An Introduction to Interconnection Policy in the United States

National Association of Regulatory Utility Commissioners Energy Regulatory Partnership Program

between

The National Agency for Energy Regulation of Moldova

and

The Missouri Public Service Commission

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National Association of Regulatory Utility Commissioners

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Agenda

I. Introduction to Interconnection Policy

II. History of Interconnection Policy

III. PJM Interconnection Procedures

IV. Ohio's Interconnection Procedures

V. Recent Reform Efforts

What are Interconnection Rules?

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, and

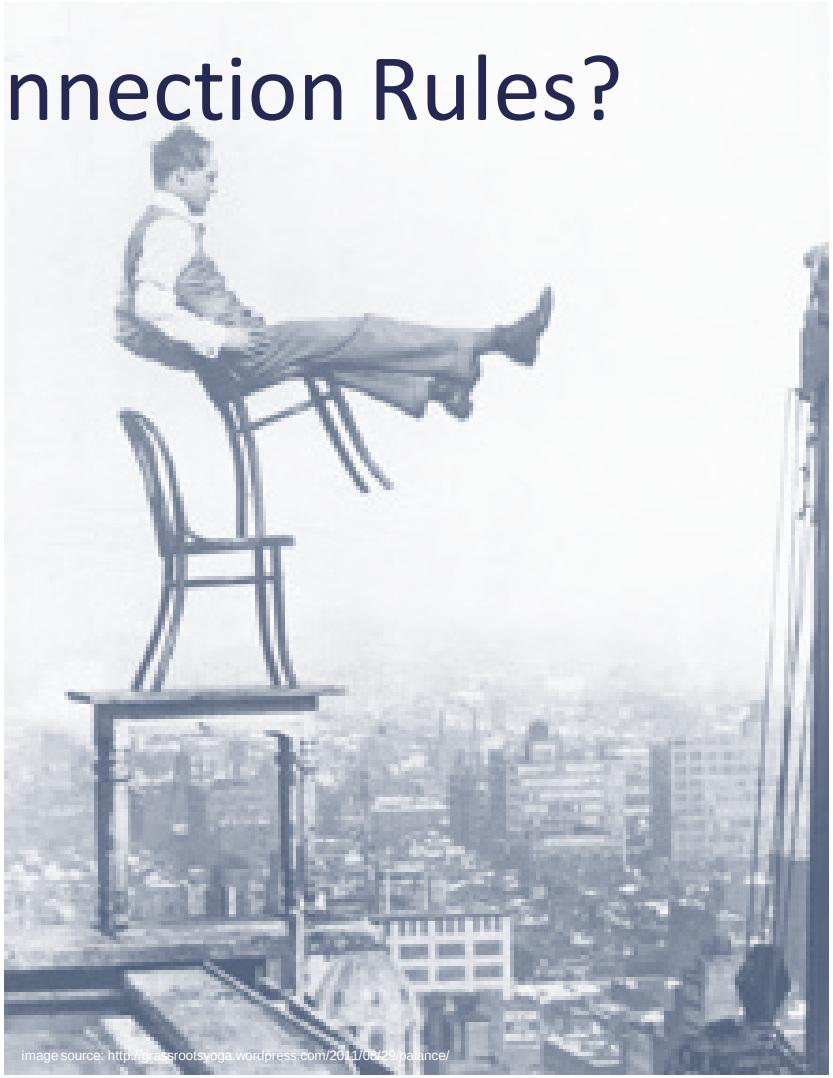
(2) standard contractual agreements stipulating operational and cost responsibilities between the electric utility and the generation resource owner.

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).

Image Source: http://www.treehugger.com/clean-technology/china-to-invest-365-billion-to-upgrade-electric-grid.html

Image source: :h ttp://www.solarenergywisdom.com/

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

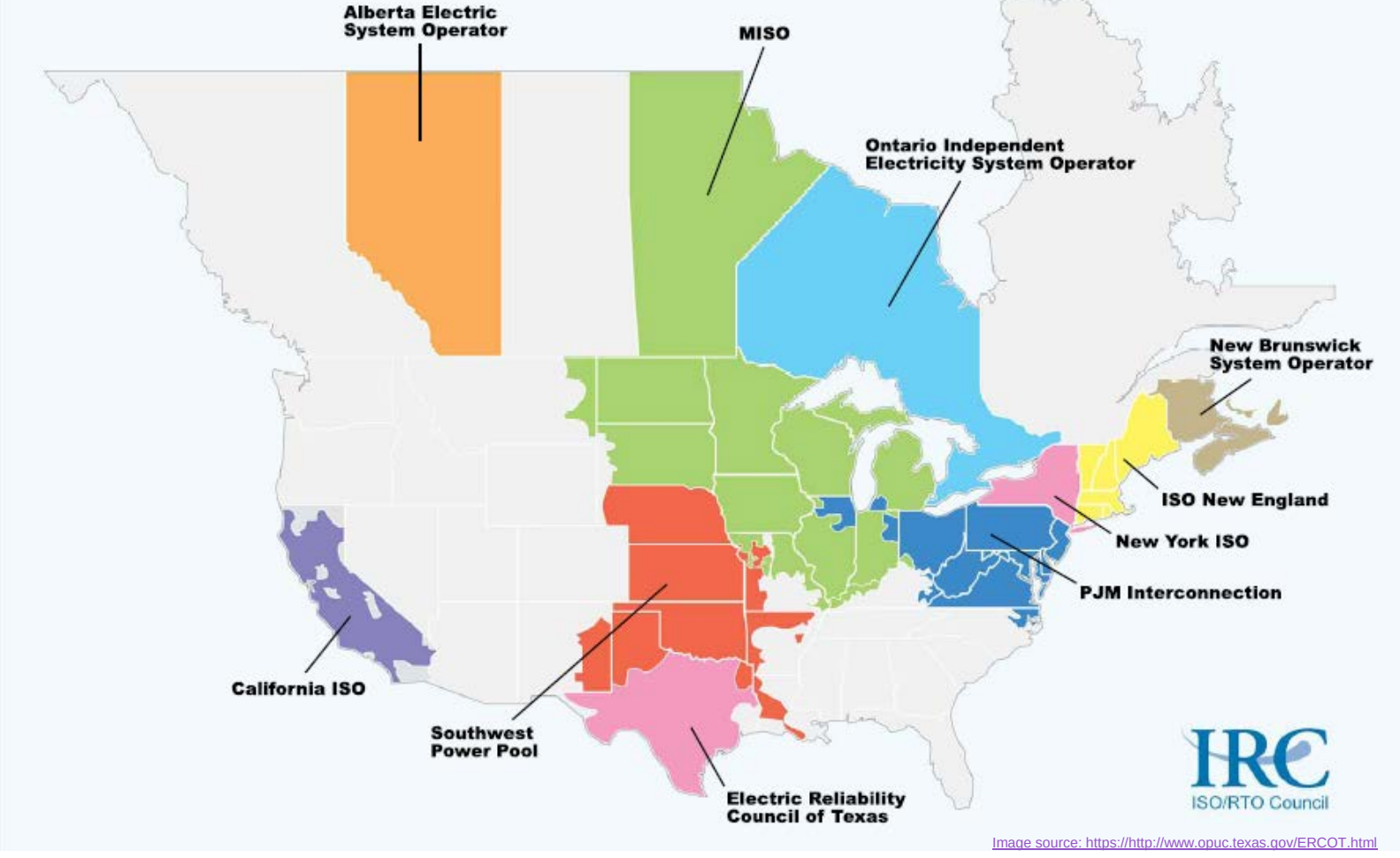


Image source: https://http://www.opuc.texas.gov/ERCOT.html

