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An Introduction to Interconnection Policy in the United States

I. Introduction to Interconnection Policy

II. History of Interconnection Policy

III. PJM Interconnection Procedures

IV. ferc small generator Interconnection Procedures

V. ohio Interconnection Procedures

What are Interconnection Rules?

Interconnection Rules generally consist of :

(1) The administrative procedures and technical standards used to evaluate potential impacts associated with interconnecting a generation resource to the electric power system.

(2) Standard contractual agreements stipulating operational and cost responsibilities between the electric utility and the generation resource owner.

Interconnection Procedures

Three steps:

1. Customer submits interconnection application
2. Utility assigns queue position and executes technical review
3. Joint signing of Interconnection Agreement*

* An Interconnection Agreement is a legal contract between the electric utility and customer establishing all terms and conditions associated with operating DG in parallel with the utility's electric power system.

Why have Interconnection Rules?

Balancing two objectives:

1. Provide a transparent and efficient means to interconnect generation resources to the electric power system.
2. Maintain the safety, reliability and power quality of the electric power system.

Interconnection Jurisdiction

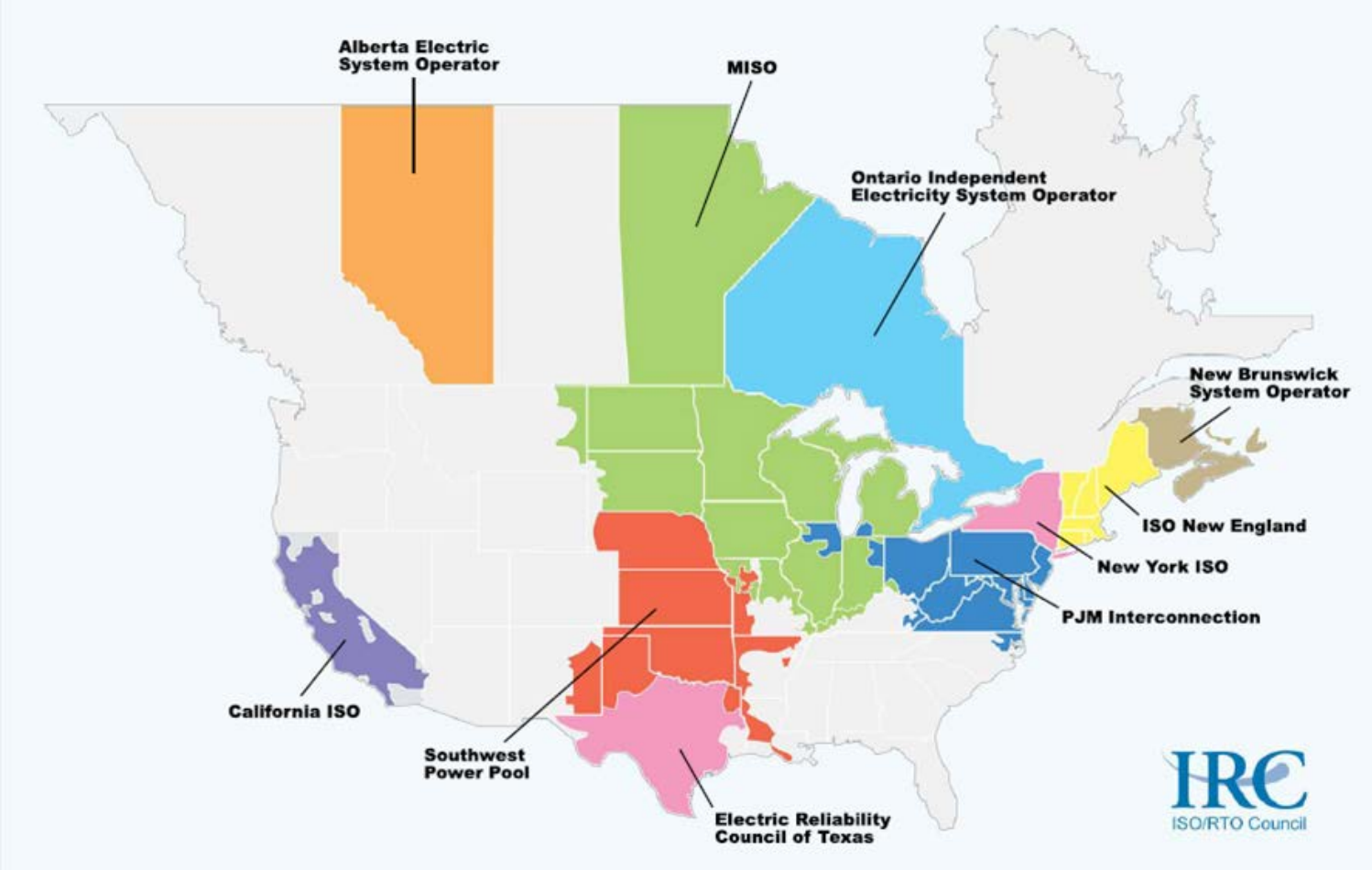
Transmission-Level Interconnections:

- Governed by federal policy and overseen by the Federal Energy Regulatory Commission (FERC).
- Generally apply to large-scale merchant generation resources.

Distribution-level Interconnections:

- Governed by state policy and administered by state public utility commissions.
- Generally apply to Distributed Generation (DG) behind-the-meter, residential and commercial facilities that are Net Energy Metered (NEM).

Federal interconnection policy is adopted and administered by Regional Transmission Organizations (RTOs). Where none exist, FERC directly oversees Transmission-Level Interconnections.



