability Tests. Does the location of the proposed DER or the aggregate DER capacity on the Line Section create specific impacts to safety or reliability that cannot be adequately addressed without a detailed study?

Discussion and Recommendation: This supplemental screen, from the FERC SGIP, doesn't provide a well-defined limit or test. As an alternative, additional protective device review (coordination, coverage and settings) as well as the JU anti islanding criteria and supplemental protection analysis should be applied for all DER installations. The recommendation is to remove this screen and consider an new screen I to address operating modes options, protection adequacy and coordination.

New Screen I: Operating Limits, Protection Adequacy and Coordination Evaluation.

Review the installation based on the JU Unintentional Islanding Protection Practice, Version 1.2-2/9/2017. Identify islanding related protection concerns and requirements by application of the JU flow charts. Consider operation mode options (such as energy storage back feed relay, changing limit or reactive power control options). Also, evaluate protection coordination and coverage, breaker ratings, fault current coordination for relays and 3V0 protection (where applicable). Determine if there are any required changes in protection setting or additions. If yes (fails supplemental screening), a quick review of the failure may determine the requirements to address the reason for failure; otherwise the Interconnecting Customer will be provided with information on the specific points of failure in the supplemental review results and may elect to go to the Coordinated Electric System Interconnection Review (CESIR) process. If no (pass), Supplemental Review may be is complete.

Recommended additional Screen J: Review of non-certified DER.

This screen requires engineering analysis and judgement to answer the question, are the required relay protection functions included and configured properly for the proposed site? The objective here is to address non-certified DER, including rotating machines, energy storage or combination of DER. It also will be need for mix of certified and non-certified DER in accordance with the new 1547 DER evaluation requirements and interpreting certification operating options from testing organizations such as UL. This screen likely requires additional submittals with specific relaying details to apply individual utility protection criterion. Protection requirements will be very site specific.

Recommended additional Screen K: Special Protection Requirements for Network-connected DG.

Is the aggregate DER less than the minimum load on any network protector? This screen provides a supplemental review path for network connected DER failing the preliminary screen A. It is aimed to enable application of advanced methods to evaluate network connections in ConEd's system, and by upgrading network protectors, controlling DER operating modes or other means.

Refinement in screening are expected with connection experience and in particular because of industry collaborative efforts such as the NY ITWG. Meantime there are ongoing new learnings about what are Harmonizing CESIR Studies and Reporting

4 Harmonizing CESIR Studies and Reporting

4.1 Overview

Though well-designed screening can handle the majority of applications, there are some situations that are going to require a detailed study. These include systems of sufficiently large size, especially weak interconnections, or circuits with sufficiently high penetration of DG. According to the current NY SIR if either the preliminary or the supplemental fails, a CESIR (Coordinated Electrical System Interconnection Review) is offered. With an improved screening process, the number of prospective interconnections that arrive at the CESIR study should be minimal. However, these installations will have a higher probability of required circuit modifications or infrastructure improvements. Additional experience with both screening and detailed studies should help focus the process and reduce the time necessary to arrive at a conclusion.

Most of the direction to applicants and utilities provided in the NYSIR on when to do studies is administrative in nature. There is little established technical guidance for actually conducting and reporting CESIR studies. IOUs have created largely independent technical approaches as a result. As evidence Table 2 provides a comparison of recent CESIR report samples. Each utility identified impacts of DG, necessary system upgrades, and estimated costs. However, reports ranged widely in length and the amount of technical justification presented to the applicant.

The variety of approaches to detailed studies has created some confusion for developers who would operate across multiple utility jurisdictions. Sometimes the differences in method or outcome of studies can be directly tied to the presence (or absence) of the required circuit and site data. Utilities generally tend toward studying many possible contingencies, because they are concerned that there will be no ability to address future violations of the service operating limits if issues are not identified prior to interconnection. Also weighing on the CESIR study is the prospect of additional costs for the developer that may be subject to engineering judgement rather than a well-defined test and criterion.

Table 3 Comparison of Current CESIR Report Styles/Contents (February 2017)

	Central Hudson	Orange & Rockland	National Grid	Avangrid	PSEG - Long Island
Page Count	2	4	23	13	4 to 12
Summary?	yes	yes	yes	yes	yes
Format?	summary	pass/fail	tutorial	narrative	efficient
Impacts Identified?	yes	yes	yes	yes	yes
Refers to SIR Screens?	no	yes	no	no	no
Limits Specified?	no	yes	by reference	?	?
Upgrades Identified?	yes	yes	yes	yes	yes
Costs Listed?	yes	yes	yes	yes	yes
Next Steps?	no	yes	yes	yes	?

