Large Load Additions Workshop

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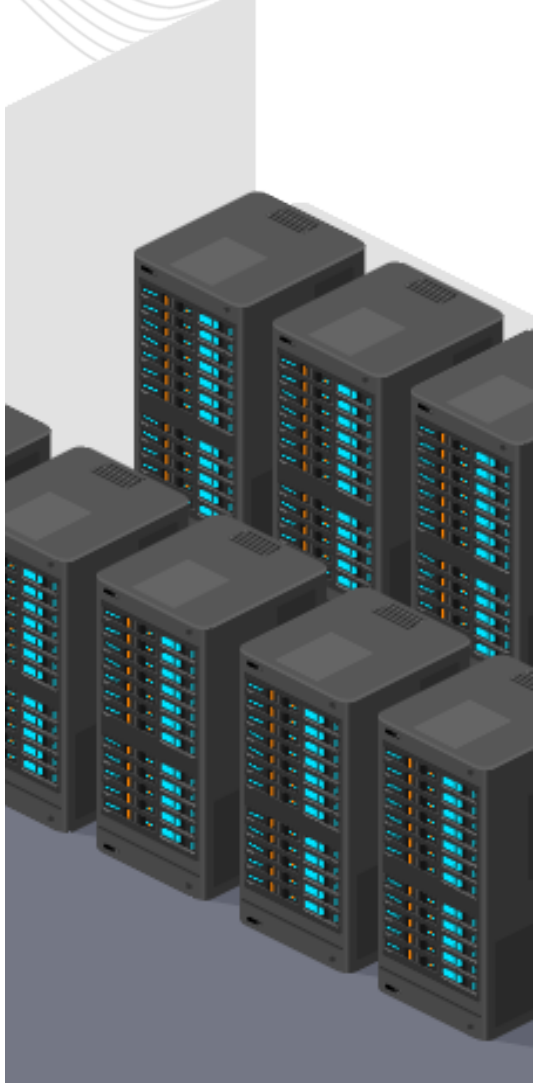
Agenda

- Introduction: Large load benefits and challenges
- PJM response in FERC 206 Proceeding on co-located load (Docket No. EL25-49)
- Existing opportunities for large load additions and opportunities to enhance flexibility
- Potential transitional Non-capacity backed load concept
- Potential next steps for continued stakeholder discussions

Large Load Benefits and Challenges

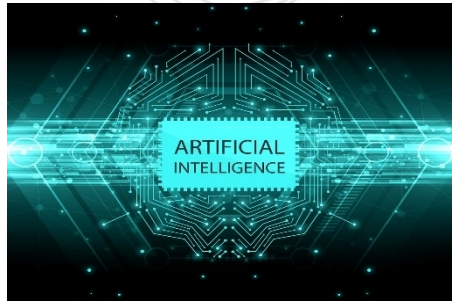
Why are we here?

- The unprecedented growth in electric demand over the next decade associated with large loads provides PJM with a unique opportunity to support economic development and be part of the solution.
- The PJM region is an attractive area for large loads to integrate because of its location, size, market opportunities, and reliable system.
- PJM recognizes the national importance and need to integrate these large loads efficiently and reliably.



The Benefits

1. Economic Growth
    - Creation of jobs
    - Attract investments
2. Technological Leadership
    - Maintain US competitive edge in technology and innovation
3. Infrastructure Development
    - Upgrades to grid infrastructure
4. Protect National Security



Large Load Market Participation Trends: Data Centers

Traditional (enterprise) data centers have a long history of participating in PJM's markets as capacity-only resources and represent ~3% of DR capacity megawatts today.

Very large (hyperscale) data centers – the largest facilities have no history of participating in the wholesale market.

Hyperscalers have so far been **hesitant in exploring market participation pathways**, indicating to PJM that the risk of interruptions, especially for customer-facing processes, far exceeds any economic value of participation under current incentives/markets.

- We will re-visit this later in the presentation.

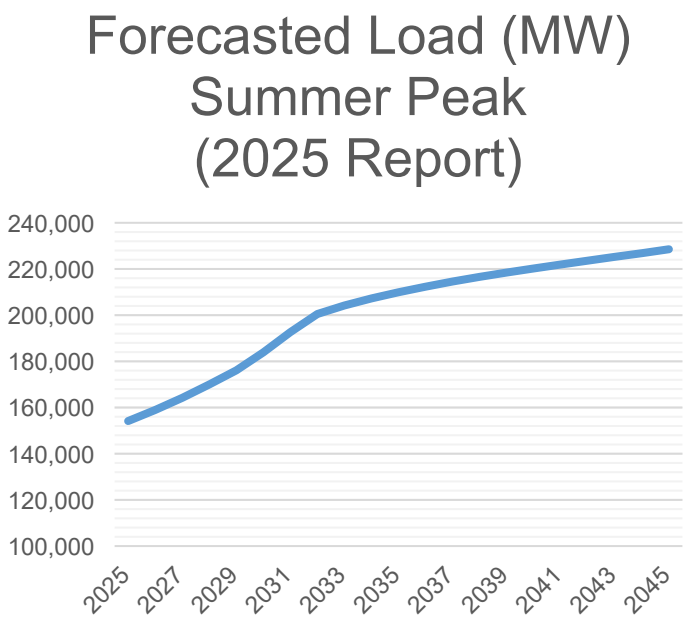
The Challenges with Reliably Connecting Large Loads