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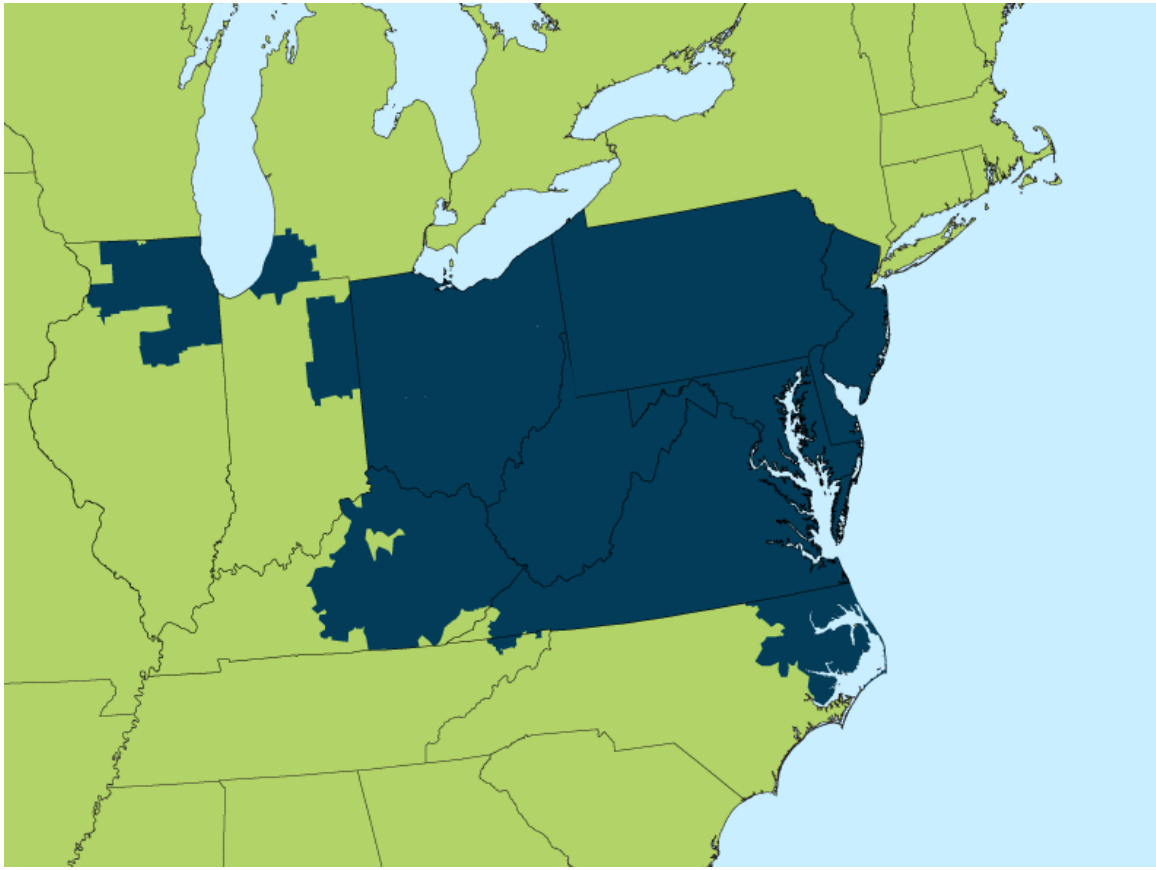
PJM Interconnection administers transmission-level interconnections and planning in compliance with FERC and NERC standards for 13 states, including Ohio.

PJM and other RTO's modify Federal Interconnection Procedures with FERC approval to meet regional conditions. Like states, each RTO has slightly unique processes.



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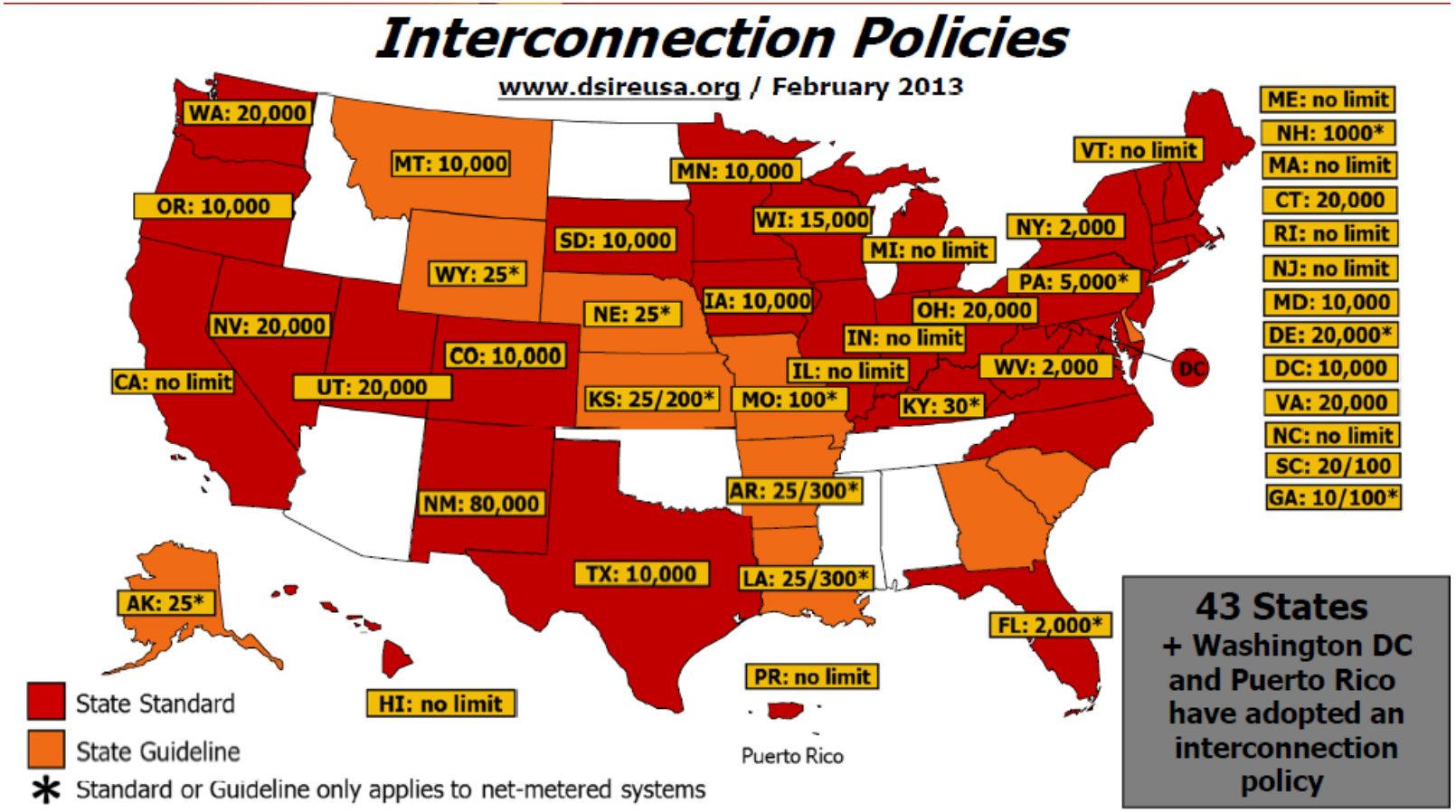
States with Distribution-Level Interconnection Policies