One of the finding of this assessment is that detailed studies should largely cover the same territory as screening, but with more detailed information on the DG, interconnection, and distribution circuit. More sophisticated tools than required for screening are likely employed along with engineering judgement.

Table 4 shows how the CESIR process fits into the overall SIR workflow. The CESIR technical scope is defined with a cost estimate in step 4, and then conducted between steps 5 and 7. As indicated in step 4, screening is a starting point for defining the CESIR study requirements.

Working from the "end" of the required screening, this section attempts to utilize the more organized preliminary work alongside individual utility interviews to:

- Lay out minimum requirements for a CESIR study with the expectation that enhanced screening has already been conducted,
- Set aside some of the less probable technical issues and instead, highlighting the potential address these in interconnection agreements, and
- Provide recommended practices for communicating study results to applicants in a generally uniform reporting format.

Table 4. Reporting requirements and recommended practice.

	NY SIR Reporting Requirements	Utility Recommended Practice
Step 1	(Applicant) initial communication	
Step 2	Determine scope/nature, assign contact, offer pre app report ($750)	Descriptions of site-related limits & identify if there are concerns
Step 3	Review of submittals, viability	Communicate with applicant
	Verify DER equipment certification	Apply SIR appendix B and C
Step 4	Run screens A-F and verify Sec II	Provide a table of limits/results
	Provide letter report on A-F	Show results and cost to continue
	Offer supplemental screen option G-I	Identify cost and issues to be addressed
	Commit to Scope of CESIR Study and provide cost estimate for study	Identify cost and issues to be addressed
Step 5	(Applicant) commits to CESIR	
Step 6	Utility Part I of CESIR	Review and disclose impacts expected
	Utility Part II of CESIR	Review applicant drawings for compliance prior to study, SIR section II
Step 7	(Applicant) commits to construction	

Based on administrative requirement in the SIR and review of existing CESIR report samples from the IOUs Table 5 provides recommended content for CESIR reporting.

Table 5. SIR Reporting requirements and recommended CESIR Contents.

	NY SIR Reporting Requirements	Recommended CESIR Contents
Step 5	(Applicant) commits to CESIR	
Step 6	Project title, date, doc number, reviewer	CESIR cover page
	Summary of project/grid connection	Include summary in Section 1
	Utility system impacts, covers voltage, thermal, protection and operations	Include technical findings in Section 2
	Interconnection requirements, specific upgrades, metering and cost estimate	Section 3 to cover utility and applicant responsibilities
	Inspections, testing and commissioning	Section 4
	Next steps	Section 5
	Inspections forms and check sheets as required	Section 6
Step 7	(Applicant) commits to construction	

Preliminary screening intentionally avoids detailed methods and the need for computed aided tools that require review from consultants or engineering departments. The supplemental screening option, as a middle step, emphases potential for interconnection approvals based on engineering judgement without detailed study.

CESIR studies, on the other hand, involve the full suite of tools available at the engineer's disposal to develop the analysis, including power flow and short-circuit studies[10]. CESIRs are intended to be the "final" word on an interconnection request under the current system structure. These studies should follow 3 key technical areas: voltage, thermal capacity, and operational protection/safety.

4.2 Voltage

Preliminary screening used the DG penetration as a function of circuit rating as a proxy for the voltage rise. Supplemental screening limited the simple voltage rise (without considering loading) to a preset limit intended to prevent overvoltage or unnecessary interaction with regulating equipment.

For the CESIR study, the existing location and magnitude of loads along with existing generation should be considered through a power flow study. Adding in the prospective DG, potential violations of existing service limits (such as ANSI C84) aren't violated in any known feasible operating condition. For PV, typically this situation occurs when the net load on the circuit is near its daytime minimum (MDL).

The power flow study results (before and after the addition of new DG) can also be used to screen for the impact of step changes in DG output on distribution voltage. Selection of a limit for voltage step changes may be subject to the presence of line regulators due to the increased likelihood of excessive regulator operations with due to PV variability.

Method and Data Requirements

The first requirement for performing the CESIR is a model of the existing distribution circuit, including the location of existing loads and generators. The additional generation capacity (both active and reactive power) and its location should also be known. Power flow analyses should be conducted at both peak and minimum load levels, with generators set to their expected outputs during those time intervals. Given that individual load and generator outputs are not known, they are often allocated a fraction of the total power

[10] The individual software package utilized is likely inconsequential so long as they include these basic elements.

based upon a feeder head measurement and a series of allocation factors (which are typically proportional to the relative size (in kW) of the customer connection). Substation regulators and capacitor banks may not be directly modeled, however, the expected status of these devices should be reflected in the voltage and feeder reactive power requirements.

