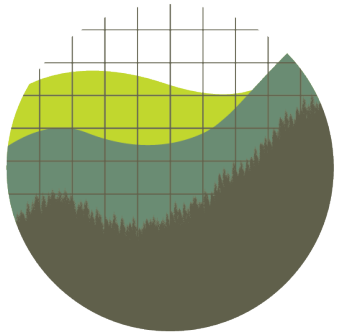


Institute *for*
Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

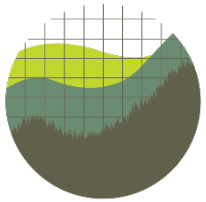
Stakeholder Presentation on FERC Order 1920

Transmission Modeling and the Importance of Solid Input Data

PJM (Online)

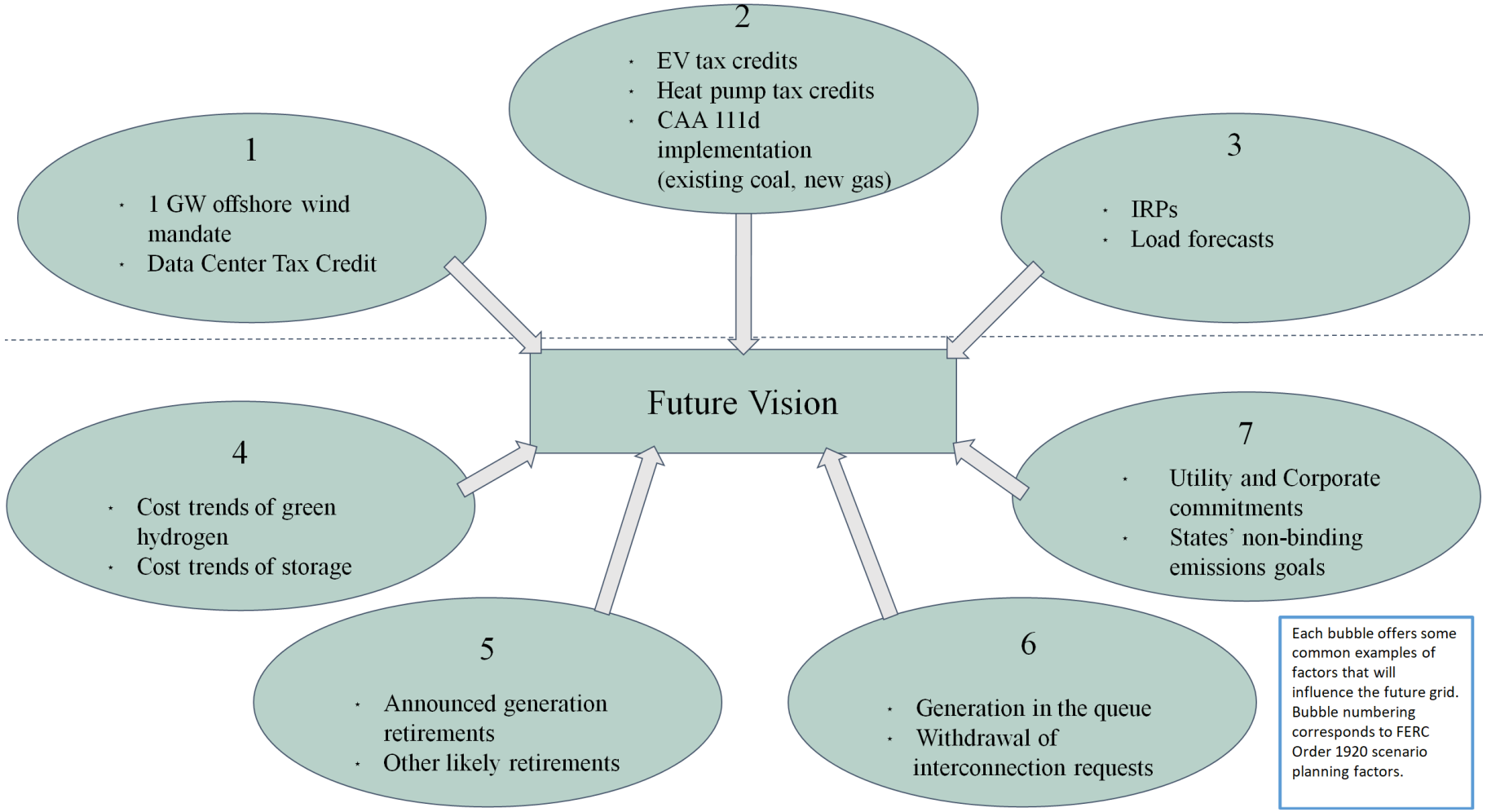
Christoph Graf (New York University)

Sept 6, 2024



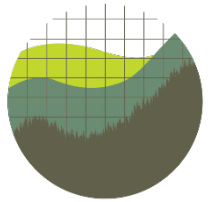
- Presentation is mainly based on
  - *Multi-Objective Transmission Expansion: An Offshore Wind Power Integration Case Study* by *Saroj Khanal, Christoph Graf, Zhirui Liang, Yury Dvorkin, Burçin Ünel* [link]
  - *Transmission Planning for the Energy Transition: Rethinking Modeling Approaches* by *Jennifer Danis, Christoph Graf, Matthew Lifson, Burçin Ünel* [link]

Future Vision / Data and Modeling / Outcomes



Future Vision / Data and Modeling / Outcomes

- Future vision of the power system is important
  - Including all laws and policies impacting supply (e.g., for clean energy) and demand drivers (e.g., demand growth from tax-incentivized data centers)
- However, at some point any vision needs to be translated into workable assumptions and inputs to model future outcomes
  - Where will future clean generation and storage be located?
  - Will electric vehicles and heat pumps be able to communicate with the grid? I.e., can we use them as storage to a certain extent?

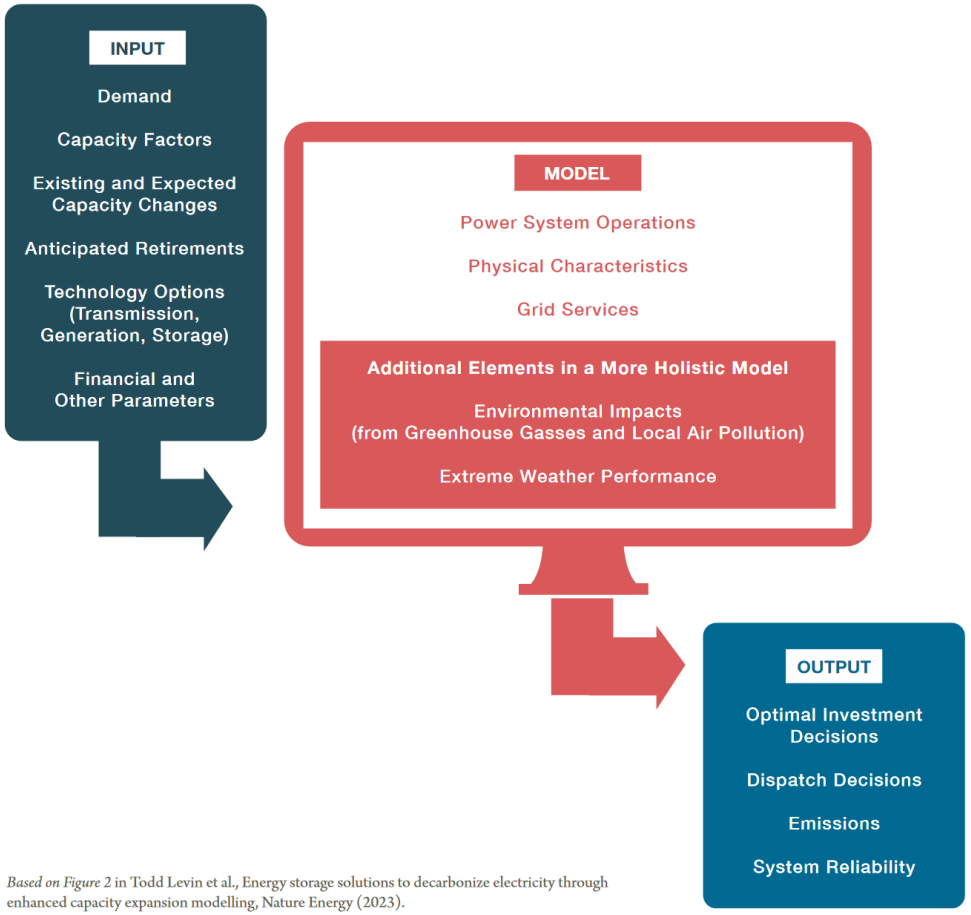


Future Vision / Data and Modeling / Outcomes

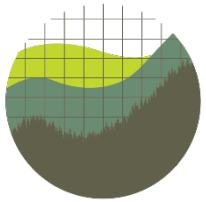
- In practice both future vision and *how* it is implemented will affect planning outcomes
- Stakeholder should not only focus on the future vision but also on data and modeling (i.e., the whole chain that determines planning outcomes)

Generation and Transmission Planning Models

Key Components of Transmission Planning Models



Based on Figure 2 in Todd Levin et al., Energy storage solutions to decarbonize electricity through enhanced capacity expansion modelling, Nature Energy (2023).



Generation and Transmission Planning Models (cont'd)

Minimize: Total Investment Cost (Generation, Storage, Transmission) +

Expected Operating Cost (including demand side valuation of power)

Subject to: *Operational Constraints of Generation and Storage*

Capacity Constraints of Generation, Storage, and Transmission

Power Balance Constraints accounting for power flows

Reserve Constraints

The operational (production) model can range from simple (economic dispatch) to very detailed (security constrained unit commitment). Model can be formulated as two-stage stochastic program or multistage stochastic program.

PJM Specifics

- For a fixed transmission plan (as well as generation/storage plan) the model can be used to compute counter-factual market simulations
- Co-optimizing transmission, generation, and storage may result in more realistic locational resource predictions than the interconnection queue
- Making a reasonable zonal representation of the PJM grid[1] publicly available, could help stakeholders to better support the planning process
  - Because specific (sets of) transmission solutions may not be publicly available, PJM could estimate their impact on zonal transmission interface limits as in Brown et al. (2023)[2]

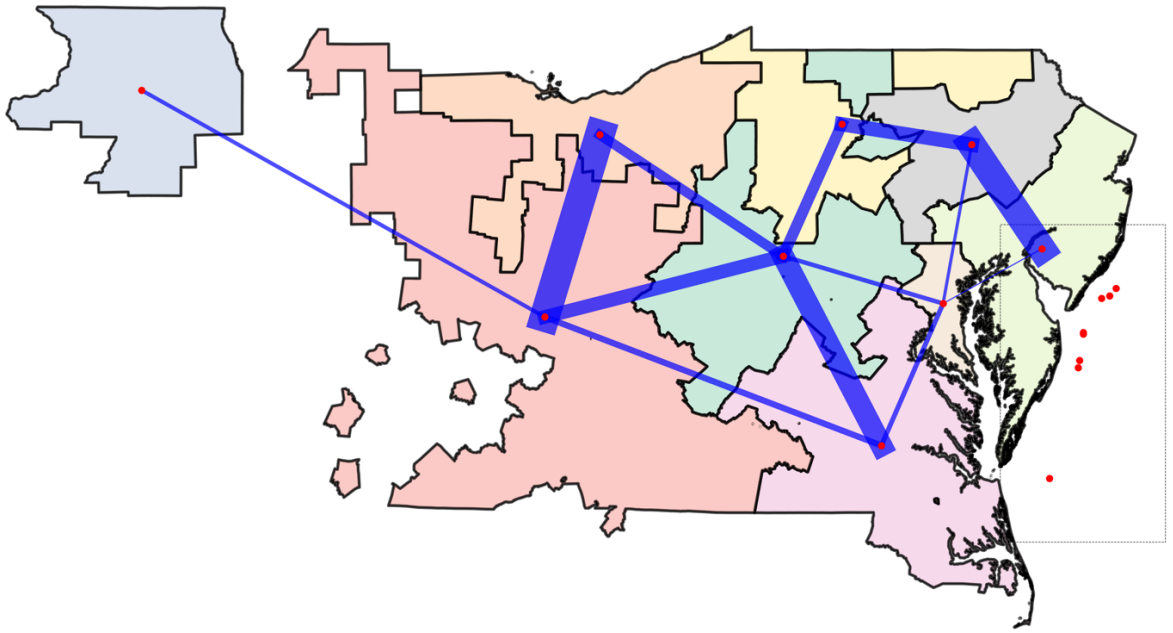
[1] E.g., the Plexos zonal model that PJM has used in the past (CAPSTF Task Force).

[2] Brown et al., 2023, "A general method for estimating zonal transmission interface limits from nodal network data," https://arxiv.org/abs/2308.03612.

Case Study: PJM

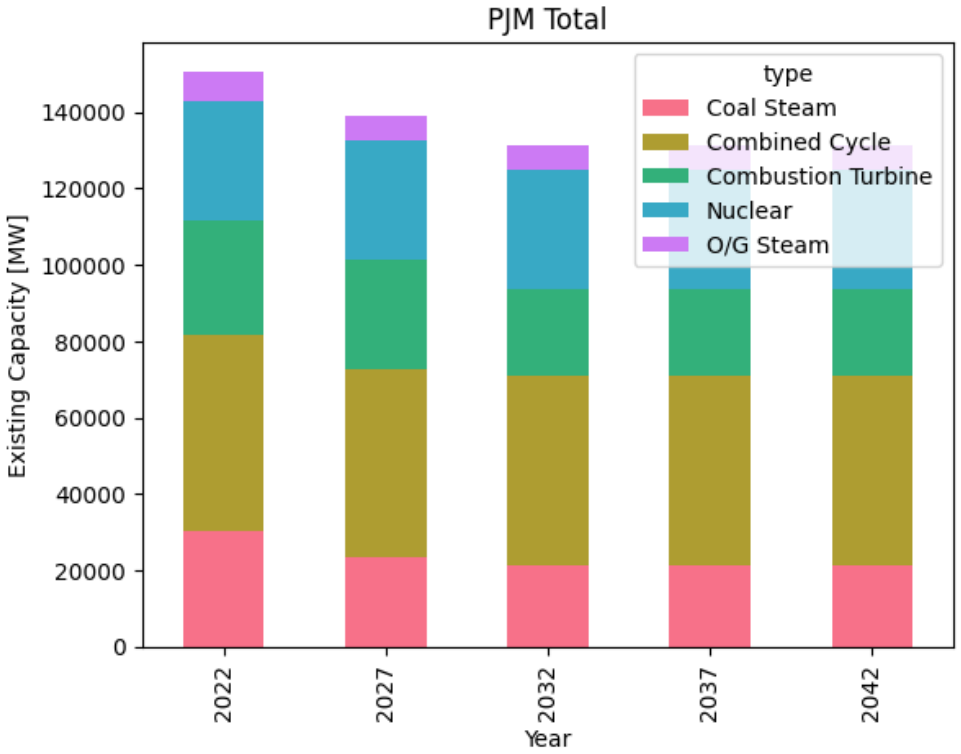
1) Generator database based on EIA-860 form data (Snapshot 2021); Exogenous retirements
2) Locational distributions of load and capacity factors from onshore wind, offshore wind, and solar (EPA IPM Model / NREL)
3) Annual Load Growth: 1%
4) 9-zone representation of the PJM grid (EPA IPM Model) + 8 offshore wind zones ("pipes-and-bubbles" energy transport)
5) Investment cost estimates from NREL (ATB 2022)
6) Modeling horizon is 20 years (4 Epochs with 5 years each)

Baseline Transmission

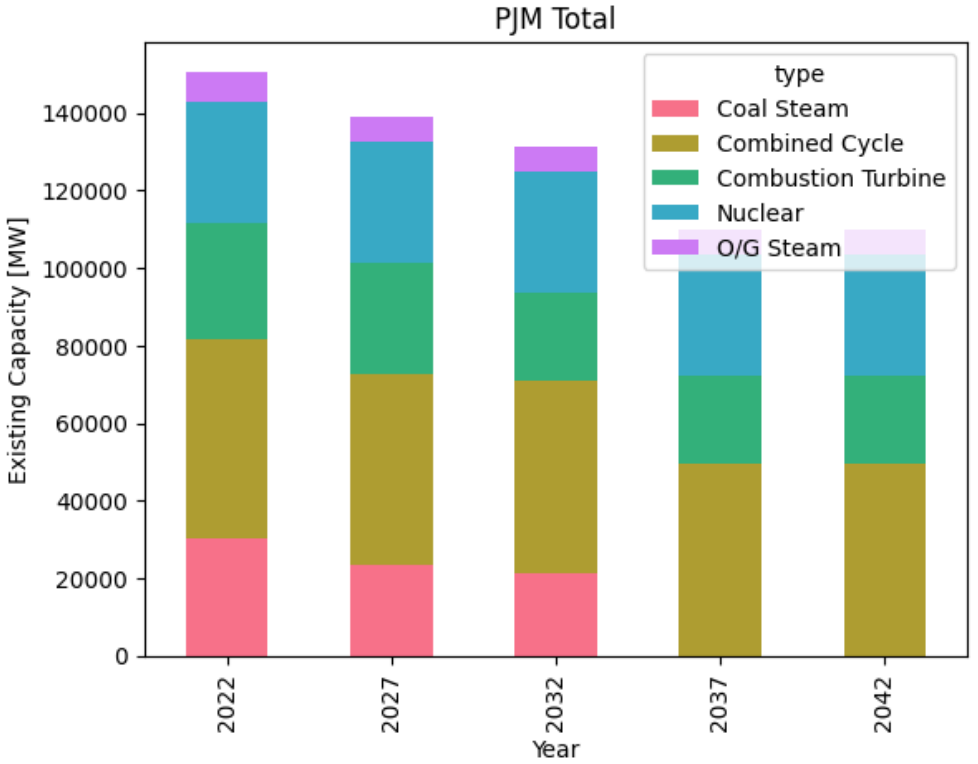


On Retirements

PJM Retirements[1]