Notes: Numbers indicate system capacity limit in kW. Some state limits vary by customer type (e.g., residential versus non-residential). "No limit" means that there is no stated maximum size for individual systems. Other limits may apply. Generally, state interconnection standards apply only to investor-owned utilities.

In the Beginning…

Prior to standardized interconnection policy, interconnection processes were left up to utility discretion.

Discretionary processes were shaped by two factors:

1. The utility's obligation to maintain the safety and reliability of their electric power system.
2. The utility's financial disincentive to facilitate DG development.

In the Beginning…

The interconnection process was characterized as being opaque, costly, time-consuming, and inconsistent across states and service territories.

- Introduced significant risk to new merchant generator development.
- A 2000 survey by the National Renewable Energy Laboratory (NREL) found that virtually all DG projects met some degree of resistance from utilities during the interconnection process. [1]

Path to Reform

Between 2000 and 2006 policymakers began implementing policy reforms to improve the interconnection process.

The policy goal:

To maintain the safety and reliability of electric power systems while providing developers a transparent, efficient, and cost-effective process that operates on reasonably predictable timeframes.

December 2000: California Rule 21

Among the first comprehensive, state-wide interconnection policies in the United States.

Developed two influential innovations:

1. Screening process streamlined review of interconnection applications
2. Procedural timelines expedited interconnection process

June 2003: Technical Standards for Small Generators

Institute for Electrical and Electronics Engineers (IEEE) 1547 Standard for Interconnecting Distributed Resources with the Electric Power System.

- Provides requirements relevant to performance, operation, testing, safety, and maintenance of Distributed Generation smaller than 10 MW interconnecting to electric power systems.

July 2003: Federal Rules for Large Generators

FERC Large Generator Interconnection Procedures (LGIP) and Large Generator Interconnection Agreement (LGIA)

- First federal policy to address the interconnection of large merchant generators greater than 20 MW in capacity.
- Established a standard three-study procedure for large generator interconnection that applies to all transmission-level interconnections in the country.

May 2005: Federal Rules for Small Generators

FERC Small Generator Interconnection Procedures (SGIP) and Small Generator Interconnection Agreement (SGIA).[4]

- Applicable to transmission level interconnections.
- Developed 3 review levels, scaling DG size with technical review scope.
- Adopted a fast track review process for systems smaller than 2 MW, utilizing technical screens.

August 2005 Energy Policy Act: (EPAct)

Section 1254 of EPAct required state regulatory commissions and certain non-regulated utilities to consider adopting interconnection procedures based on IEEE 1547 standards and current 'best practices.'[5]

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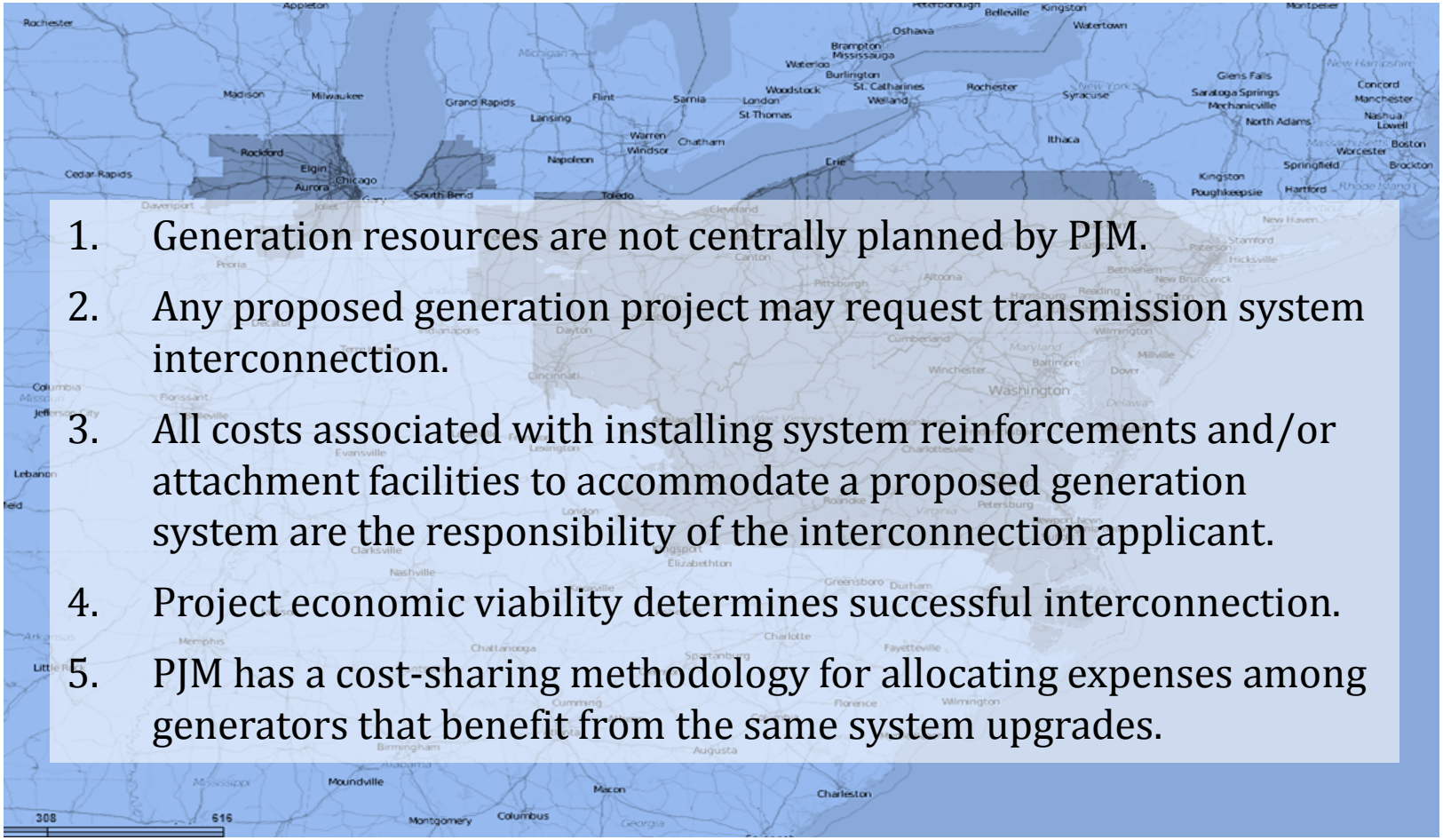
PJM INTERCONNECTION PROCEDURES