Depending on the level of detail in the circuit model, the distribution voltage may be evaluated at the primary (MV) level or the customer secondary (LV) level. If the MV level is used, the expected voltage rise or drop may be accounted for across the customer's transformer. The addition of this buffer may depend on whether or not customer-sited PV on the circuit is expected (for instance Hawaiian Electric considers a 2% rise across their transformers during mid-day to account for the presence of rooftop solar generation). This might be used to adjust (shrink) the allowable range for voltages in the power flow study (from 105% to 103%, for instance).

The process involves at least two power flow cases. The first is a baseline, without the additional generation being considered. The second should include the additional generation source at its requested interconnection point. In both power flows, the voltages should be recorded at key points, as indicated in Figure 6 including the substation, DG interconnection, the nearest regulator to the DG, as well as each customer. In the second power flow, the voltage at each customer should not exceed the planning limits (determined by required service voltages). Additionally, the voltage change, either at the interconnection point or the nearest regulator should not exceed a fixed limit (often 3-5% or ½ the regulator bandwidth, respectively).

If either the voltage limits or voltage change limits are violated, the second power flow may be repeated with modifications to either the circuit (to reflect a conductor size increase, for instance) or a change to the inverters settings (such as having the inverter absorb reactive power). Available DG starting and stopping ramp rate control options may also be considered.

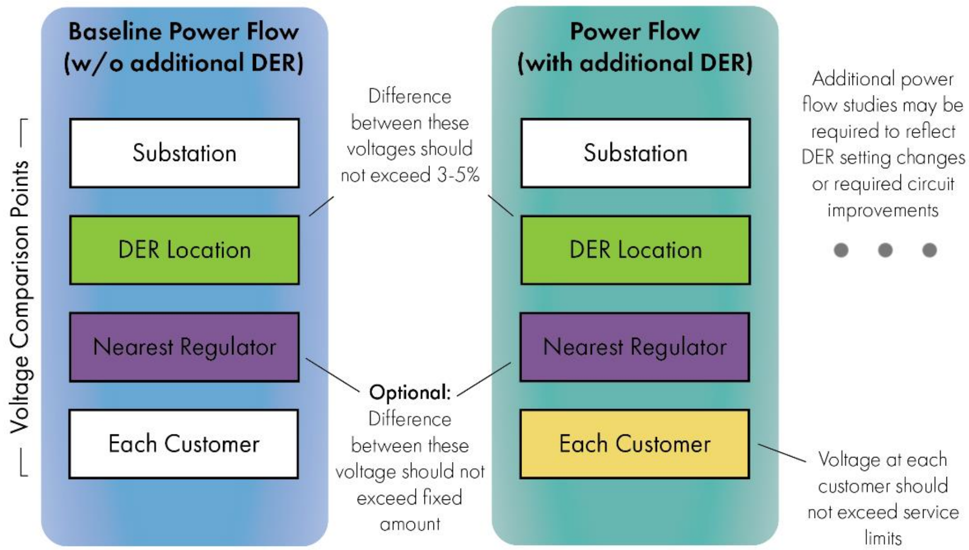

Figure 5. Comparison of Voltage Issues in Power Flow with and without DG

Expected Results

In summary, the outputs recorded should include:

- Highest and lowest simulated voltages at any customer location (or MV proxy), which should be within planning limits.
- Expected change in voltage at the DG interconnection between the two power flows, which should be less than 3-5%
- Expected change in voltage at the nearest regulator (where applicable), which should not exceed planning limits.

If any of the limits are violated, the power flow should be repeated with at least one option for circuit improvement or DG modification such that all criteria are passed.

4.3 Thermal

Though less common than voltage issues, overloading of distribution equipment should be avoided when adding DG to an existing distribution circuit. Though most power system equipment doesn't fail immediately when overloaded, these conditions often lead to increased temperatures that accelerate the deterioration of components (particularly insulation). With load, typically the most at-risk elements have a combination of a limited capacity and a central location between most of the customer loads and the substation. This situation is common for substation getaway cables or duct banks that lead out from underneath the substation.