1. Forecasted supply may not be sufficient to meet the forecasted load.

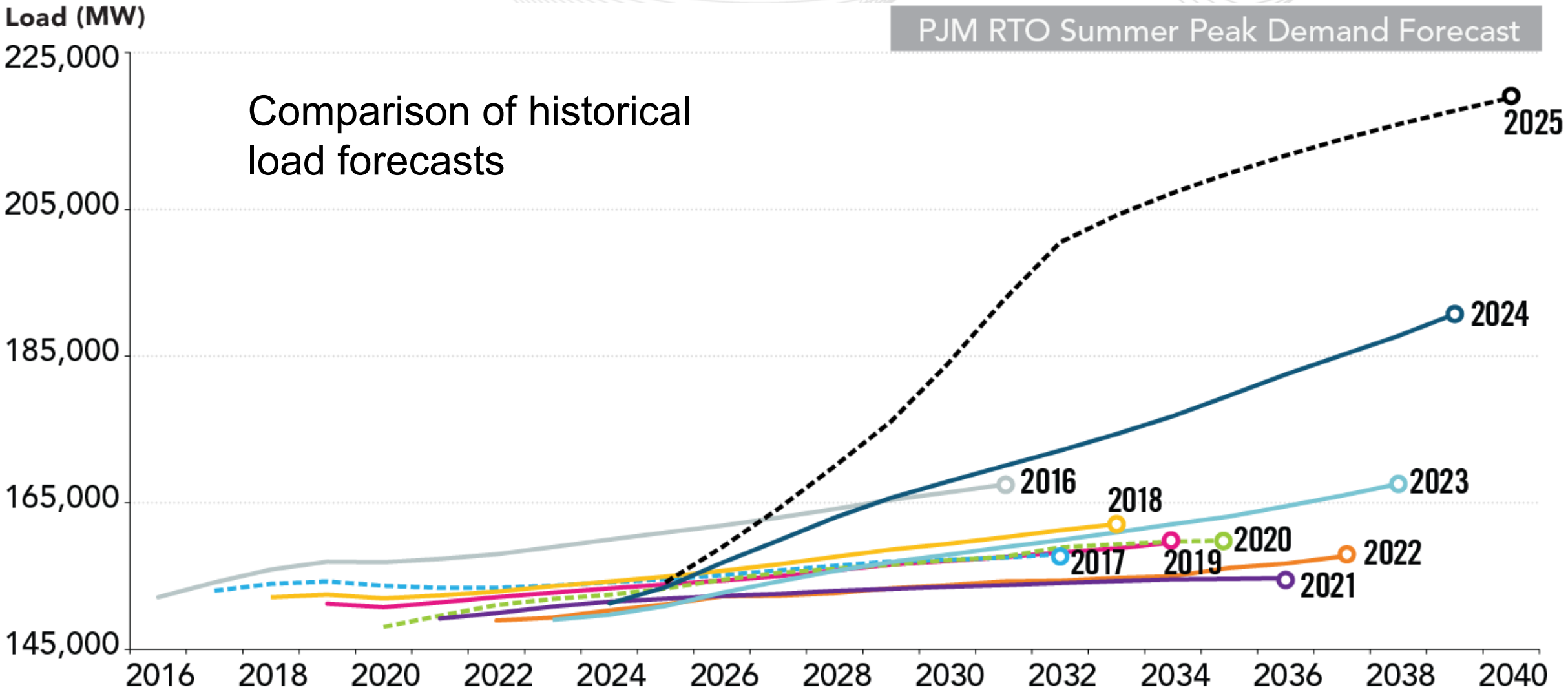
2. The pace of forecasted load growth combined with anticipated resource retirements presents timing challenges for needed investment.
    - Transition mechanisms may be needed to support resource adequacy

3. Existing demand side products do not provide adequate incentives for large load participation.
    - Acquiring flexibility is challenging because large loads prefer to stay online.
    - Back-up diesel units cannot operate for long periods because of environmental restrictions.

4. Data centers' desired time to market creates the need for alternative mechanisms to connect to the grid
    - May seek co-located arrangements outside the market that are less reliable.



Electricity Demand Growth



PJM response in FERC 206 Proceeding on co-located load (Docket No. EL25-49)

Co-located Load: PJM response (Docket No. EL25-29)

PJM's approach to large load expansion, co-located or not, focuses on:

1. Maintaining resource adequacy.
2. Enabling reliable system operations.
3. Facilitating the states' and stakeholders' efforts to timely and effectively integrate large loads in a manner that meets their unique needs.
4. Providing information and analysis that supports the equitable alignment of transmission system usage and cost allocation.

Network Load

PJM prefers Network Load status for Large Loads

- Less operating complexity and reduced dependence on protective schemes.
- More reliable service for these critical loads.
- Enhanced ability to manage load curtailment priority in emergency conditions.
- Greater access to potential Demand Response capabilities of large loads, including ability for switching to backup generation (e.g., diesel units) on site.
- More comprehensive and holistic system planning
- Less negative implications for resource adequacy if it is accompanied by some of the opportunities presented later in this slide deck.
  - Demand Response
  - Bring your own incremental generation
  - Non-capacity backed load

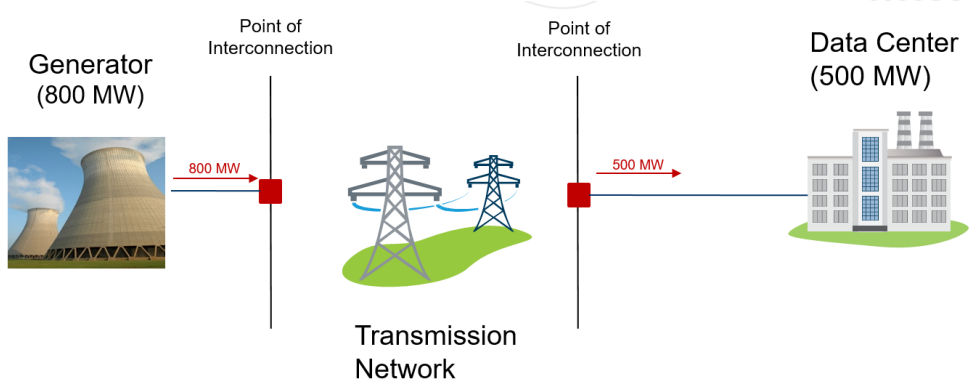
Co-located Load: PJM response

PJM provided eight potential options for additional large load co-location (as well as large load integration in general)

- Three of the options already exist under PJM's Tariff.
- Five are potential options that have been proposed by others or developed by PJM.
- Not all identified "options" are equivalent, desirable, or even necessarily workable. State laws may specifically limit when and how load in a jurisdiction can be served by a supplier other than a franchised public utility.
- Options are not mutually exclusive.

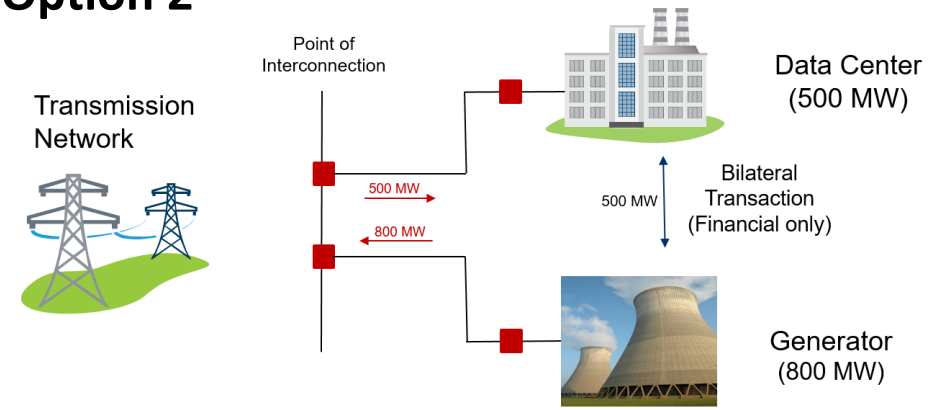
Load Arrangements - Existing

Load with a separate Point of Interconnection (POI) that is Network Load - Existing Option 1



This option is where the load is network load and generation is a capacity resource and they are not electrically co-located. The load and generation may be physically located at the same location but they are electrically connected to the grid separately. Load fully served by grid and therefore pays transmission services and energy and ancillary service charges while being incorporated into and accounted for in future planning processes.

Co-located load that is at the same Point of Interconnection (POI) but separately metered that is Network Load – Existing Option 2

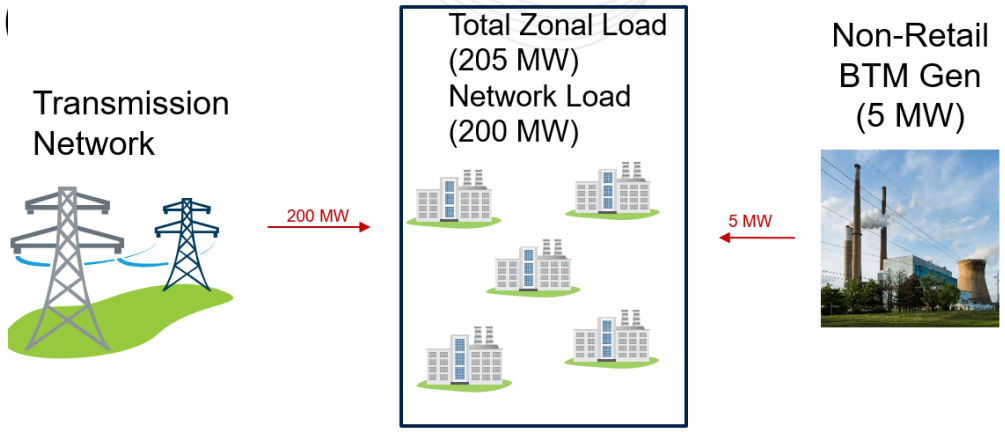


This option is where the load is network load and generation is a capacity resource and they are metered separately. Load fully served by grid and therefore pays transmission services and energy and ancillary service charges while being incorporated into and accounted for in future planning processes.

Electrical proximity between load and generation may provide efficiencies

Co-located Load Arrangements - Existing

Existing Non-Retail Behind The Meter Generation (NRBTMG) where the load is the customer – Existing Option 3a

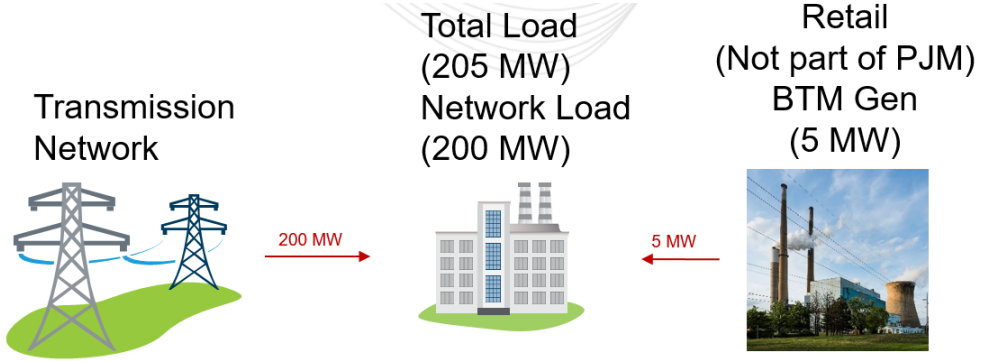


This option reflects PJM's existing NRBTMG rules where the load (muni/coop/EDC wholesale area) is the primary customer and nets with NRBTMG.

Reliability consideration: Adding load to PJM without reserves will degrade reliability to worse than 1 in 10 (increase loss of load expectation ("LOLE") to greater than 0.1 days/year). PJM accommodates some level of this configuration through a settlement agreement in 2006 that allows the PJM LOLE to be relaxed from 1 in 10 years to 1 in 9.5 years. Results in total cap around 2000 MWs

Large load behind generation was not intended.

Existing Retail Behind The Meter Generation (BTMG) where the load is the customer – Existing Option 3b (Retail BTMG)



This option reflects PJM's existing BTMG rules where the load is primary customer and nets with BTMG.

These configurations may exist without PJM awareness due to the generation being retail and not part of PJM

Reliability consideration: Same as Option 3A but there is currently no cap because the generation is not part of PJM

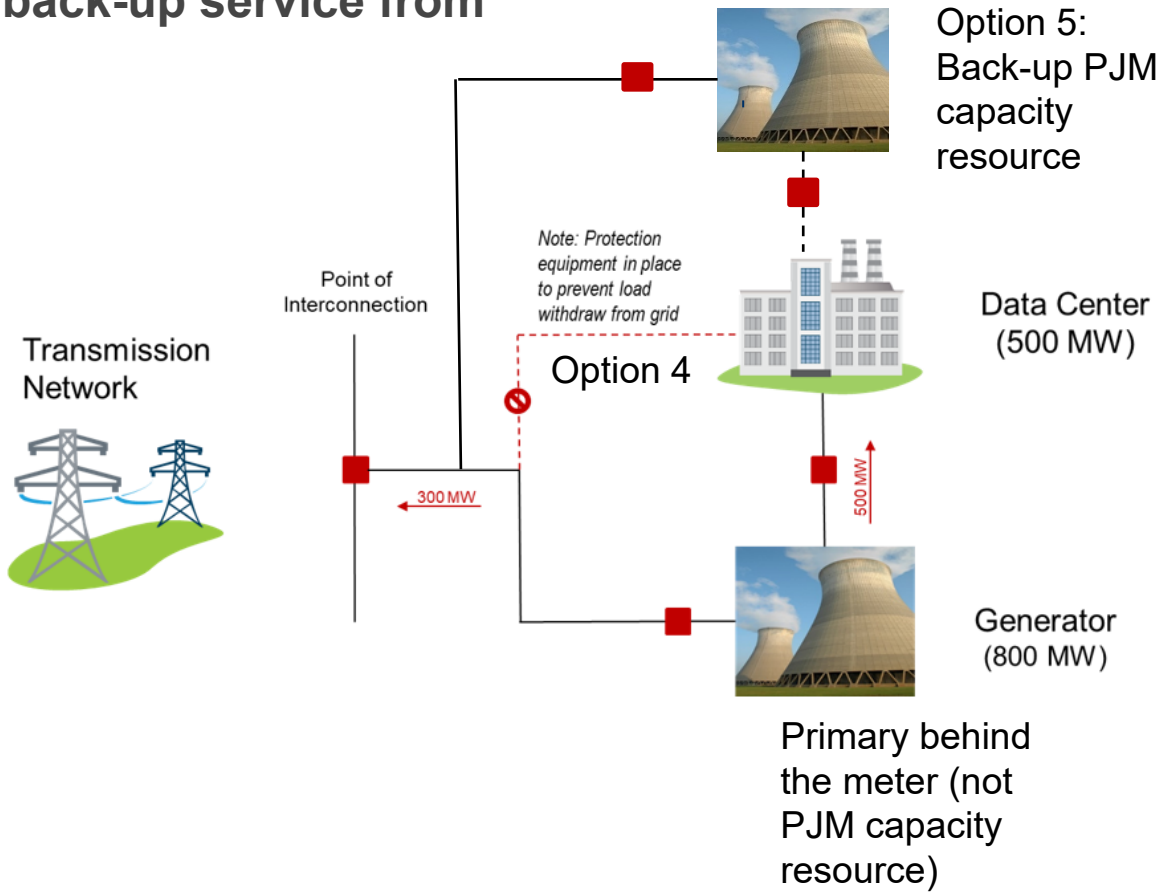
Large load behind generation was not intended.

Co-located Load Arrangements – New Options 4 and 5 (Not preferred by PJM)

Co-located load with connection to grid with protections to avoid delivery of system energy to serve the load (New Option 4) or receive back-up service from PJM with permission (New Option 5)

These options are when the load is located behind the generation and there are protection mechanisms in place to prevent delivery of energy from the grid to serve the load in the event the generation is offline.

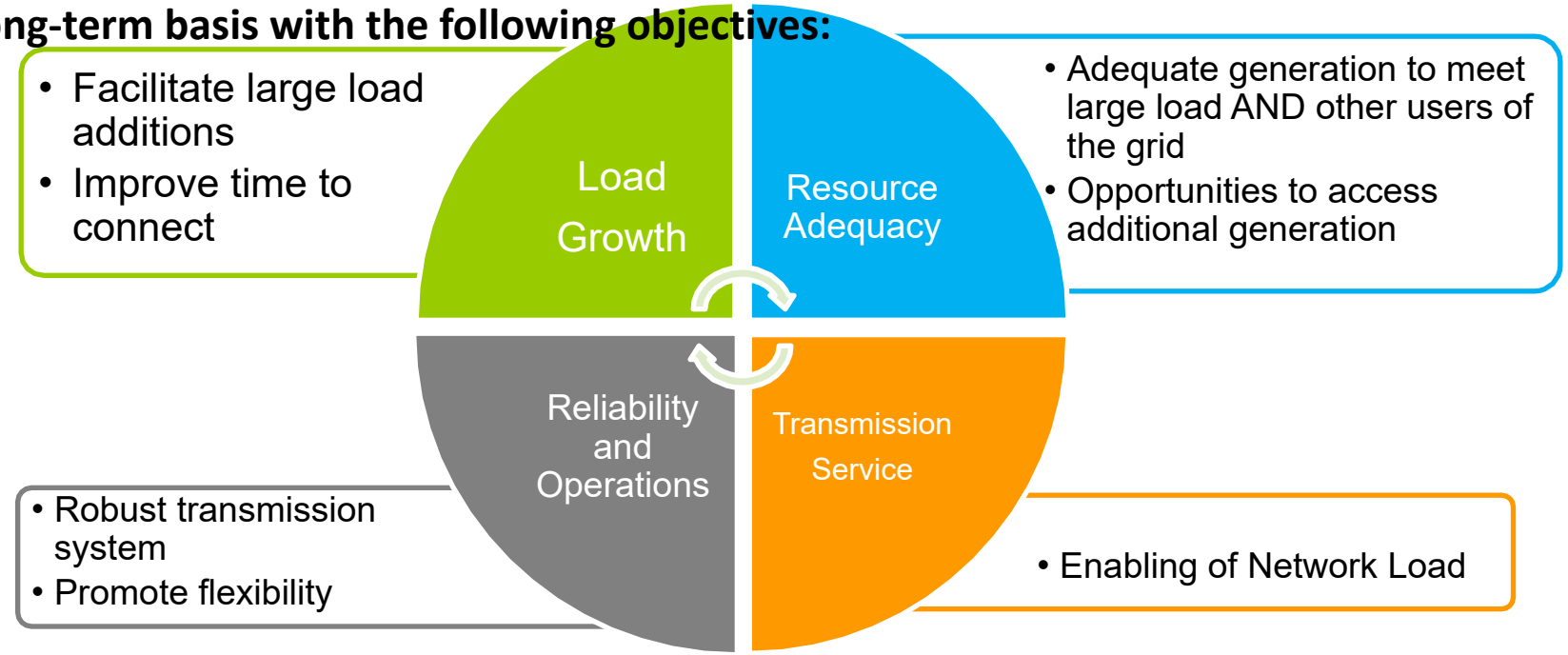
- Option 5 also allows for back-up service from a PJM capacity resource with permission.
- Neither the generator (primary) nor the co-located load is assessed charges for transmission services or energy and ancillary services.
- The load is not included in future planning forecasts, and is not accounted for holistically in forward-looking planning processes.
- Operational challenges with power swings and transient impacts to voltage and frequency from complex relay schemes.



Additional Co-located Load Options 6 thru 8 Large Load Addition Objectives

Options 6 thru 8 as proposed in the PJM response in the FERC 206 proceeding on co-located load are NOT exclusive to co-located load arrangements as discussed in the remainder of this presentation.

These options are designed to address resource adequacy challenges with large load additions on a transient or long-term basis with the following objectives:



Existing opportunities for large load additions and opportunities to enhance flexibility

Status Quo and Existing Options

Maintaining resource adequacy is a major challenge in PJM with the integration of large loads.

Enhancements to existing PJM mechanisms can assist with the resource adequacy challenges.

Status Quo:

Potential higher cost to load and risk of load shed if resource inadequate

Path 1:

Facilitate the ability to bring your own generation

(co-located load option 6)

Path 2:

Demand Response opportunities

(co-located load option 8)

What if there is not enough supply to strengthen resource adequacy?

Markets

- RPM procured supply will be less than Reliability Requirement (includes reserves).
- Capacity prices will reflect shortage conditions, potentially reaching price caps.
- Load receives less reliability.

Operations

- Increased risk of load shed specifically during peak or outage periods.
- Current curtailment procedures may be indifferent to the type of customer.
    - Transmission Owner is responsible for which load is curtailed.
    - Residential load may be curtailed at same time as large data centers.

Planning

- PJM cannot refuse load integrations. TOs/EDCs/LSEs provide guidance to PJM on forecasted load additions for incorporation into the load forecast.
- RTEP will continue to identify upgrades to ensure reliability by using more generation in the existing queue to ensure deliverability to all forecasted load

Existing Path 1
Facilitate the ability to bring your own generation (co-located load option 6)

Path 1: Incremental Generation

Bring Your Own Generation

- New large loads can bring incremental generation that commits to participation in PJM RPM with their new load – either through ownership or demonstration of a Power Purchase Agreement (PPA).

Advantages

- Load will only be curtailed in the event of an Emergency Manual Load Dump Action similar to residential load – Network Load.
- Provisional Interconnection Service may allow for expedited interconnection before interconnection process is complete.
- State agreement approach could provide alternative path.
- PJM can provide a web portal for prospective generation developers to pair with large loads.

Data Center
In front of meter
(500 MW)

Bilateral
Transaction
(Financial only)

Incremental
PJM capacity
(500 MW)

*New generation does not need to be co-located; quantity of generation needs to meet or exceed load on a UCAP basis

Path 1: Provisional Interconnection Service Potential Modifications

Potential Change

Offer Provisional Interconnection Service for developers to interconnect generation faster if willing to take on risk

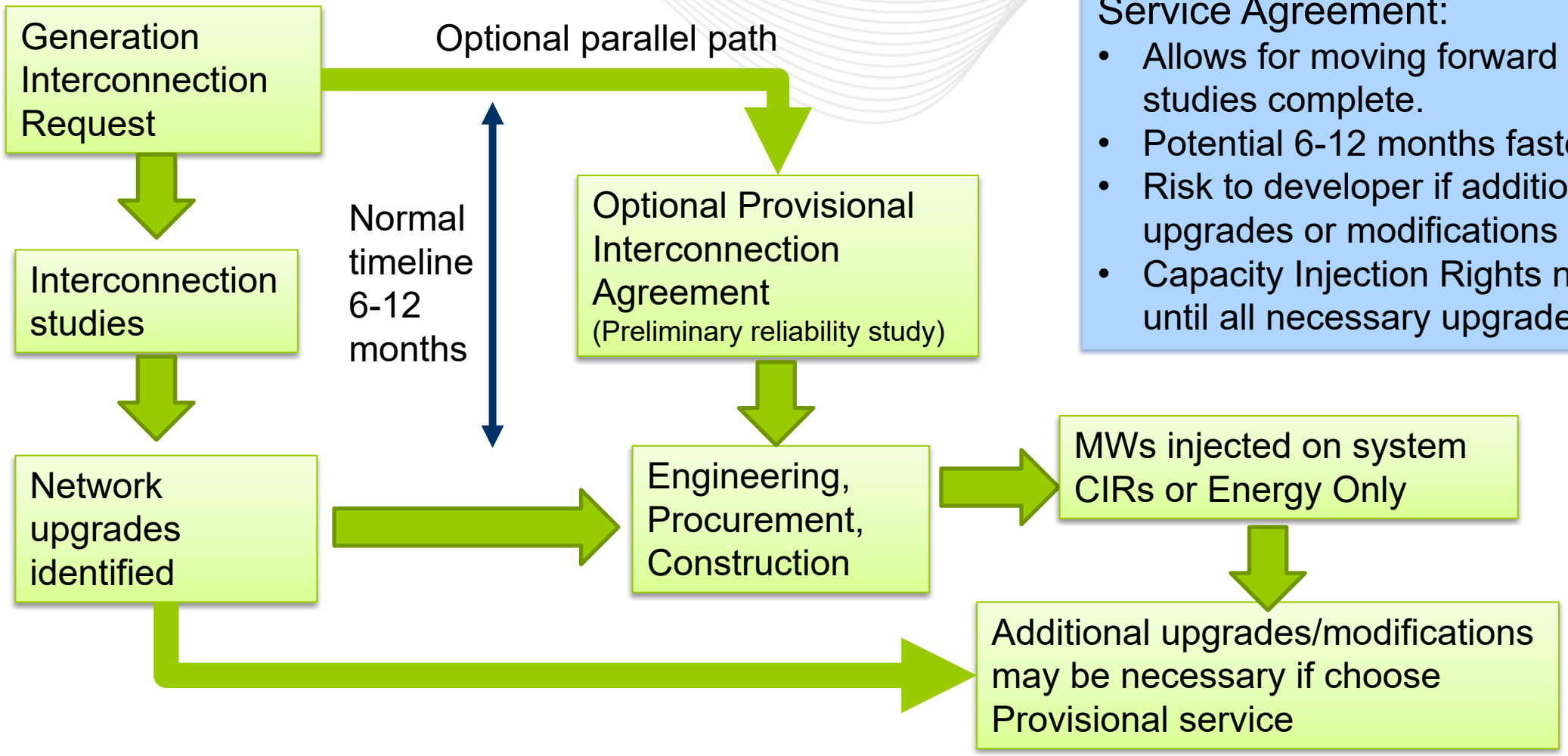
Advantages

- Offered to all types of generation
- Works within PJM existing construct
- Already part of a FERC approved framework*
- Shortens the study process timeline (at the expense of developer risk) by potentially 6-12 months depending on the type of project.

*FERC Order 845 addressed Provisional Interconnection Service by allowing developers to enter into an provisional interconnection agreement prior to the interconnection studies and network upgrades being completed.

Path 1: Provisional Interconnection Service

Concept Only



Optional Provisional Interconnection Service Agreement:

- Allows for moving forward before studies complete.
- Potential 6-12 months faster
- Risk to developer if additional network upgrades or modifications necessary
- Capacity Injection Rights not assigned until all necessary upgrades complete

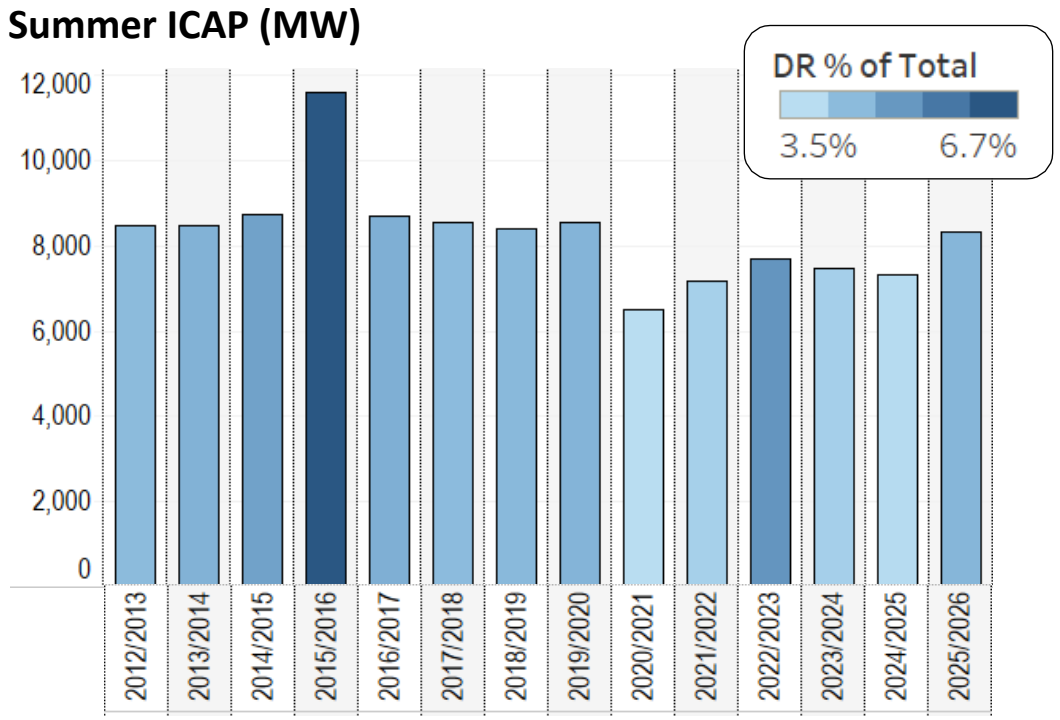
Existing Path 2
Demand Response Opportunities
(co-located load option 8)

Overview of Demand Participation Trends

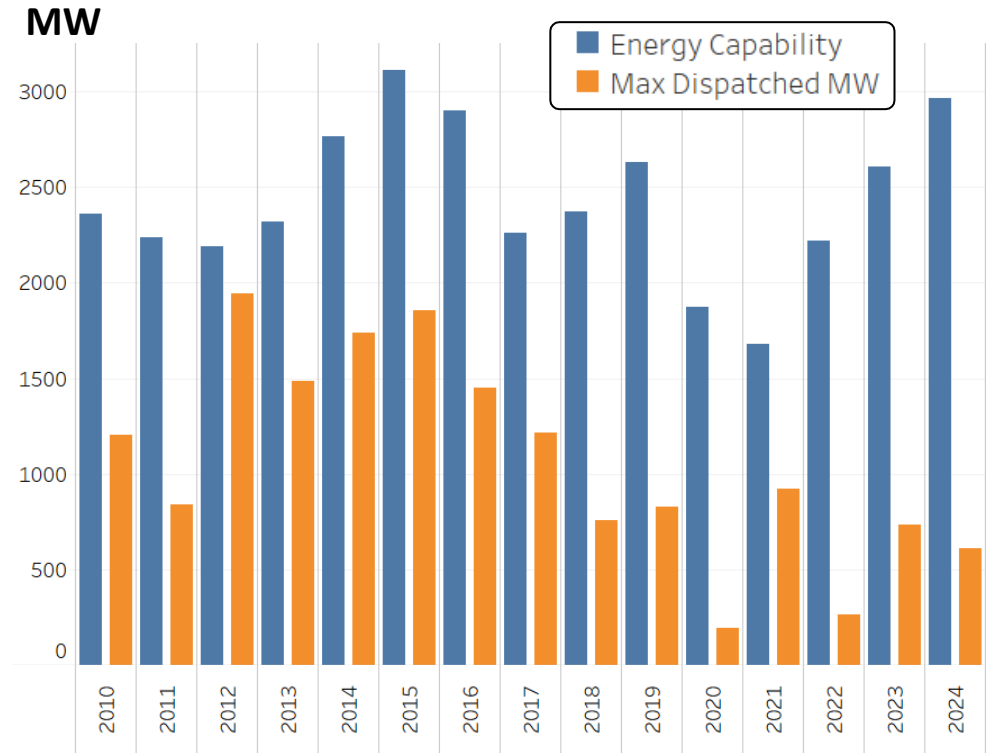
The amount of DR providing capacity to PJM has held relatively flat over the last decade.

Active participation in PJM's economic DR program has declined over the same period.

DR Providing Capacity (MW & % of Total)



Economic DR: Registered vs. Dispatched MW

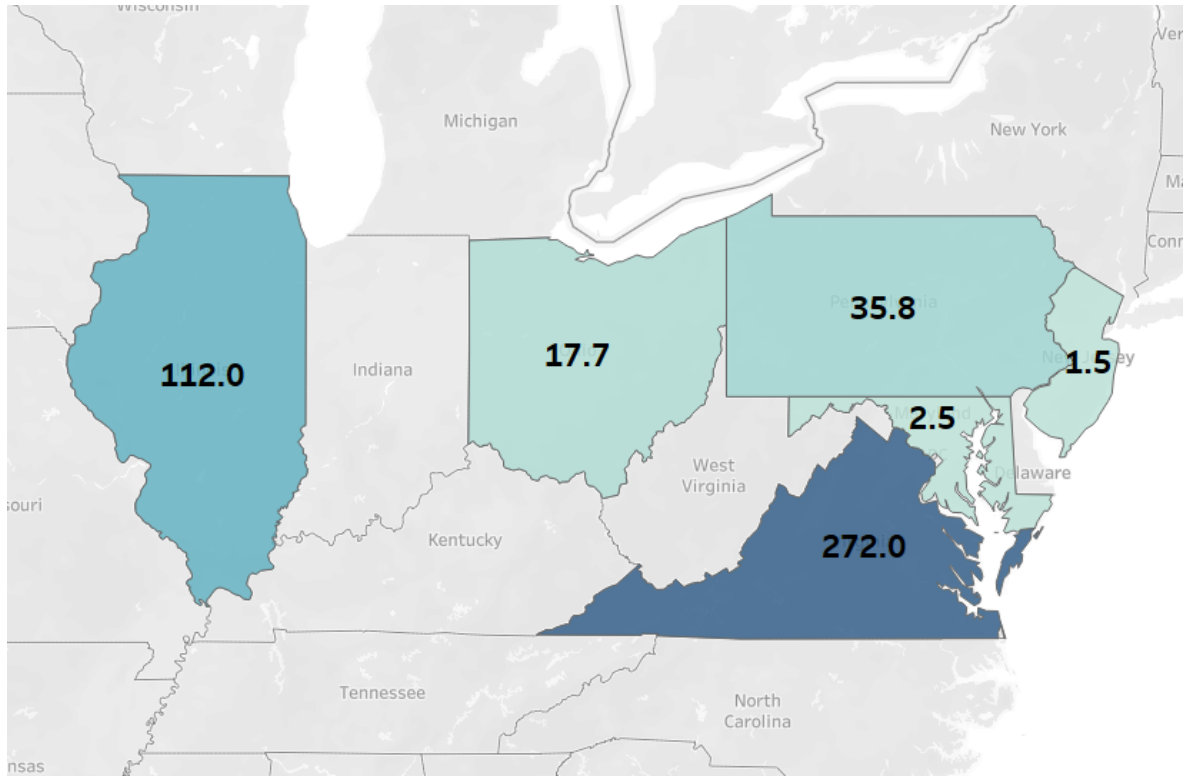


Large Load Participation Trends: Data Centers

Committed Capacity From Data Centers

	# Participants	Summer ICAP
2014/2015	80	179
2015/2016	96	234
2016/2017	48	113
2017/2018	34	200
2018/2019	48	264
2019/2020	56	287
2020/2021	57	309
2021/2022	61	334
2022/2023	61	315
2023/2024	52	293
2024/2025	47	243

Geographic Distribution of Data Center Capacity (MW) for the 2024/2025 DY



Perceived Barriers to Demand Response Large Load Participation

Market Design

- ELCC inadequately captures the value of some DR.
- Excess winter capacity is being stranded.
- Cost recovery

Operational Risk

- Providing load flexibility is perceived as adding too much risk to critical load.
- Implementation runs into utility interface issues and other operational complexities.
- Air quality permits limit participation options.
- Unknown expectations of DR curtailments

Path 2: Demand Response Opportunities

Potential solutions to incent Demand Response participation:

Partner with Federal/State to Enhance Back-Up Generation Flexibility

- Modify emissions restrictions
- Create exceptions during pre-emergency conditions

DR becomes much more attractive if there are less restrictions on running back-up units.

Improve Capacity Accreditation

- Create new data center ELCC class
  - More accurately calculate accreditation based on reliability of operating backup generation

Expand Capacity and Energy Cost Recovery for DR

- Allow curtailment cost in offers (costs to run back-up units)
  - Modify shutdown cost rules

If the data center can recover costs then it is revenue neutral.

