Generation, Storage, and Transmission Co-Optimization

PJM (Online)

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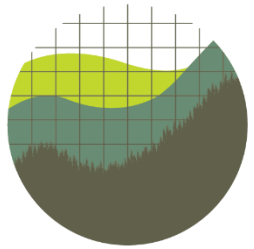

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Introduction

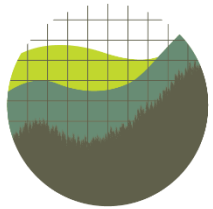
Exploratory Scenario Development Work

- PJM will work with states and stakeholders on an informational Base LT Scenario in 2025 to mockup the scenario building process and strengthen the compliance process and filling
  - PJM, states and other stakeholders will discuss assumptions and methods through an iterative process (to be discussed later today)
  - PJM will develop an information Base LT Scenario using the copperplate approach, as standard industry practice
- Stakeholders asked PJM to consider a capacity expansion approach that accounts for transmission costs ("coexpansion")
- PJM is collaborating with NREL on a DOE-funded project to implement National Transmission Planning Study's (NTPS) methods into a county-level model of PJM
  - The NTPS represent industry best-practice on coexpansion

Source: 2025-4-10, PJM TEAC Special Session – Order 1920, Item 03 - FO1920 Stakeholder Engagement Timeline Update

Where Vision Meets Action

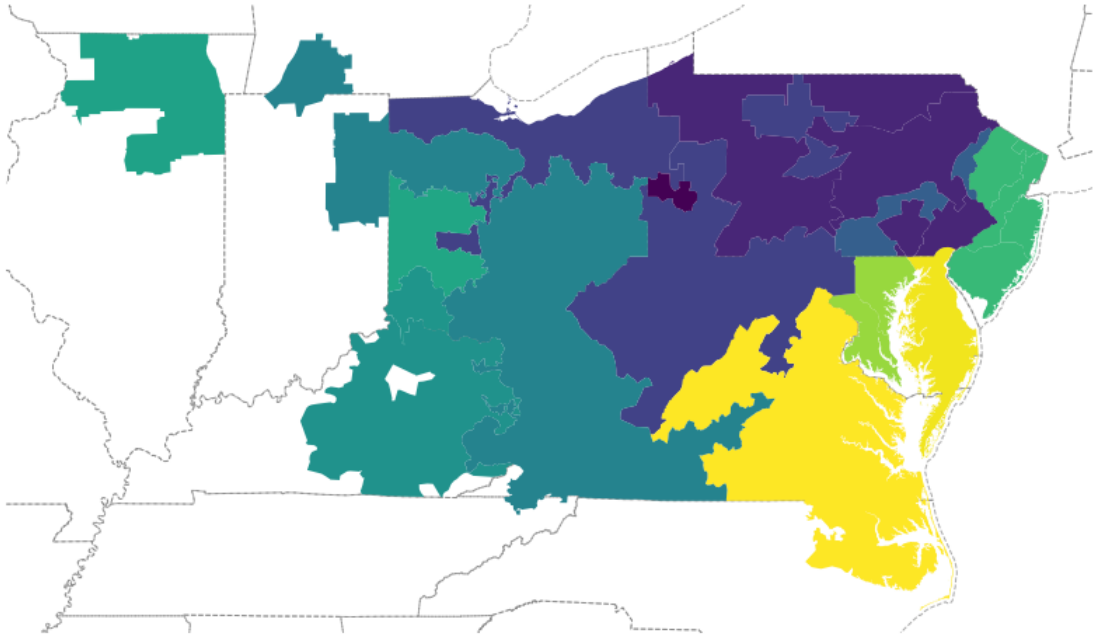
- PJM should move to co-optimized planning as soon as possible
- In its Order 1920 compliance filing, PJM should present its timeline for transitioning from the current modeling approach to a co-optimized planning approach
- PJM should begin a process to collect and vet necessary data like transmission upgrade costs, perhaps through a consultant or through direct engagement with developers, or both



Why Plan Transmission?

- Locations within PJM differ in
  - Resource quality (Wind, Solar)
  - Investment costs (Generation, Storage, Transmission)
  - Fuel costs (including delivery)
  - State policies (e.g., tax incentives for data centers, renewable portfolio standards, etc.)
  - ...
- Transmission planning can reduce costs and increase reliabilty given those differences across space