Exceeding the thermal rating is typically attributed to excessive load, however, generation can also cause thermal issues. This is somewhat less common, since the generation must exceed the component rating plus the minimum load through the component, as shown in Figure 6. Rather than at the substation, where minimum loads are at their highest, at-risk elements are likely small conductors near to interconnections for large DG and away from other loads. At these points, it is reasonable to neglect the minimum load since it is largely unknown.

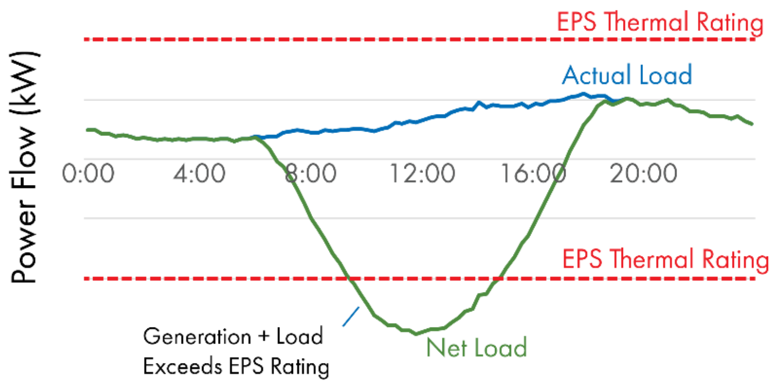

Figure 6. Considering Generation with Net Load relative to Thermal Rating.

In prior screening, only the EPS ratings nearest to the generator were considered during screening. Also, nearby loads were not accounted for in the screening.

Method and Data Requirements

Along with the circuit model referenced during the voltage-related portion of the study, detailed information on the normal and emergency (where applicable) ratings of the circuit are necessary. This includes the ratings of overhead lines, underground cables, and transformers.

Using most power flow programs, the current through each power system element may be tracked and compared against the element ratings. This will allow the engineers conducting the study to quickly identify if the generation or load exceeds any equipment ratings. With solar or other generation sources, this analysis only needs to be run at minimum load conditions. Battery storage or other resources that can inject and absorb active power in an uncoordinated fashion must be studied at minimum load conditions (as generators) and at peak load conditions (as loads).

If any circuit or DG operating adjustments are made, those should also be reflected in the power flow results in this step.

Expected Results

In summary, the outputs recorded should include:

Pass or fail indication if the normal ratings of any of the distribution equipment in the area is exceeded during the power flow study.

If the thermal limits of any of the lines, cables, or transformers are exceeded, the power flow should be repeated with at least one option for circuit improvement or DG modification such that all criteria are passed.

4.4 Reporting Technical Review Results

Since reporting practices have evolved more or less independently among IOUs it is recommended that reporting templates be introduced in the SIR. In particular, CESIR reporting has evolved to a range of different formats and level of detail. Appendix C provides several straw man templates for consideration. These include; a letter report template for preliminary screening results; a supplemental reporting template for this option; and a CESIR report template.

4.5 Issues Omitted from Technical Reviews

Occasionally CESIR studies have referenced requirements that are generally rare and difficult to conduct analyses, such as flicker or harmonic interaction. Steady state power flow is an effective tool for analyzing most potential distribution impacts from interconnected DG, however some issues are very difficult to study because they depend on site-specific conditions. In addition to limitations in simulations, many issues typically result from abnormal or unexpected operation of the DG or interaction with other power system elements. A time-domain simulation tool may allow investigation, however, the level of model detail required may exceed that which is available to utilities. Unknown loading and circuit conditions also affect the output of the study, making the results somewhat unreliable.

We recommend that these be omitted from standard technical reviews unless a special case is identified. As an alternative we recommend that that these be identified as potential contingencies in interconnection agreements. Also, lacking simple tools to effectively study the phenomena beforehand, robust commissioning tests may be needed for larger systems along with the ability to adjust DG operations if issues are observed after the system begins operation.

4.6 Operational Protection/Safety

Protection is typically the most contentious part of the interconnection review, because issues are difficult to assess and are largely high impact/low probability events. Addressing these issues often involves some of the largest costs (for example, transfer trip, added reclosures, 3VO and related cost to coordinate new protection equipment) . Assumptions and requirements are also highly dependent on utility practices, such as fuse-saving, reclosing practice and overall system protection strategy. At the screening level, most protection concerns are addressed by limiting the total capacity of the DG that may be added relative to either the feeder rating or minimum load. However, as the DG capacity on a particular feeder grows, these issues may need to be independently evaluated, including fuse coordination, grounding, reverse power flow, and anti-islanding.