Transmission-Level Interconnection within the PJM RTO



1. Generation resources are not centrally planned by PJM.
2. Any proposed generation project may request transmission system interconnection.
3. All costs associated with installing system reinforcements and/or attachment facilities to accommodate a proposed generation system are the responsibility of the interconnection applicant.
4. Project economic viability determines successful interconnection.
5. PJM has a cost-sharing methodology for allocating expenses among generators that benefit from the same system upgrades.

PJM's Interconnection Policy Foundations

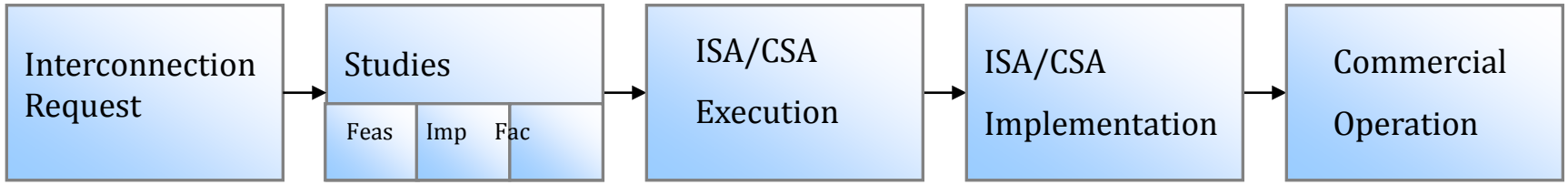
- FERC Order 2003 establishing Large Generator Interconnection Procedures and Agreements
- FERC Order 661 establishing Standardized Interconnection Agreements for Wind Generators
- FERC Order 2006 establishing Small Generator Interconnection Procedures and Agreements
- PJM Open Access Transmission Tariff Section IV 'Interconnections with the Transmission System'
- PJM Manual 14 Series establishing business practices for the interconnection of Generation and Transmission resources

PJM Generator Request Queue Activity

	MW
Active	48,825
In Service	35,017
Under Construction	14,940
Withdrawn	257,781
Grand Total	356,563

*Through 9/30/2013

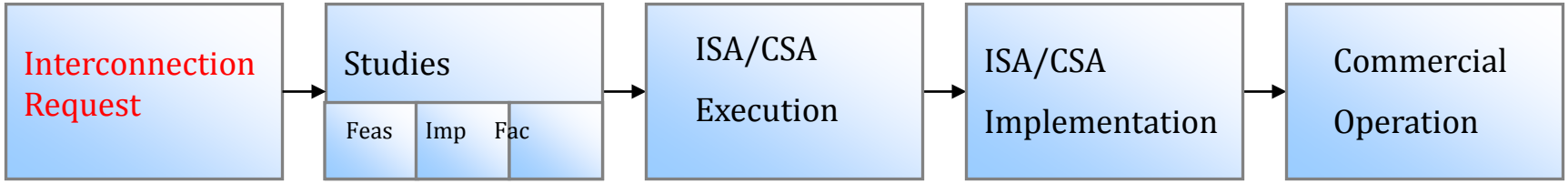
PJM Interconnection process



- Applicants initiate the Interconnection process by submitting an Interconnection Request to PJM.
- Three analytical steps: (1) Feasibility Study, (2) System Impact Study, (3) Facilities Study.
- Each step imposes its own financial obligations and establishes milestone responsibilities between the interconnection applicant, Transmission Owner (TO), and PJM.

Feas: Feasibility Study
Imp: System Impact Study
Fac: Facilities Study
ISA: Interconnection Service Agreement
CSA: Construction Service Agreement

PJM Interconnection process



- Applicants submit request to connect at a Point of Interconnection (POI) on the transmission system.
- Projects assigned a queue position based on the timing of request submission.
- Projects may drop out of their queue at any time.
- To retain queue position, applicants must agree to proceed with each phase within specified timeframes, (i.e. 60 days).

Required Information:

- Location
- Size
- Ownership
- Configuration
- Planned In-Service Date

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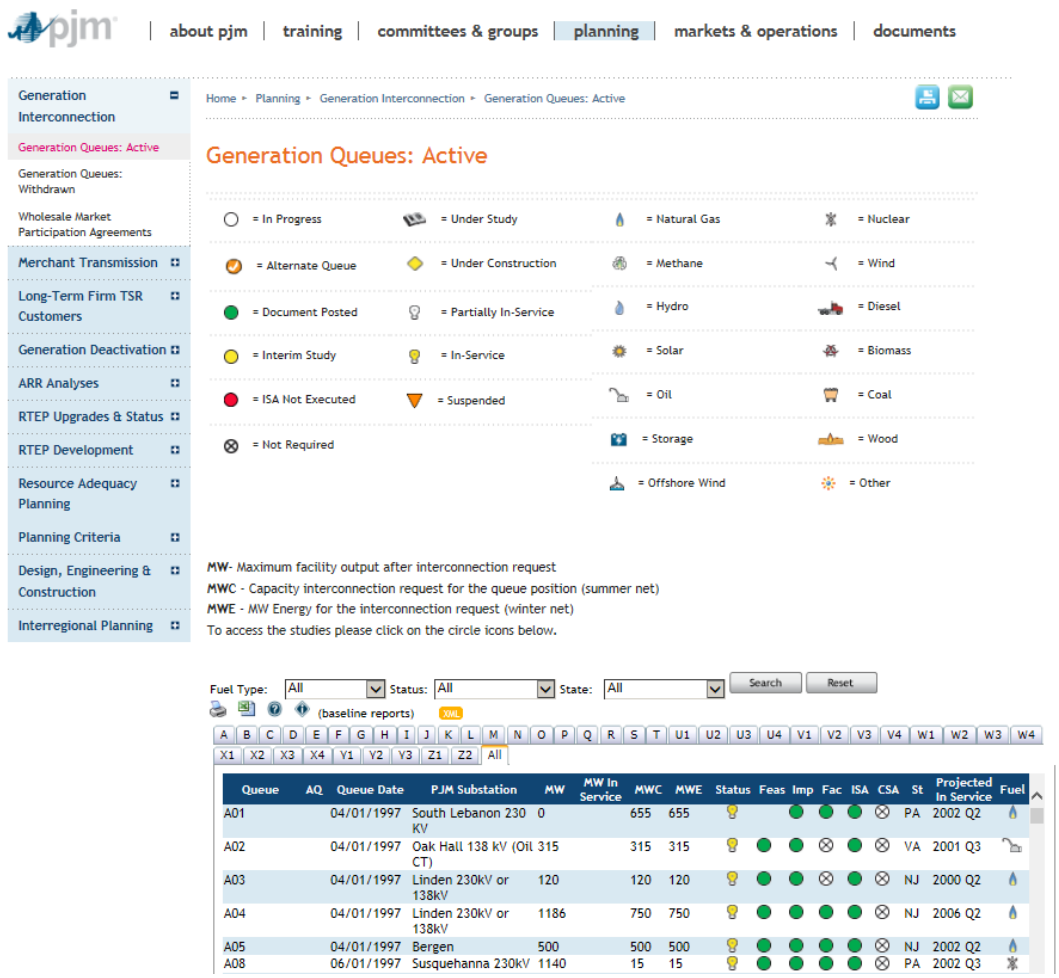
The PJM Interconnection Queue is publically available online.

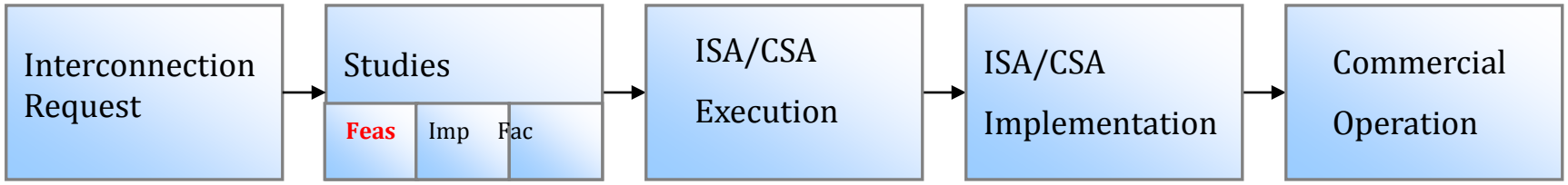


Scoping Meeting

PJM offers a meeting between the interconnection applicant, PJM staff, and Transmission Owner (TO) representatives following receipt of interconnection request to determine the following:

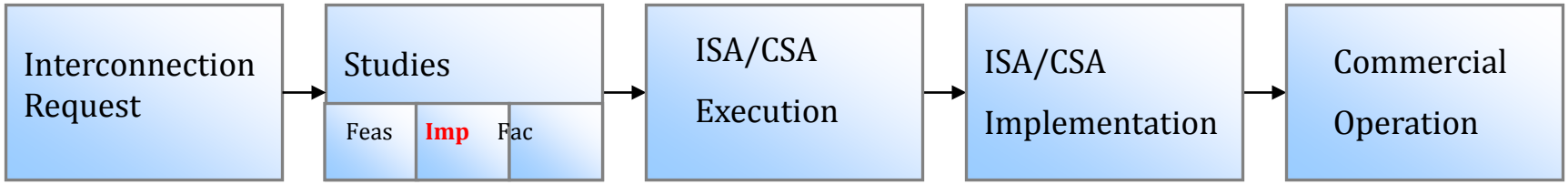
- One alternative point of interconnection
- Configurations to evaluate in the 3 interconnection studies
- Applicants may select up two (2) Points of Interconnection (POIs).
- The scoping meeting may be waived by mutual agreement of the parties.

PJM Interconnection process



- Required for study:
  - Deposit based on request receipt timing & MW size
  - Applicants must provide proof of site control
  - Projects must be in-service within seven years after PJM's receipt of interconnection request
- Different Procedures for Large Generators (>20 MW) and small generators (≤20 MW).
- Study completion within 90 days.
- Study coordinated between the Transmission Owner and PJM.
- Results:
  - Identify Transmission Upgrades
  - Cost Estimates
  - Construction Schedule

PJM Interconnection process

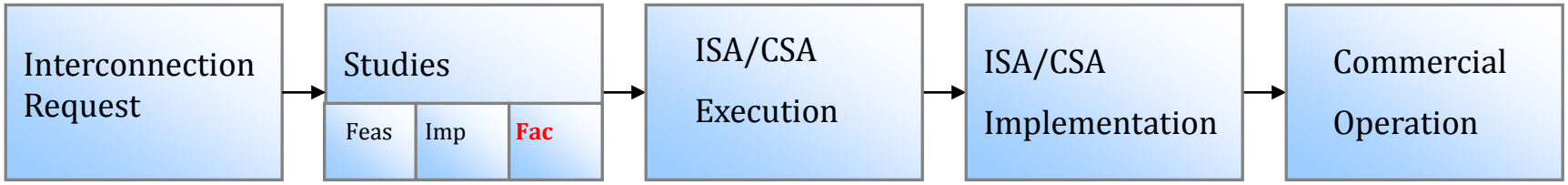


- Required for study:
  - $50k Deposit (> 20 MW)
  - Study cost estimate (2 - < =20 MW)
  - Initial Air Permit Application
- Study Completion within six months.
- Study coordinated between the Transmission Owner and PJM.
- Two or more projects within electrical proximity may be studied together for cost sharing.
- Results:
  - Regional Analysis (DFAX Modeling)
  - Gen & Load Deliverability Analysis
  - Stability Analysis
  - Cost Estimates
  - Milestone Schedule

If the developer agrees to proceed with the project, the results of the System Impact Study are incorporated into to PJM's Regional Transmission Expansion Planning (RTEP) process.

- RTEP Development
- Transmission Expansion Advisory Committee Review
- Re-Evaluate RTEP Plan
- PJM Board Approval

PJM Interconnection process



- Required for Study:
  - Greater of $100k deposit or 1st three months cost estimate of facility design
- Study Completed within six months.
- Study Coordinated between the Transmission Owner and PJM.
- Results:
  - Conceptual Design
  - Portions of Detailed Design for:
    - Attachment Facilities
    - Network Upgrades
  - Cost Estimate
  - Engineering and Construction Schedule
  - Cost Allocation

The Developer may separately arrange for the design of the required facility upgrades, either through its own resources or by a third party.

PJM Interconnection process

Interconnection Service Agreement

- Three Party Agreement filed with the FERC.
  - TO, Developer, PJM
- Description of Generating Units.
- Identifies Obligations of Developers:
  - Attachment Facilities
  - Upgrades Costs
  - Capacity Interconnection Rights
- Developers must post security for estimated costs with PJM to maintain queue position.

Construction Service Agreement

- Three Party Agreement.
  - TO, Developer, PJM
- Identifies:
  - Scope of Work
  - Construction Schedule
  - Payment Schedule
- Developers may elect to design and build necessary upgrades, retaining services of Approved Contractors.
- Developers electing Option to Build must adhere to PJM's independent activity timeframes.

PJM Interconnection process

- Construction Milestone Tracking
  - Generation Facilities
  - Attachment Facilities
  - Network Upgrades
- Billing Approval / Cost Tracking
- Coordination of
  - Energy Management System (EMS)
  - Data Link / Communications
  - eTools Setup and Implementation
- Outage Coordination
- Coordination of Test Energy Injection

ISA: Interconnection Service Agreement
CSA: Construction Service Agreement

PJM Interconnection process

Generation Resources required to comply with all relevant operational terms and conditions set forth in PJM's Operating Agreement and Open Access Transmission Tariff.

Cost Allocation Methods

Interconnection Customer requests are studied as a single study for all active projects in an individual New Services Queue.

PJM Applies three cost allocation methodologies, which apply to different kinds of system impacts and reinforcements:

1. Load Flow Cost Allocation Method

2. Short Circuit Cost Allocation Method

3. Generator Step Up Change Cost Allocation Method

PJM Interconnection Cost Allocation

Each respective generator project bears the cost responsibility for direct connection attachment facilities required for interconnection.

The cost responsibility for local and network upgrades identified through system impact study analysis is allocated among parties according to the following:

- Upgrades costing less than $5 million are shared by all proposed projects in a new services queue for which the need for the local and network upgrades was identified.
- Upgrades costing greater than $5 million are allocated according to the order of the interconnection requests in the new services queue and the MW contribution of each individual interconnection request for those projects which cause or contribute to the need for the local or network upgrades.

Sharing Load Flow Upgrade Costs greater than $5 million

Costs are shared

- if individual project impact is greater than 5 MW **and** greater than 1% the applicable line rating,

  OR

- if its distribution factor (DFAX) on the facility is greater than 5% **and** its MW impact on the facility's rating is greater than 3%

The contribution of an interconnection customer is determined by the voltage level of the transmission facility that it impacts:

- For transmission facilities less than 500 kV, a project will have cost allocation if its DFAX on the facility is greater than 5% **or** if its MW impact on the facility's rating is greater than 5%.
- For transmission facilities greater than 500 kV, a project will have cost allocation if its DFAX on the facility is greater than 10% **or** if its MW impact on the facility's rating is greater than 5%.

Allocating Load Flow Upgrade Costs less than $5 million

The first project to cause the need for the system upgrade will in all cases have some cost allocation, which only considers the loading above the facility's capability.

If subsequent project impact is greater than 5 MW **and** greater than 1% the applicable line rating, the contribution of the new project to causing upgrade need is determined by the voltage level of the transmission facility that it impacts:

- For transmission facilities less than 500 kV, a project will have cost allocation if its distribution factor (DFAX) on the facility is greater than 5% **or** if its MW impact on the facility's rating is greater than 5%.
- For transmission facilities greater than 500 kV, a project will have cost allocation if its DFAX on the facility is greater than 10% **or** if its MW impact on the facility's rating is greater than 5%.

Short-Circuit Cost Allocation Method

All interconnection customer/developer projects are studied in queue order.

A generation project will have some cost allocation if it results in a greater than 3% increase in fault current at the substation where a system upgrade is required.

A generation project will be assigned costs in proportion to its fault level contribution. The first generation project to cause a system upgrade due to increased fault current will in all cases have some cost allocation, which only considers the loading above the equipment's capability.

Generator Step Up (GSU) Cost Allocation Method

If a developer changes the generator or GSU characteristics after initiation of the System Impact Studies, any additional system problems and any resulting reinforcements will be assigned completely to the generation interconnection project that made the changes. Future queued generation may share some cost allocation based on when the generator or GSU changes were provided to PJM.

Example:

Impact studies for Queue Z identified the need to replace five 230 kV breakers at a substation. Project Z2, within this queue, provides new system data after the System Impact Study commenced indicating that six new breakers are now needed. Project Z2 pays 100% of the sixth breaker costs and shares in the costs of the original five breakers among all other projects in Queue Z.

Allocating Costs Greater Than $5 million for the 3 Methods

- Cost allocation for upgrades in excess of $5 million are assigned to projects in subsequent queues in proportion to their contributing impacts.

- New project developers are responsible for sharing the upgrade costs of previous projects in earlier queues for which they benefit, if the original network upgrade costs were determined five years prior to the new project coming online. There is a limit to inter-queue cost sharing.

- Finally, depreciation of as-built upgrades are not factored into cost allocation between developers.

  - Cost-allocation methodologies are continually revised by PJM
  - Cost-allocation methodologies are very contentious

Integration of Intermittent Resources

Specific procedures to determine capacity values for intermittent resources:

- Amount of generating capacity that can be reliably contributed during peak summer hours
- Capacity factor is based on rolling three years of historical operating data
- If new, class average capacity factor applied (wind 13%; solar PV 38%)

Certain power factor and low-voltage ride-through requirements apply to wind generators as stated in PJM's OATT.

Behind the Meter (BTM) Generation

- One or more generating units with load at a single electrical location (e.g. combined heat and power facilities).
- No transmission or distribution facilities owned or operated by any transmission owner or electric distributor are used to deliver energy from the generating unit(s) to load.
- Requires interconnection request if capacity or energy resource status sought.

PJM Interconnection Reforms

Approved by FERC and Implemented May of 2012:

- Six-month queue cycle to replace three-month cycle; resulting in fewer restudies and greater accuracy in modeling.
- Modification of project size may require project to "slide back" in queue, depending on impact on later queued project timing and cost allocation.
- Alternate queue for projects 20 MW or less that do not require PJM to upgrade its transmission system.

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FERC SMALL GENERATOR INTERCONNECTION PROCEDURES

FERC Small Generator Interconnection Procedures

FERC's SGIP* are designed to:

- Serve as a useful model for state-level interconnection standards.
- Include provisions for three levels of interconnection (mostly at the transmission level):
  - The 10-kilowatt (kW) Inverter Process
  - The Fast Track Process (based on individual system and generator characteristics up to a limit of 5 MW)
  - The Default Study Process (all other systems ≤ 20 MW)

*Small Generators Interconnection Procedures
http://www.ferc.gov/industries/electric/indus-act/gi/small-gen.asp

FERC Interconnection Reforms

November 22, 2013 FERC's adoption of amended Small Generator Interconnection Procedures.

Five significant amendments:

- A pre-application report.
- Scaled fast-track eligibility size limit.
- Supplemental review screens.
- Third-party review of required upgrades.
- Clarified definition of small generating facility that explicitly includes storage devices.

Pre-application Report

Intended to reduce the number of speculative, unviable projects

- provide developers access to system information at a specific point of interconnection prior to submission of interconnection request.

For a fee, transmission owners provide developers with formalized reports

- contain pre-specified data points that may help characterize project viability at a certain point on the transmission system.

Possible items include:

- Total and available generation capacity of the facilities serving the considered Point of Interconnection.
- Circuit distance between facility and substation.
- Circuit voltage, phases, number and rating of protective devices.

Scaled Fast-Track Eligibility Size Limit

Line Voltage	Fast Track Eligibility- Regardless of Location	Fast Track Eligibility- on a Mainline and ≤ 2.5 Electrical Circuit Miles from Substation
< 5kV	≤ 500 kW	≤ 500 kW
≥ 5kV & < 15 kV	≤ 2 MW	≤ 3 MW
≥ 15 kV & < 30 kV	≤ 3 MW	≤ 4 MW
≥ 30 kV & ≤ 69kV	≤ 4 MW	≤ 5 MW

Intended to increase the number of projects eligible for fast-track review by modifying the flat 2 MW eligibility cap to a tiered framework, scaled to system conditions.

Under this scheme, projects as large as 5 MW can be eligible for fast-track review if they are located on high voltage lines and proximate to substations.

Supplemental Review Screens

- Intended to decrease the number of projects that fail fast track review and must proceed to the costly/time-consuming three study process.

- In the event that a project fails one or more fast track screens, the application can be reviewed under a second set of technical screens that address common technical problems in a transparent manner.

These supplemental review screens include:

1. A distributed generation penetration screen, setting a limit of aggregate generation on a line section at 100% minimum line load.
2. A power quality screen, addressing flicker and voltage stability standards.
3. A safety and reliability screen, addressing other relevant considerations.

Third Party Upgrade Cost Review

- Provides the developer the opportunity to review and comment on system upgrades required by the transmission provider (RTO/ISO).

- Developers can either review and comment directly or consult with third parties to evaluate whether or not network upgrade costs are just and reasonable.

- Transmission providers retain final determination of upgrade requirements.

OHIO'S INTERCONNECTION PROCEDURES

Interconnection Policy in Ohio

Ohio's Interconnection Rules* are designed to:

- Standardize technical requirements across the state
- Streamline development of DG pursuant to Ohio renewable energy policy objectives
- Maintain the reliability, safety, and power quality of electric service in the state

*Applicable to distribution-level interconnections

Ohio Interconnection Policy Language

Ohio Revised Code: ORC: 4928.02 (K) (statute)

http://codes.ohio.gov/orc/4928.02

Ohio Administrative Code: 4901:1-22 (rule*)

http://codes.ohio.gov/oac/4901%3A1-22

* On December 4, 2013 the Public Utilities Commission of Ohio adopted amended rules for electric interconnection services and standards in Chapter 4901:1-22 in accordance with the State of Ohio's 5-year rule review procedures (Commission Finding and Order , Case no. 12-2051-EL-ORD).

Ohio Interconnection Rule Review

PUCO staff evaluated the rules contained in Chapter 4901:1-22, O.A.C following July 17, 2012 notice of rulemaking.

- Included stakeholders in the development of the rule
- Considered the continued need for the rules, the nature of any complaints or comments received concerning the rules, and any change in the subject matter area affected by the rules
- Evaluated the impact of the rule on businesses
- Followed due process of law

- Recommends whether to amend/rescind/continue the rules

Ohio's Interconnection Rules Adopt the Principal Features of the FERC SGIP

- Require adherence to the IEEE 1547 and UL 1741 technical standards.
- Similar customized, multi-level approach matching degree of technical review with project characteristics.
- Establish standard and simplified applications and interconnection agreements.
- Expenses for application processing, technical studies, and system or facility upgrades are the responsibility of the applicant, not the utility (or its ratepayers).

Ohio's Interconnection Review Levels

<table>
<tr><th>Review Level</th><th>Eligibility</th><th>Application / Contract</th><th>Review</th></tr>
<tr><td>Pre-Application</td><td>any project</td><td>applicant's informal request / discussion of information specified in 4901:1-22-04 (B)(1)
applicant's formal written request / Pre-Application Report</td><td>Pre-Application Review</td></tr>
<tr><td>1</td><td>» IEEE 1547 and UL 1741 compliance certified
» inverter-based systems ≤ 25 kW</td><td>Short Form Application / Standard Interconnection Agreement</td><td>Simplified Review</td></tr>
<tr><td>2</td><td>» IEEE 1547 and UL 1741 compliance certified
» systems that are ineligible for/failed to pass Level 1 Review
» system types not exceeding the limits identified below
<table>
<tr><th>Line Voltage</th><th>Expedited Review Regardless of Location</th><th>Expedited Review on line capacity ≥ 600 amp and distance < 2.5 feeder miles from substation</th></tr>
<tr><td>≤ 5kV</td><td>≤ 500 kW</td><td>< 2 MW</td></tr>
<tr><td>≥ 5kV & ≤ 15 kV</td><td>≤ 2MW</td><td>< 3 MW</td></tr>
<tr><td>≥ 15 kV & ≤ 30 kV</td><td>≤ 3MW</td><td>< 4 MW</td></tr>
<tr><td>≥ 30 kV & ≤ 69 kV</td><td>≤ 4MW</td><td>< 5 MW</td></tr>
</table></td><td>Standard Application / Standard Interconnection Agreement</td><td>Expedited Review</td></tr>
<tr><td>2 Supplemental</td><td>» systems reviewed under Level 2 and failed to meet the criteria but could possibly be interconnected consistent with safety, reliability, and power quality standards after minor modifications/further study</td><td>applicant's written agreement within 15 days of EDU's offer to perform Supplemental Review / Standard Interconnection Agreement</td><td>Expedited Review including customized studies based on technical screens</td></tr>
<tr><td>3</td><td>» not IEEE 1547 and UL 1741 compliance certified
» all system types ≤ 20MW that are ineligible for/failed to pass Level 1 and Level 2 Review</td><td>Standard Application or applicant's agreement to continue evaluating the application that fails the Supplemental Review criteria / Standard Interconnection Agreement</td><td>Standard Review including customized studies</td></tr>
</table>

Application Processing and Queuing

Interconnection requests are interdependent

- Applications are processed in the order they are received.
- The utility assigns the application a queue position in relation to other interconnection requests on the same or nearby distribution system sections.
- The queue position is used to determine the cost responsibility of any necessary facility upgrades in relation to other interconnection requests on the same or nearby distribution system sections.

Ohio Interconnection Reforms

December 4, 2013 amendments:

- Consolidation of the application process into a three-level review procedure
- A Pre-application report
- Locational criteria to determine expedited eligibility size limit
- Supplemental review screens

Technical screens and Studies

- The pre-application report does not obligate the EDU to conduct a study or other analysis.
- Level 1, level 2 and supplemental reviews utilize technical screens largely adopted from the SGIP to expedite facility review.
- Level 3 review initiates a detailed study process consisting of three tests similar to PJM's procedure:
  - Feasibility study
  - System impact study
  - Facilities study

**One or all of these tests can be waived by the utility.*

Potential Interconnection Issues

- Operator issues
- Network issues
  - Changing voltage profiles
  - Voltage transients
  - Increased short circuit levels
  - Changing load losses
  - Congestion in system branches
  - Power quality and reliability
  - Utility protection and DG protection
- Generation issues

Questions?

1 R. Brent Alderfer, Thomas Starrs, and M. Monika Eldridge, Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects, NREL/SR-200-28053 (Revised July 2000), available at www.nrel.gov/docs/fy00osti/28053.pdf.

2 See CPUC Decision 00-12-037 (December 21, 2000), available at http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION//4117.pdf.

3 IEEE Std 1547™ -2003, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems

4 See Standardization of Small Generator Interconnection Agreements and Procedures, Order No. 2006, FERC Stats. & Regs. ¶ 31,180 (Order 2006), order on reh'g., Order No. 2006-A, FERC Stats. & Regs. ¶ 31,196 (2005)(Order 2006-A), order on reh'g, Order No. 2006-B, FERC Stats. & Regs. ¶ 31,221 (2006)(Order 2006-B).

5 See Energy Policy Act of 2005 Public Law 109-58 (August 8, 2005), available at: http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf

6 DSIRE, Summary Maps, RPS Policies.