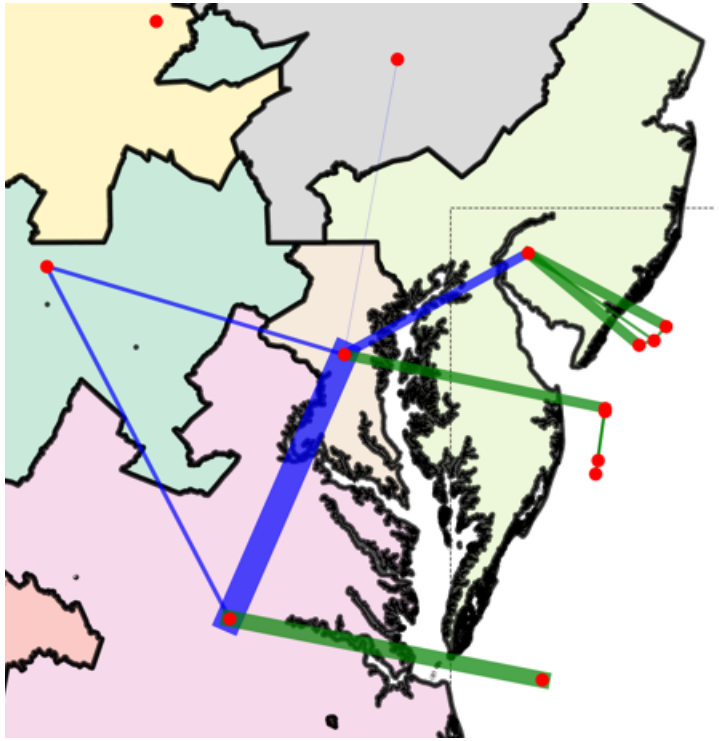
PJM Retirements + 2035 Coal Phaseout



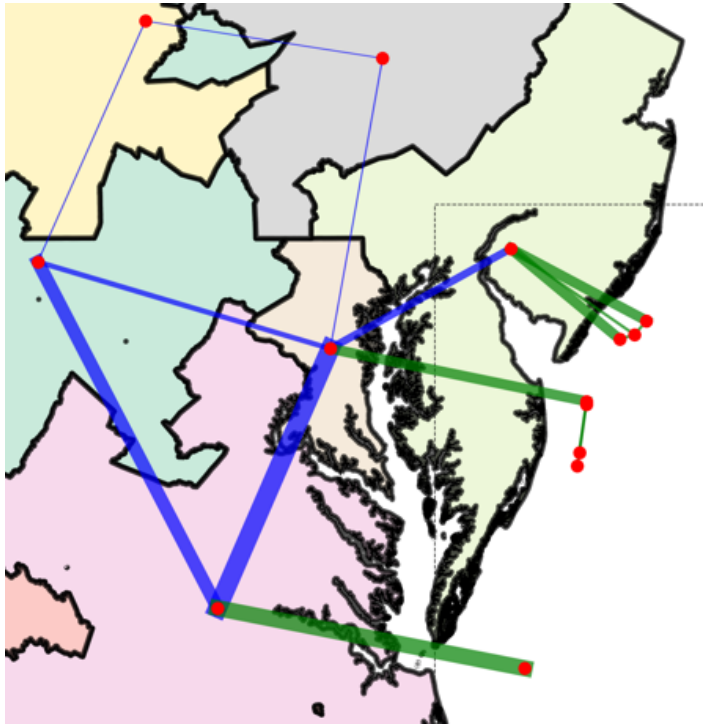
[1] Based on PJM's modeled retirements from the CAPSTF Task Force.

On Retirements (Transmission Upgrades)

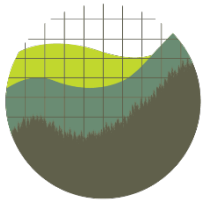
PJM Retirements



PJM Retirements + 2035 Coal Phaseout

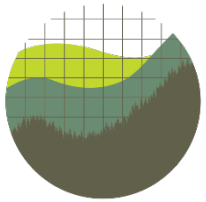


More (approx. +1 GW) and different transmission needed if Coal is phased out in 2035 on top of PJM retirements



Conclusion

- Best possible input data are essential for sound transmission planning outcomes.
- Operationalizing transmission drivers into modeling data and assumptions is an important part of sound planning.
- Transparent transmission modeling can support the stakeholder process.



Thank You

Christoph Graf

christoph.graf@nyu.edu