Method and Data Requirements

Studies typically provide results on a full set of issues even though required data for each protection issue is slightly different, as is the specific approach:

Effective grounding[11] (ground-fault overvoltage) - Effective grounding is a criteria referring to the expected overvoltage on the distribution circuit in the event of a fault (should be less than 1.3x the rated line voltage on any phase)[11] Symmetrical component methods for evaluating effective circuit grounding with rotating machines (voltage sources) are mature, and are incorporated into several industry tools.

Inverters are generally current sources in these situations, and existing protection software doesn't properly account for them in grounding studies. Grid-connected inverters are current sources in the positive sequence, typically a finite impedance in the negative sequence, and almost always an open-circuit in the zero sequence. Due to the current source operation, and unlike rotating machines, the magnitude of the overvoltage is mostly determined by the phase-to-neutral connected loads. If overvoltage on the MV circuit with inverter-based generation is a concern, analysis may have to be conducted by hand until such tools are developed12.

Substation neutral overvoltage protection (3V0) -

[11] IEEE Std C62.92.1, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part 1 – Introduction

[12] IEEE Std C62.92.6, Draft Guide for Application of Neutral Grounding in Electrical Utility Systems, Part VI - Systems Supplied by Current-Regulated Sources

Overvoltage protection is required for substations comprised of delta-wye transformers that are radially fed or tapped from a single transmission source where back-feeding is expected and islanding may be sustained for some time. The 3V0 neutral overvoltage protection reduces prolonged over voltage from phase to ground faults on these delta-wye connected transformers. The principal protection mechanism is rapid disconnection of the downstream DG (or an entire circuit) if the neutral voltage exceeds a certain threshold.

This concern is significantly less applicable if the substation transformer is wye-wye, because grounding sources (including loads) can keep the upstream system effectively grounded. Substations with multiple transmission sources are already protected against over-voltage conditions resulting from phase to ground faults.

The conditions that may lead to neutral overvoltage, including contingencies, usually N-1, such as loss of load may be identified as part of a study. However, transient analysis, evaluation of protection options and arrester rating is beyond the realm of traditional planning software. As a result, generation to load back-feed potential often triggers additional 3V0 protection requirements without otherwise detailed studies.

Anti-islanding – Given the necessity of generation and load balancing for both active and reactive power, a detailed investigation of anti-islanding possibility requires a significant amount of circuit and load data. Three methods are currently used for anti-islanding studies in New York:

1. Screening criteria from Sandia National Labs provides some guidance that is at least partially used by utilities. However, the complexity of the screening, data requirements, and potential for misapplication is prompting a revisiting of the screening criteria.

2. A detailed time-domain simulation using the inverter manufacturers proprietary inverter model can determine if the lifetime of an island is likely to extend beyond an acceptable time limit. This technique often requires access to confidential information regarding the inverter's control design.

3. The Joint Utilities have recently developed a method for determining required protection based on the relative size of generation and load, reducing the number of applications that reach the Sandia screens or the detailed simulation.

Reverse power flow (on a radial system) – The calculation of reverse power flow on a radial system is straightforward, calculated either by hand (comparing the expected DG output to the minimum load) or from the previous power flow result. If reverse power flow is a possibility, additional effort may be required to locate the control systems that may need to be replaced if they don't support regulation with reverse power flow (i.e. cogeneration mode on a regulator).

Expected Results

Results from the individual investigations regarding protection and safety are largely pass/fail, with "fail" results resulting in the requirement for improvements to existing protection (such as relaying or fuse ratings) or additional protection at the DG site (such as a recloser or transfer-trip).

Appendix A Summary of Screening Recommendations

Proposed Preliminary Screens:

A. Is the PCC on a networked secondary system?

B. Is certified equipment used?

C. Is the EPS Rating exceeded?

D. Is the DG Compatible with the Power Service at PCC?

E. Is aggregate DG less than 15% of feeder peak load?

F. Is feeder capacity at PCC adequate for aggregate DG?

Proposed Supplemental Screens:

G. Supplemental Penetration Test: Does DG exceed minimum load during 12-month period?

H. Voltage Change Test: Does DG change voltage beyond limits at; PCC, any point on feeder, or at regulator?

I. Protection Adequacy and Coordination (e.g. JU anti islanding assessment criteria or other conditions)?

J. Review for non-certified DG - are the required relay protection functions included and configured properly?

K. Special Protection Requirements for Network Connected DG.

Appendix B: Screening and CESIR Report Templates

Utility Logo

CESIR Technical Review Report Template

(March 2016 NYS SIR)