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

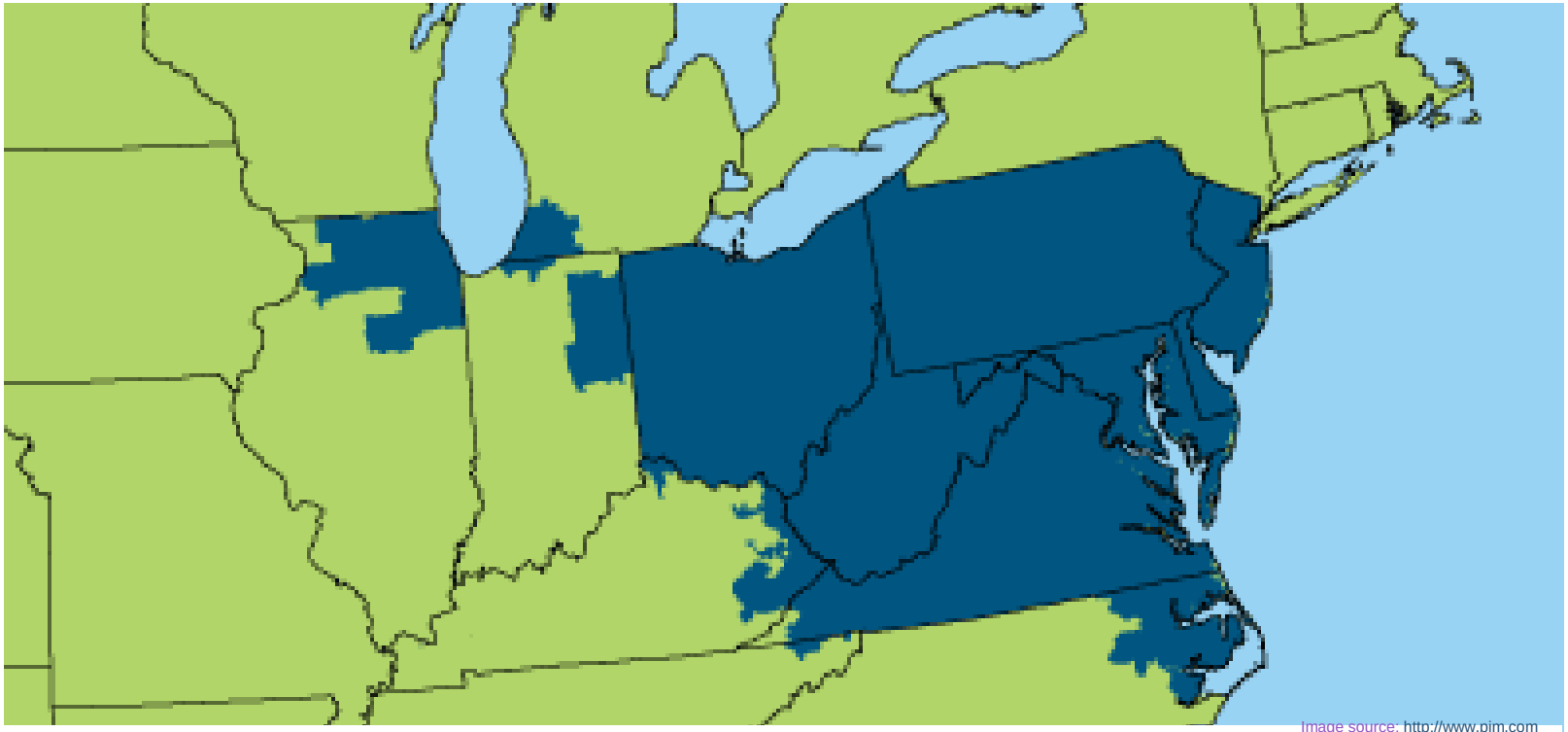
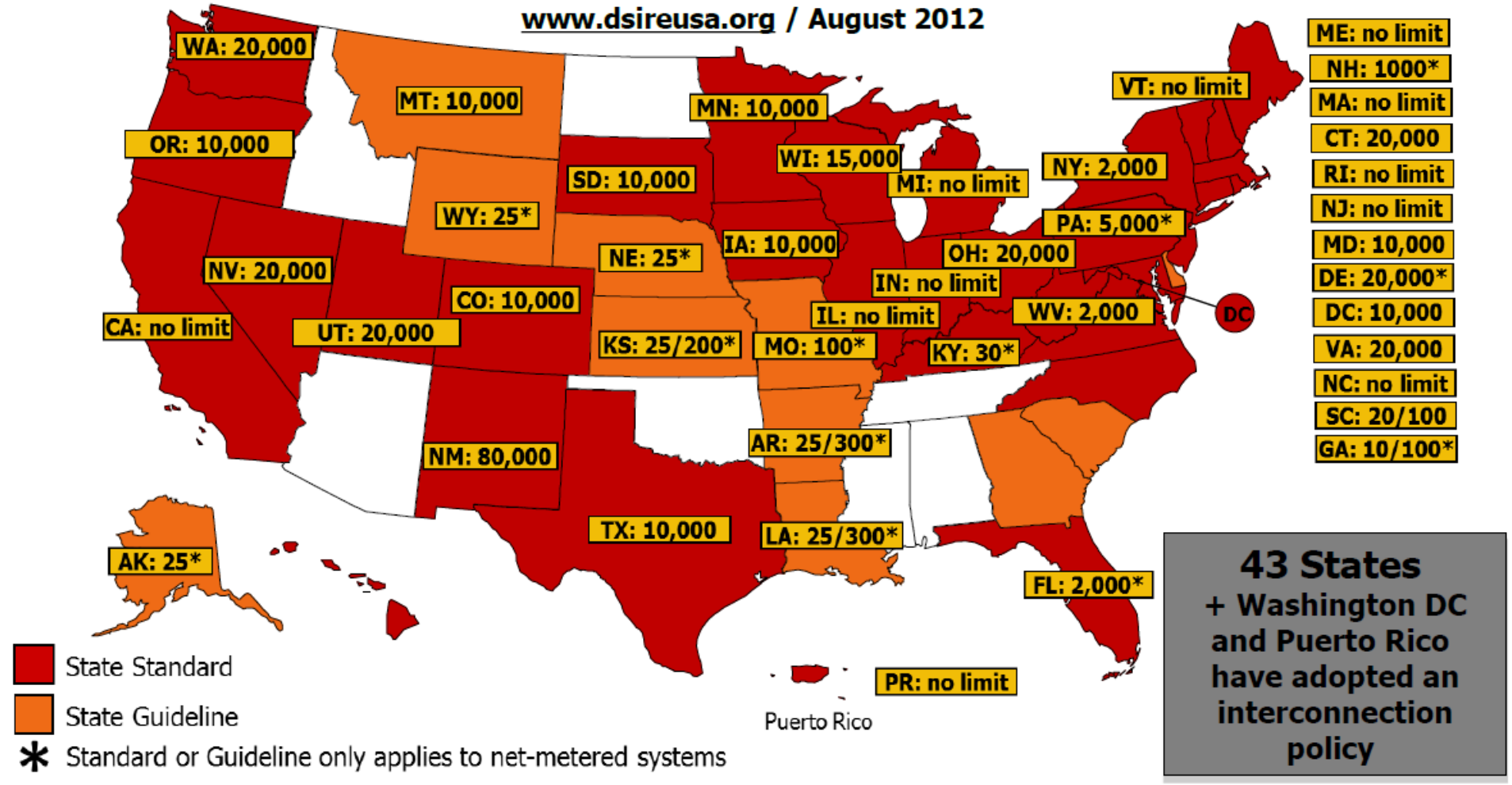


Image source: http://www.pjm.com

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

States with Distribution-Level Interconnection Policies



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

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.

image source: http://smbwebguru.com/2008/09/10/the-path-to-online-success-for-your-business/

December 2000: California Rule 21

Among the first comprehensive, state-wide interconnection policies in the United States.[2]

Developed two influential innovations:

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

July 2003: Federal Rules for Large Generators

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

The 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.

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.[3]

May 2005: Federal Rules for Small Generators

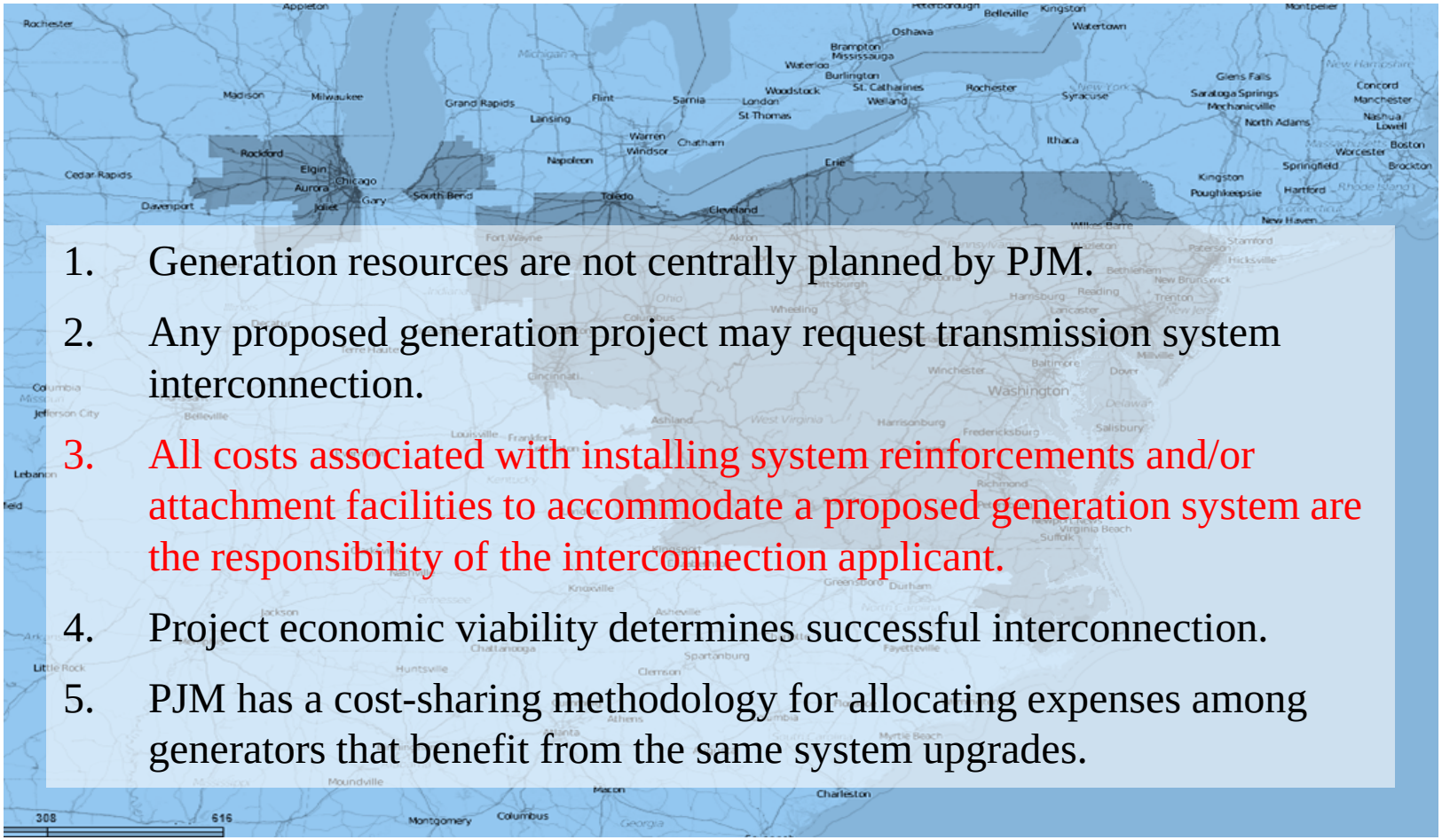
FERC *Small Generator Interconnection Procedures* (SGIP) and *Small Generator Interconnection Agreement* (SGIA).[4]

1. Applicable to transmission level interconnections.
2. Developed 3 review levels, scaling DG size with technical review scope
3. 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 Standard and current ‘best practices.’[5]

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.

Image source: https://edata.pjm.com/eContour/#

PJM's Interconnection Policy Foundations

PJM Interconnection Process

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

	# of Projects	MW
Active	544	74,254
In Service	391	31,357
Suspended	32	3,344
Under Construction	195	10,880
Withdrawn	1,005	220,056
Grand Total	**2,167**	**341,893**

*Through 1/31/2012

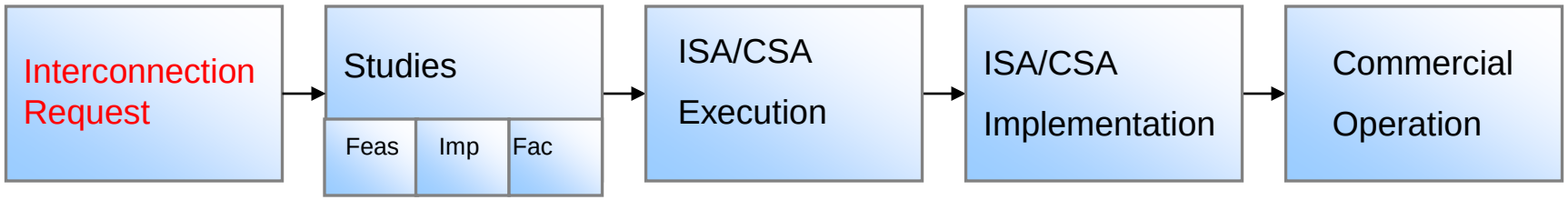
PJM Interconnection Process

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



Interconnection Request

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

The PJM Interconnection Queue is publically available Online.

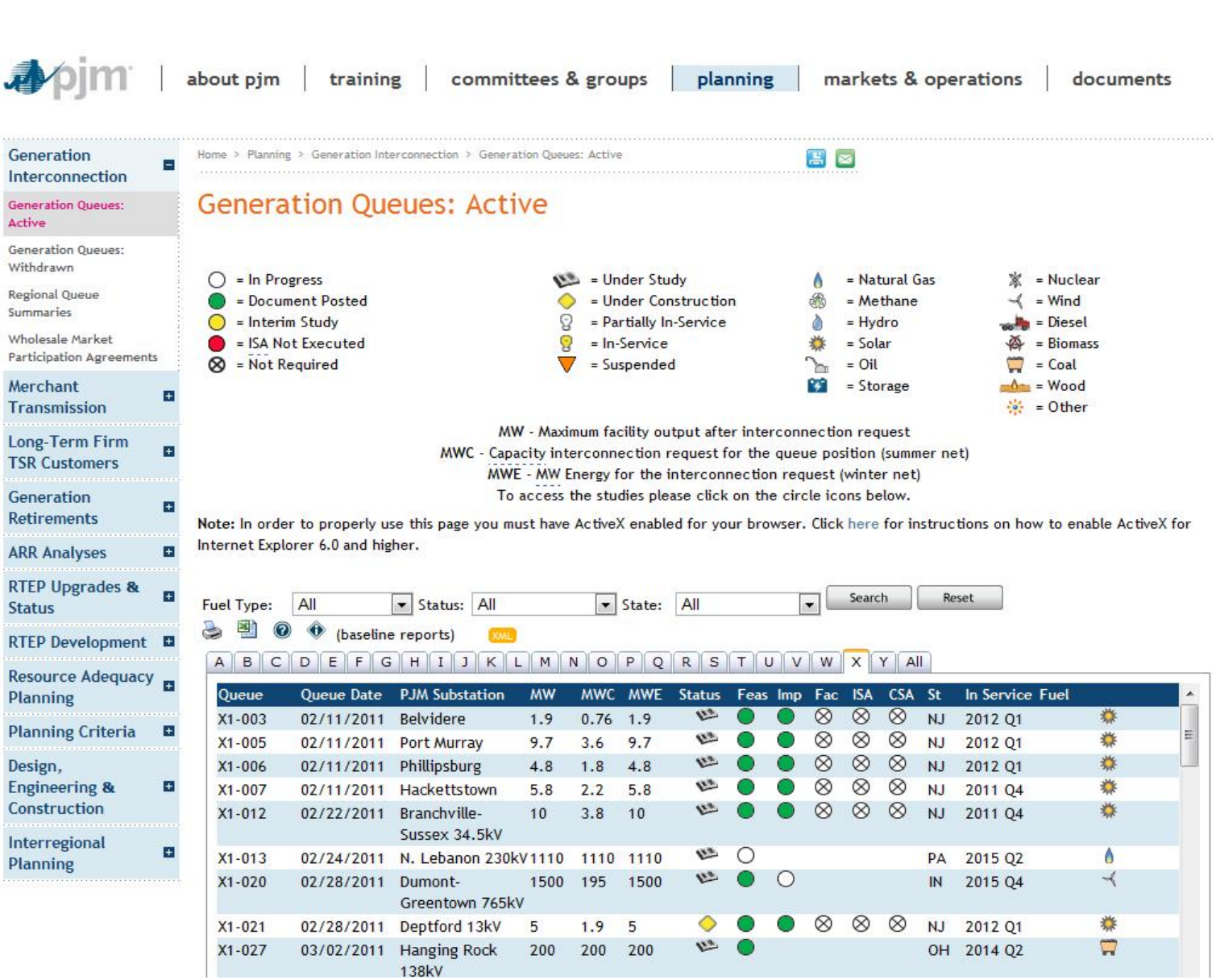


Image sourcehttp://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx

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:

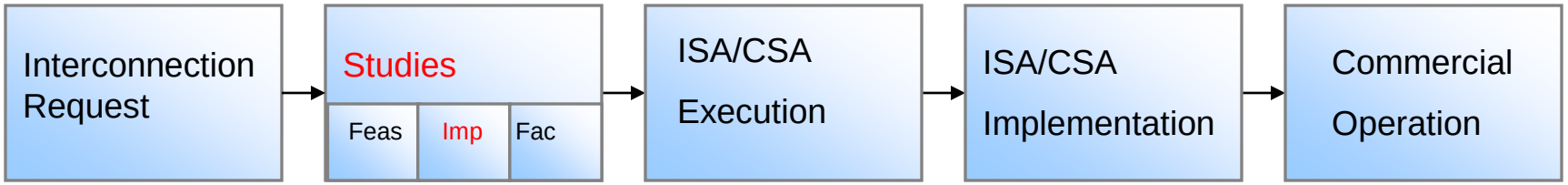
- One alternative point of interconnection
- Configurations to evaluate in the 3 interconnection studies

Applicants may select up two (2) Points of Interconnection (POIs)

The scoping meeting may be waived by mutual agreement of the parties.

Feasibility Study

- Required for study:
  - Deposit based on request receipt timing & MW size
  - Applicants must provide proof of Site control
  - Projects must be In-service within 7 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



System Impact Study

- Required for study:
  - $50k Deposit (> 20 MW)
  - Study cost estimate (2 - < =20 MW)
  - Initial Air Permit Application
- Study Completion within 6 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

Facilities Study

- Required for Study
  - Greater of $100k Deposit or 1st 3 months cost estimate of Facility Design
- Study Completed within 6 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.

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.

ISA/CSA Implementation

- 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

Commercial Operation

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 $5,000,000 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 $5,000,000 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 < $5,000,000

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 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 Distribution Factor (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 > than $5,000,000

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 Distribution Factor (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 > $5,000,000 for the 3 Methods

- Cost allocation for upgrades in excess of $5,000,000 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 3 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

1. One or more generating units with load at a single electrical location (i.e. combined heat and power facilities)

2. 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.

3. Requires interconnection request if capacity or energy resource status sought.

Ohio's Interconnection Rules are designed to:

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

Applicable to distribution-level interconnections

image source: http://wwp.greenwichmeantime.com/time-zone/usa/ohio/flag/index.htm

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

Ohio's interconnection rules adopt the principal features of the FERC SGIP*:

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

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

Application Processing and Queuing

Interconnection Requests are Interdependent

1. Applications are processed in the order they are received.

2. The utility assigns the application a queue position *in relation to other interconnection requests on the same or nearby distribution system sections*.

3. 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's procedure consists of five review levels, scaled to system type, size, and configuration.

Review Level	Eligibility	Application / Contract	Application Fees
1	inverter-based systems ≤ 10 kW to radial or spot networks	Short-form applications Simplified Interconnection Agreement	one tenth an hour of simplified review
1.1	inverter-based systems ≤ 10 kW to the load side of area networks		
1.2	inverter-based systems ≤ 50 kW to an area network		
2	all system types ≤ 2 MW	Standard application Standard Interconnection Agreement	$50, plus one dollar per kilowatt of system capacity
3	all system types ≤ 20 MW		$100, plus two dollars per kilowatt of system capacity

All level 1 and level 2 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:

1. Feasibility study
2. System impact study
3. Facilities study

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

Interconnection Issues

Numerous challenges threaten timely and cost-effective interconnections, resulting in bottlenecks.

- Requests to interconnect unviable projects
- Speculative applications filed at multiple queue locations
- Highly variable, location-dependent, system upgrade costs
- Projects changing size and parameters or Point of Interconnection, necessitating re-studies
- Quantity of new interconnection requests complicates deriving System Impact Study results

image source: http://spinnakr.com/blog/start-ups/2013/03/how-to-identify-your-products-bottleneck/

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

FERC Interconnection Reforms

January 17, 2013 Notice of Proposed Rulemaking (NOPR), to revise FERC's Small Generator Interconnection Procedures.

Proposes four significant modifications:

1. A pre-application report
2. Scaled fast-track eligibility size limit
3. Supplemental review screens
4. Third-party review of required upgrades

Pre-application Report

Intended to reduce the number of speculative, unviable projects by providing 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 containing pre-specified data points that may help characterize project viability at a certain point on the transmission system.

Possible items include:

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

Scaled Fast-Track Eligibility Size Limit

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:

Line Voltage	Fast Track Eligibility- regardless of location	Fast Track Eligibility- on a 600 amp line and < 2.5 feeder miles from substation
< 5kV	< 1MW	< 2 MW
5kV ≤ 15 kV	< 2MW	< 3 MW
15 kV ≤ 30 kV	< 3MW	< 4 MW
30 kV ≤ 69 kV	< 4MW	< 5 MW

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 percent 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.

image source: http://www.lesliehawes.com/wordpress/?p=731

[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.