Other Considerations

- Provide additional transparency around forecasted curtailment hours
- Seasonal DR product
- Consider transitional product with limit on curtailment frequency.

Educate CSP and DR providers on options to aggregated DR across multiple data centers not geographically at the same location

Potential transitional Non-capacity backed load concept

Path 3: Non-Capacity Backed Load (includes co-located load Option 7)

Non-capacity backed load option provides a unique **transitional** option to large loads above a certain threshold **only when** a Resource Adequacy test fails.

- PJM determines the maximum quantity of non-capacity backed load allowed based on a resource adequacy test derived from comparing Reliability Requirement vs. projected supply.
- Non-capacity backed load provides the option to integrate load at a reduced cost if willing to curtail before emergency procedures.
- No impact to load forecasting, determination of RPM planning parameters, or RTEP planning.
- Electric Distribution Company (EDC) coordinates with Large Load entities to determine optional participation.

Path 3: Non-Capacity Backed Load

Planning

Non-capacity backed load is part of RTEP and is Network load

Benefits

- System is built to ensure fully deliverable.
- Network Load ensures highest reliability.

Markets

Non-capacity backed load is not part of RPM

Benefits

- Non-capacity backed load does not pay for capacity
- Minimal or no impact on RPM prices (given the option is only available if already short capacity)

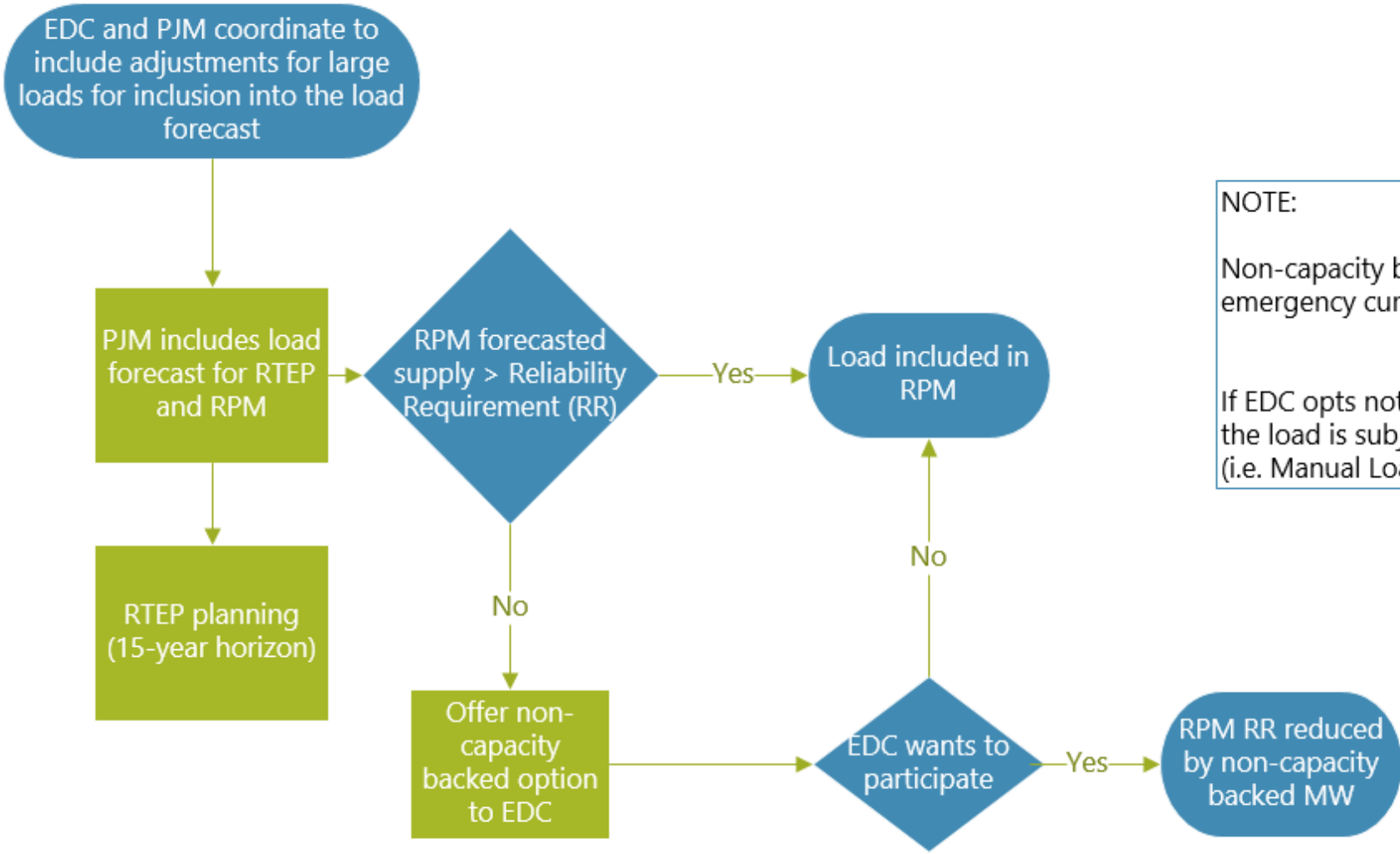
Operations

Non-capacity backed load could be curtailed in advance of emergency procedures

Benefits

- Priority to residential customers in extreme conditions
- Advance coordination to run back-up facilities to minimize or eliminate down time

Path 3: Non-Capacity Backed Load



NOTE:

Non-capacity backed load MW are subject to pre-emergency curtailment.

If EDC opts not to take non-capacity backed option, the load is subject to status quo curtailment rules (i.e. Manual Load Dump).

Large Load Additions – Next Steps

- Solicit feedback from Stakeholders.
- Monitor FERC 206 co-located load proceedings.
- Potential Critical Issue Fast Path process to achieve timely resolution.
  - Implementation in time for 28/29 RPM BRA to be conducted in June 2026.
  - Potential changes in the RPM, Demand Response, Planning, and Settlement areas.

Contact

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Large Load Additions Workshop

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