Issue Date: ________________________________
Reviewer: ________________________________

Applicant: ____

Project Title: ___________

I. Executive Summary: (Cover overview and general findings)

Project Address and Description (included rating of the DG and any grid ratings that are exceeded and required upgrades):

____
____

If relevant, reference any preliminary screening analysis report and results, dated:

____

II. Grid Impacts Assessment: (Include all technical findings related to application)

A. Voltage Regulation, Overvoltage and Regulation Coordination Analysis
(address and make clear analytical approach, any requirements not met and mitigations options)

____
____

B. Thermal Ratings and Overload
(address and make clear analytical approach, any requirements not met and mitigations options)

____
____

C. Operational Protection and Safety
(address and make clear analytical approach, any requirements not met and mitigations options)

____
____

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III. Interconnection Responsibilities and Cost Estimate

(spell out interconnection-specific responsibilities, upgrades with estimated costs and break down on utility side and DG installation requirements**)**

____

____

V. Next Steps to Interconnection

(address the steps and likely schedule based on requirements and system upgrades)

____

____

Utility Letter Head

Subj: Interconnection preliminary screening results for___________________________________

Utility has completed preliminary screen for the subject project. This screening is according to the NY SIR requirements and the screens A through F. The determination is that your proposed system cannot pass the relevant screens allowing streamlined interconnection approval. See the results for each of the screens that are described below.

Please notify us within (10) Business Days whether you choose to (i) either proceed to preliminary results meeting, (ii) to process to supplemental review, (iii) to proceed to a full CESIR, (iv) or to withdraw the interconnect request.

Listing of Preliminary Screens and Results (pass/fail)
A thru F
See attachment for details on

- ***Distribution details***
- ***Application details***
- ***Screening results details***

Per the NY SIR, if you fail to notify Utility of your decision within (30) business days of receipt of this notification, your interconnection request will be removed from the queue. Please notify us in writing of your decision.

Signature

CC

Utility Logo

Supplemental Screening Analysis Report

(March 2016 NYS SIR)

Issue Date: ___________________________________
Reviewer: ___________________________________

Applicant: ____

Project Title: ____________

Project Address: ____

Ratings of the DG and connection point: ____________________________________

Reference Preliminary Screening Analysis Report dated: ____

I. <u>Executive Summary</u>:

II. <u>NYS SIR Appendix G Screening Review</u>:

Screen G: Supplemental Penetration Test (from current SIR)
Where 12 months of line section minimum load data is available, can be calculated, can be estimated from existing data, or determined from a power flow model, is the aggregate Generating Facility capacity on the Line Section less than 100% of the minimum load for all line sections bounded by automatic sectionalizing devices upstream of the Generating Facility?

- If yes (pass), continue to Screen H.
- If no (fail), a quick review of the failure may determine the requirements to address the failure; otherwise the Interconnecting Customer may be required go on to the Coordinated Electric System Interconnection Review (CESIR) process. Continue to Screen H.

Utility Review and Results

Screen H: Power Quality and Voltage Tests (from current SIR)
In aggregate with existing generation on the Line Section,

a. Can it be determined within the Supplemental Review that the voltage regulation on the line section can be maintained in compliance with current voltage regulation requirements under all system conditions?
b. Can it be determined within the Supplemental Review that the voltage fluctuation is within acceptable limits as defined by IEEE 1453 or utility practice similar to IEEE1453?
c. Can it be determined within the Supplemental Review that the harmonic levels meet IEEE519 limits at the Point of Common Coupling (PCC)?

- If yes to all of the above (pass), continue to Screen I.
- If no to any of the above (fail), a quick review of the failure may determine the requirements to address the failure; otherwise the Interconnecting Customer may be required go on to the Coordinated Electric System Interconnection Review (CESIR) process. Continue to Screen I.

Utility Review and Results

Utility Logo

Screen I: Safety and Reliability Tests (from current SIR)
Does the location of the proposed Generating Facility or the aggregate generation capacity on the Line Section create specific impacts to safety or reliability that cannot be adequately addressed without a detailed study?

- If yes (fail), a quick review of the failure may determine the requirements to address the failure; otherwise the Interconnecting Customer will be provided with information on the specific points of failure in the supplemental review results and may go to the Coordinated Electric System Interconnection Review (CESIR) process.
- If no (pass), Supplemental Review is complete.

Utility Review and Results

III. Requirements for Connection and Cost Estimate

IV. Next Steps: