Interconnection Process Overview

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Manager – Interconnection Projects

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Manager – Interconnection Analysis
Purpose of the Interconnection Process

- Facilitate interconnection of new generation by performing planning analyses and coordinating with the transmission owners to ensure system reliability and generation deliverability to all PJM load.

- Guide developers through the interconnection process on a timely basis while maintaining fair and equitable treatment between customers within the terms and conditions of the PJM Tariff.

- Provide the cost to physically connect the generator to the transmission system along with all necessary network upgrades.
Foundations of the Interconnection Process

- Adherence to federal policy
- Studies conducted consistent with annual RTEP studies
- Generation deliverable to all PJM load
- Cost assigned to the causer
- All projects treated equally regardless of size, location or fuel
• Process overview

• Interim deliverability and rights

• Recent trends

• Recent changes

• Other RTO processes
PJM Interconnection Process Overview
Process Diagram

Interconnection Projects

New Service Request

Study
Feasibility, Impact, Facility

Agreements
ISA | CSA | UCSCA | WMPA

Infrastructure Coordination

Implementation
ISA | CSA | UCSCA | WMPA

Commercial Operation
Operational Readiness

Market Participation

Client Mgmt. + Ops + Markets

Interconnection Analysis
PJM Department Roles

Interconnection Projects
- Single point of contact for study phases
  - Interconnection customers
  - Transmission owner
  - Interconnection Analysis engineers
- Process facilitation and mediation
- Draft & review reports
- Draft service agreements

Interconnection Analysis
- Model and study all projects
  - Load flow, short circuit and stability analysis
- Test system upgrades from transmission owners
- Calculate cost responsibility
- Coordinate with neighboring RTOs

Infrastructure Coordination
- Single point of contact for construction phase
  - Interconnection customers
  - Transmission owner
  - Interconnection Analysis engineers
- Oversight of billing
- Coordination of model in operations systems and final testing
Submitting a New Service Request

OATT Attachment N, Y, BB, S, EE, PP*
- N – Generation
- Y – Generation (≤2 MW synchronous, ≤5 MW inverter-based, and energy-only)
- BB – Generation (≤10 kW inverter-based & energy-only)
- S – Merchant transmission
- EE – Upgrade request
- PP – Long-term firm

Required Information
- Location
- Project size
- Ownership (site control for interconnection requests)
- Equipment configuration
- Planned in-service date
- Deposit
- Queue point data

* NOTE: Transmission service requests are received through OASIS and are then communicated to System Planning for inclusion in the New Services Queue with remainder of the New Service Requests.
**Feasibility Study**

### Required
- Deposit for interconnection requests based on request receipt timing and MW size
- Site control for generation requests
- In-service date within 7 years of entering queue
- Customer can select a primary and secondary Point of Interconnection (POI)

### Study Completion
- Target approximately 120 days after close of queue

### Study participants
- PJM & TO (Contractor under TO)

### Results
- Attachment facilities needed for interconnection
- **Powerflow Analysis** – Identify thermal overloads and required upgrades (costs and construction schedule estimates for primary POI)
- **Powerflow Analysis** – Identify thermal overloads with secondary POI (no cost/schedule estimates)
- **Short-Circuit Analysis**

### Customers
- Customers receive a Feasibility Study Report and have 30 days to sign a System Impact Study Agreement (SISA)
- **Required**
  - Deposit based on MW size
  - Initial Air Permit Application (N/A for solar/wind projects)
  - Ownership (Transmission Interconnection Requests)
- Customer must select a single POI (if two were evaluated in the Feasibility Study)
- **Study Completion**: Target 120 days after start of queue study or execution of System Impact Study Agreement
- **Study participants**: PJM & TO (contractor under TO) and affected systems (FSA)

- **Results**
  - Summer-peak powerflow analysis
  - Light-load powerflow analysis (if applicable)
  - Short-circuit analysis
  - Other Powerflow analyses as applicable
  - Cost estimates and allocations
- Customers receive a System Impact Study Report and have 30 days to sign a Facility Study Agreement (FSA)
- Conduct governed by procedures as set forth in Attachment D of Manual M-14A
- **Required**
  - Deposit based on MW size
- **Completion**
  - Dependent on individual transmission owner zone and queue volume
- **Study By**
  - TO (or contractor under direction of TO)
  - Affected system study
- Potential for System Impact Study re-tool analysis
- Stability analysis
- Additional studies as required by type of technology being connected
- Facility Study Report: conceptual design
- Attachment facilities
- Network upgrades
  - Cost estimates
  - Preliminary engineering and construction schedule
## Interconnection Process Timing

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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</table>

- **Queue Window**
- **Feasibility Study**
- **System Impact Study**
- **Facilities Study**

**PJM model build and analysis**

**Customer reviews reports and returns next study agreement**

**Customer reviews final reports and executes Interconnection Service Agreement**

- **Queue Window**
- **Feasibility Study**
- **System Impact Study**
- **Facilities Study**

**Ideal timeline – 26 months**
Small Generation Timeline (≤20 MW)

- Feasibility and System Impact Studies combined during the Feasibility Study window.

- Permitted when:
  - Project is 20 MW or less
  - Does not cause any transmission system violations
  - Does not request a Secondary Point of Interconnection
Small Generation Timeline (≤20 MW)

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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</thead>
<tbody>
<tr>
<td>Large generation process</td>
<td>Feasibility Study</td>
<td>System Impact Study</td>
</tr>
<tr>
<td>Queue Window</td>
<td>Feas &amp; Imp Study</td>
<td>Facilities Studies</td>
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<tr>
<td>Small generation expedited process</td>
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ISA or WMPA issued to customer
Can be requested at any time prior to the issuance of an Interconnection Service Agreement

Allows engineering and procurement to start while the project is under study

Scope must be mutually agreed to by customer and transmission owner

Does not allow a project to interconnect or grant any rights
**Material Modification:** A change that has a material adverse impact/effect to any later subsequently queued project in relation to scope, cost or time.

- Changes that result in a Material Modification will not be accepted by PJM for current queue position held.
- A project may never increase the Maximum Facility Output (MFO) or Capacity Interconnection Rights (CIR) without an additional new service request.
- A change in fuel type would require a Material Modification review.
- Significant changes to POI are considered material. Project must be withdrawn, and a new interconnection request submitted for the modification. (Tariff Section 36.2A.3)
A Technological Advancement submitted to PJM no later than the return of an executed Facilities Study Agreement (or return of an executed ISA if a Facilities Study is not required) is classified as a Permissible Technological Advancement if the proposed change does not:

- Increase the capability of the generating facility
- Represent a different fuel type
- Cause any material adverse impact(s) on the transmission system

If a proposed technological advancement is deemed a Permissible Technological Advancement, then the proposed change will not be considered a Material Modification, and no additional PJM study will be required. All other proposed technological changes will require a study to determine if the change would constitute a Material Modification.
Interconnection customer may reduce its project by up to 60 percent of the electrical output. Timing of the announcement depends on which month of the queue they entered:

i. For projects that enter the queue in months 1–5, customer must identify the change prior to the close of business on the last day of the sixth month.

ii. For projects that enter the queue in month 6, the customer must identify the change no later than close of business on the day following the completion of the scoping meeting.
Interconnection customer may reduce its project by up to **15 percent** of the electrical output. For a request to reduce by more than 15 percent, customer must request PJM to determine whether such a change would be a Material Modification. PJM will allow the customer to reduce the size of its project:

i. To any size if PJM determines the change is not a Material Modification, or

ii. By up to **60 percent** of the electrical output if PJM determines it is material; however, in this case the project would be removed from its current position and be assigned a new queue position at the beginning of the subsequent queue, and your future studies will be performed consistent with the timing of studies for projects submitted in the subsequent queue.
Modifications After the System Impact Study Agreement but Prior to Executing an Interconnection Service Agreement (Tariff Section 36.2A. 2)

Interconnection customer may reduce its project by the greater of 10 MW or 5 percent of the electrical output. For a request to reduce by more than this, customer must request PJM to determine whether such a change would be a Material Modification. PJM will allow the customer to reduce the size of its project:

i. To any size if PJM determines the change is not a Material Modification, or

ii. By up to the greater of 50 MW or 20 percent of the electrical output if PJM determines it is material; however, in this case the project would be removed from its current position and be assigned a new queue position at the beginning of the subsequent queue, and a new System Impact Study will be performed consistent with the timing of studies for projects submitted in the subsequent queue.
<table>
<thead>
<tr>
<th>Agreement Type</th>
<th>New Service Customer</th>
<th>FERC Jurisdictional ?</th>
</tr>
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<tbody>
<tr>
<td>Interconnection Service Agreements (ISA)</td>
<td>Generation/Transmission Interconnection Customer</td>
<td>Yes</td>
</tr>
<tr>
<td>Wholesale Market Participation Agreements (WMPA)</td>
<td>Generation Interconnection Customer</td>
<td>No</td>
</tr>
<tr>
<td>Interconnection Construction Service Agreement (CSA)</td>
<td>Generation/Transmission Interconnection Customer</td>
<td>Yes</td>
</tr>
<tr>
<td>Upgrade Construction Service Agreement (UCSA)</td>
<td>Transmission Interconnection Customer (Merchant Network Upgrades)</td>
<td>Yes</td>
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</tbody>
</table>
ISA and CSA Overview