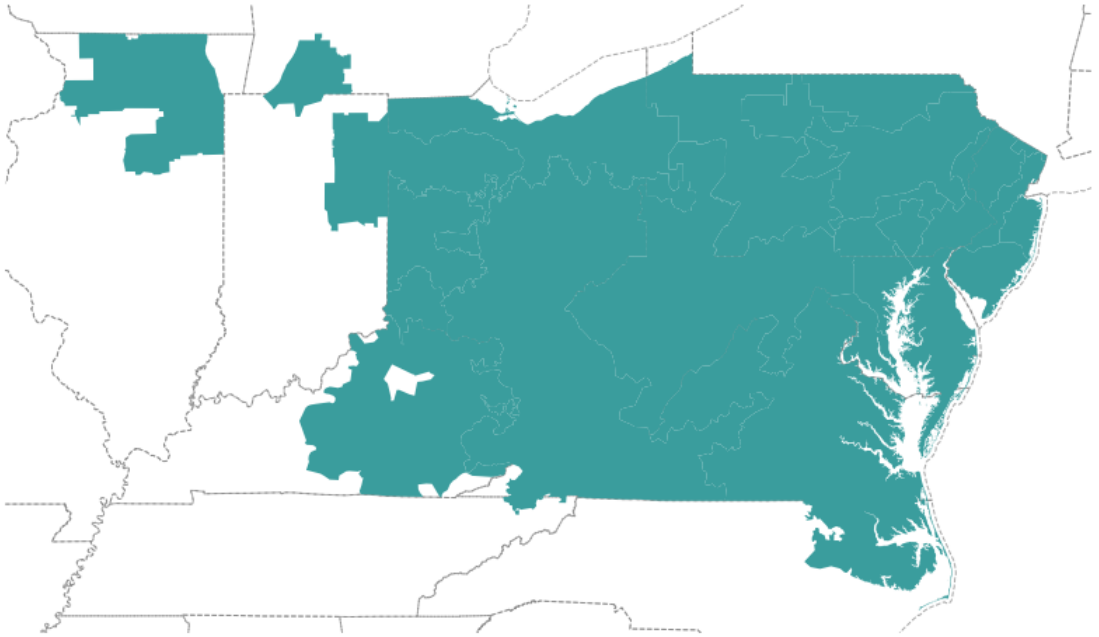
Average Solar Availability Factors



Extreme 1:

Generation → Regional Transmission

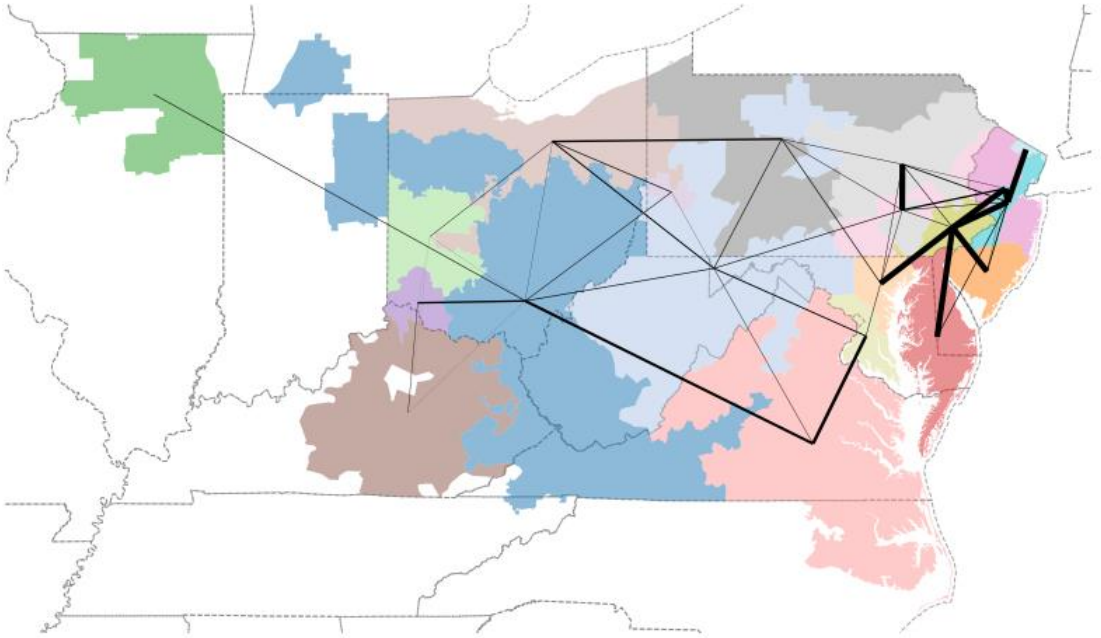
- Expand generation and storage capacity by ignoring existing transmission
- Allocate generation and storage across space
- Plan transmission to accomodate the additional generation and storage capacity
  - Transmission planning solutions heavily depend on how additional generation and storage are allocated across space; using the interconnection queue to limit locational entry may not be appropriate
- Similar to PJM‘s current proposed Order 1920 Planning Process



Extreme 2:

Fixed Regional Transmission → Generation → Local Transmission

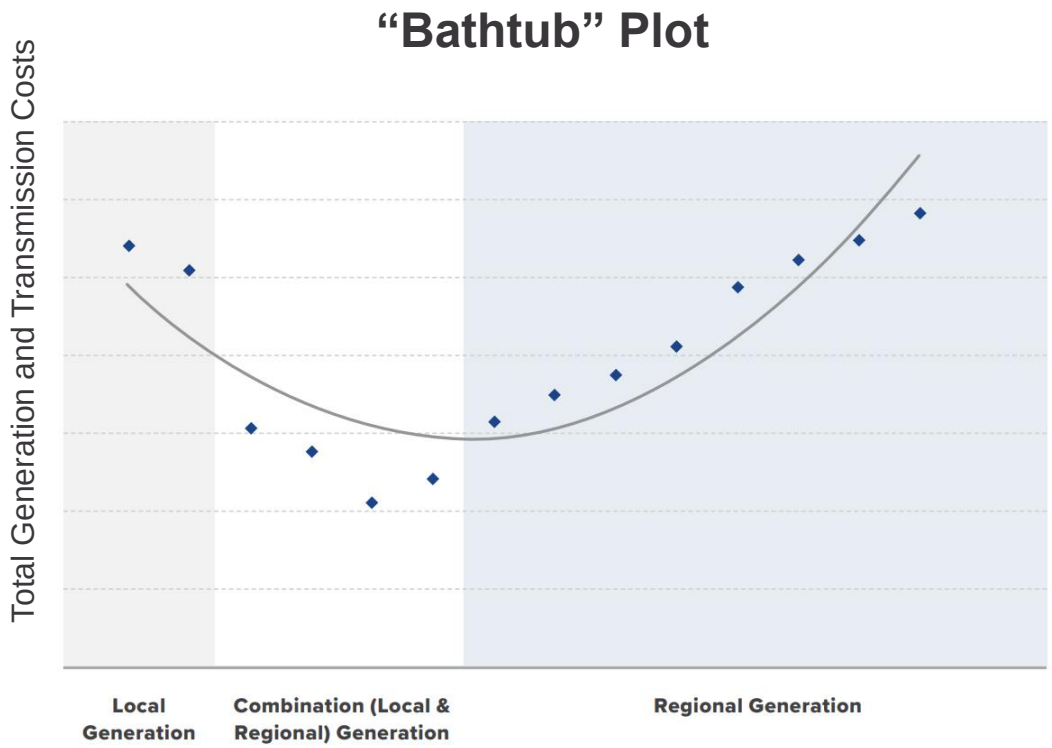
- Expand generation and storage capacity using a zonal representation of the grid with fixed transmission corridor capacity
- Get zonal generation and storage capacity mixes
- Plan transmission to accomodate the additional generation and storage capacity
  - Will likely lead to very local solutions



Co-Optimization:

Generation ⟳ Transmission

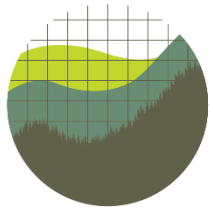
- Produces lower cost systems
- Gold standard in academia
  - A mathematical model for long range expansion planning of generation and transmission in electric utility systems (Sawey and Zinn, 1977)
  - Co-optimization of electricity transmission and generation resources for planning and policy analysis: review of concepts and modeling approaches (Krishnan, Ho, *et al.*, 2015)
  - Multi-Objective Transmission Expansion: An Offshore Wind Power Integration Case Study (Khanal, Graf, *et al.*, 2024)
- Computationally feasible even for larger real-world systems
  - National Transmission Planning Study (DOE, 2024)



Source: *Transmission Planning for PJM's Future Load and Generation,* Americans for a Clean Energy Grid, 2024, Figure 13

Co-Optimization: What's Needed?

- Transmission Data:
  - Mapping (MW and $/MW-corridor mile) from actual transmission equipment (lines, substations, shunt reactors, asynchronous compensators, GETs, etc.) to corridor transmission capacity and cost
- Reliability Modeling Upgrade:
  - ELCCs for each technology, location, and time are functions of everything else that is on the system (including transmission). ELCCs should therefore be included in the planning model as high dimensional functions.



Final Remarks

- Co-optimized modeling will help create lower-cost and more reliable transmission plans
- Transmission planning is not an exact science. The goal is to get better high-level (zone/corridor) planning solutions that can be used as a starting point for actual transmission planning
- Detailed power flow modeling, including all relevant operating and security constraints, is still necessary and may drive additional transmission needs
- All resources contribute both energy and reliability value to the system, depending on the other resources present, regardless of whether they are incentivized by policy or driven by merchant investment

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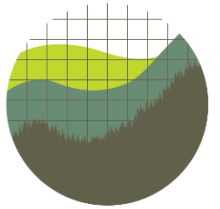

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