**Interconnection Service Agreement**
- Grants rights to interconnect and generate
- Defines project milestones
- Describes the project’s point of interconnection
- Describes system upgrades and costs
- Outlines metering requirements
- Security requirement
- Persists after construction

**Construction Service Agreement**
- Outlines construction responsibility
- Contains upgrade construction schedule
- Contains notification and insurance obligations
- Terminates after construction
Wholesale Market Participant Agreement

- Connects to distribution line
- No prior wholesale sales
- Requires customer to pursue a two-party Interconnection Agreement with TO
- Grants rights to participate in PJM’s market
- Persists after construction
### Agreement Implementation

**Interconnection Projects**
- New Service Request
- Study
  - Feasibility
  - Impact
  - Facility
- Agreements
  - ISA
  - CSA
  - UCSA
  - WMPA

**Infrastructure Coordination**
- Implementation
  - ISA
  - CSA
  - UCSA
  - WMPA
- Commercial Operation
  - Operational Readiness
- Market Participation
  - Client Mgmt. + Ops + Markets

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**PJM’s Responsibilities:**

- Periodic construction status meetings
- Outage coordination
- Billing and cost tracking for each network upgrade number
- Metering and telemetry from IC to PJM
- Test energy injection
- Project close out
Interim Deliverability and Rights
Interim Deliverability Study is targeted toward:

- Projects coming into service prior to the study year
- Projects that are dependent on a network or baseline upgrade that expect the dependent reinforcement to be not completed at the time of the project coming online*

*Only facilities identified at constraints in the System Impact Study will be monitored
Incremental Auction Study Timeline

- **Base Residual Auction**: May
- **First Incremental Auction**: Sept.
- **Second Incremental Auction**: July
- **Third Incremental Auction**: Feb.
- **EFORd Fixed**: June
- **Delivery Year**: May

- **Ongoing Bilateral Market**

Timeline:
- **3 years**
- **20 months**
- **10 months**
- **3 months**
Example Schedule for 2020

**1st IA 2022**
- **Study Begin:** June 2020
- **Study End:** August 2020
- **Auction Date:** October 1st Week

**2nd IA 2021**
- **Study Begin:** February 2020
- **Study End:** June 2020
- **Auction Date:** August 1st Week

**3rd IA 2021**
- **Study Begin:** September 2020
- **Study End:** January 2021
- **Auction Date:** March 1st Week

*BRA studies are performed as needed*
Recent Trends
New Generation Requests

As of Oct. 20, 2020

New Requests Submitted to PJM

Proposed Generating Capability, MW

As of Oct. 20, 2020
Study Volume and On-Time Rates

As of Oct. 20, 2020

Feasibility Studies

- 2015: 86%
- 2016: 85%
- 2017: 70%
- 2018: 34%
- 2019: 30%
- 2020: 100%

System Impact Studies

- 2015: 75%
- 2016: 39%
- 2017: 31%
- 2018: 22%
- 2019: 57%
- 2020: 95%

Facilities Studies

- 2015: 8%
- 2016: 6%
- 2017: 9%
- 2018: 5%
- 2019: 0%
- 2020: 1%
Projects by Proposed Capability

**Natural Gas**
- 11,626 MW

**Solar**
- 73,820 MW

**Storage**
- 15,078 MW

**Wind**
- 28,369 MW

**Other Fuel**
- 1,000 MW

**Multiple Fuels**
- 17,882 MW

**1,600 projects under study**

**147,775 MW proposed generation capability**

As of Oct. 20, 2020
Recent Changes
### Recent Changes

<table>
<thead>
<tr>
<th>Education / Transparency</th>
<th>Process</th>
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</thead>
<tbody>
<tr>
<td>• Order 845 metrics</td>
<td>• Streamlined small generation analysis</td>
</tr>
<tr>
<td>• Pre-queue / Post-ISA training</td>
<td>• Improved Attachment Y treatment</td>
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<td>• Improved manual language for site control</td>
<td>• Improved PJM tools for analysis and reporting</td>
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<tr>
<td></td>
<td>• 6-month schedule for TOs</td>
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<td>• Delayed start of stability analysis</td>
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<tr>
<td>• Order 845 permissible technological advancement</td>
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<tr>
<td>• Deficiency cure changes</td>
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</tbody>
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<thead>
<tr>
<th>PJM Personnel</th>
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<tbody>
<tr>
<td>• Increased contractor support</td>
</tr>
<tr>
<td>• Realigned interconnection departments</td>
</tr>
<tr>
<td>Change</td>
</tr>
<tr>
<td>------------------------------------------------</td>
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<tr>
<td>Order 845 performance metrics (<a href="#">link</a>)</td>
</tr>
<tr>
<td>Pre-queue training (<a href="#">link</a>)</td>
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<td>Improved manual language for site control</td>
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<tr>
<td>Change</td>
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<tr>
<td>------------------------</td>
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<tr>
<td>Contractor support</td>
</tr>
<tr>
<td>Department realignment</td>
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</tbody>
</table>
Continued Challenges

• Large volume of projects leading to large volume of violations and upgrades
  – Total queued generation just below installed capability
  – Pockets of high density of proposed generation requests
  – Lower-voltage system infrastructure not designed to deliver high quantities of energy

• Timeline to complete Facilities Studies
  – Large scope from network upgrades

• Duration to complete study process versus timeline to construct facilities

• Timelines with Affected System Studies
RTO Comparison
Distinctive Features of PJM

- Analysis of the transmission system and upgrades to ensure deliverability to all RTO load
- Planning criteria focuses on reliability not economics
- Planning criteria more conservative than NERC standards
- Cost for upgrades not reimbursed by load
- No obligation for ongoing transmission service
<table>
<thead>
<tr>
<th>RTO statistics</th>
<th>PJM</th>
<th>CAISO</th>
<th>ERCOT</th>
<th>ISO-NE</th>
<th>MISO</th>
<th>NYISO</th>
<th>SPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak load, MW</td>
<td>165,492</td>
<td>50,116</td>
<td>74,850</td>
<td>25,000</td>
<td>127,125</td>
<td>33,956</td>
<td>50,662</td>
</tr>
<tr>
<td>Installed capability, MW</td>
<td>180,086</td>
<td>51,765</td>
<td>78,000</td>
<td>31,000</td>
<td>175,000</td>
<td>40,191</td>
<td>90,466</td>
</tr>
<tr>
<td>NERC Planning Authority</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>NERC Transmission Planner</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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| Interconnection queue   |           |           |           |           |           |           |          |
| Active projects         | 1,600     | 231       | 633       | 149       | 693       | 346       | 790      |
| Proposed generation, MW | 147,775   | 67,335    | 126,464   | 38,390    | 105,453   | 47,737    | 135,535  |
## RTO Benchmarks

As of Oct. 20, 2020

### Ratios

<table>
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<tr>
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<tbody>
<tr>
<td>Queued generation / peak load</td>
<td>89%</td>
<td>134%</td>
<td>169%</td>
<td>154%</td>
<td>83%</td>
<td>141%</td>
<td>268%</td>
</tr>
<tr>
<td>Queued generation / installed</td>
<td>82%</td>
<td>130%</td>
<td>162%</td>
<td>124%</td>
<td>60%</td>
<td>119%</td>
<td>150%</td>
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### Order 845 Metrics (aggregated) January–June 2020

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<tbody>
<tr>
<td>Total studies issued (A)</td>
<td>650</td>
<td>101</td>
<td>17</td>
<td>526</td>
<td>34</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total studies issued late (B)</td>
<td>62</td>
<td>101</td>
<td>11</td>
<td>256</td>
<td>32</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Backlogged studies (C)</td>
<td>198</td>
<td>0</td>
<td>0</td>
<td>429</td>
<td>14</td>
<td>0</td>
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**Aggregate performance rate**

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<tbody>
<tr>
<td>(B+C)/(A+C)</td>
<td>30.7%</td>
<td>0%</td>
<td>64.7%</td>
<td>71.7%</td>
<td>95.8%</td>
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</tbody>
</table>

**Performance rate** measures late studies and backlogged studies. Any study phase with a rate greater than 25 percent for two consecutive reporting periods require a detailed filing to FERC explaining causes and corrective actions.
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