Integrated Planning Module 1

Planning for different entities

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

Debbie Lew, Executive Director, ESIG

NARUC/NASEO/NASUCA Training

February 13, 2025

Bulk Power System Virtual Learning Modules:

Integrated Electricity Planning Trainings

This three-part trainings series will dive into key concepts of integrated planning, a holistic planning approach to develop affordable, reliable, and robust investment plans by integrating traditionally siloed processes.

***Open to NARUC, NASEO, NASUCA, NGA, NCSL, and NACAA Members**

Spring 2025 Sessions (all hosted virtually from 2:00 to 4:30 p.m. ET):

- **February 13: Integrated Electricity Planning for Different Types of Entities**
- **February 20: System Expansion Modeling: Considering Transmission and Distribution in Capacity Expansion Modeling**
- **March 6: Tools, Data and Processes for Integrated Planning**

Register Now

NARUC
National Association of Regulatory Utility Commissioners

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About NARUC

- Founded in 1889, the National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization dedicated to representing the state public service commissions who regulate the utilities that provide essential services such as energy, telecommunications, power, water, and transportation.

- NARUC's members include all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands.

- Our mission is to serve the public interest by improving the quality and effectiveness of public utility regulation.

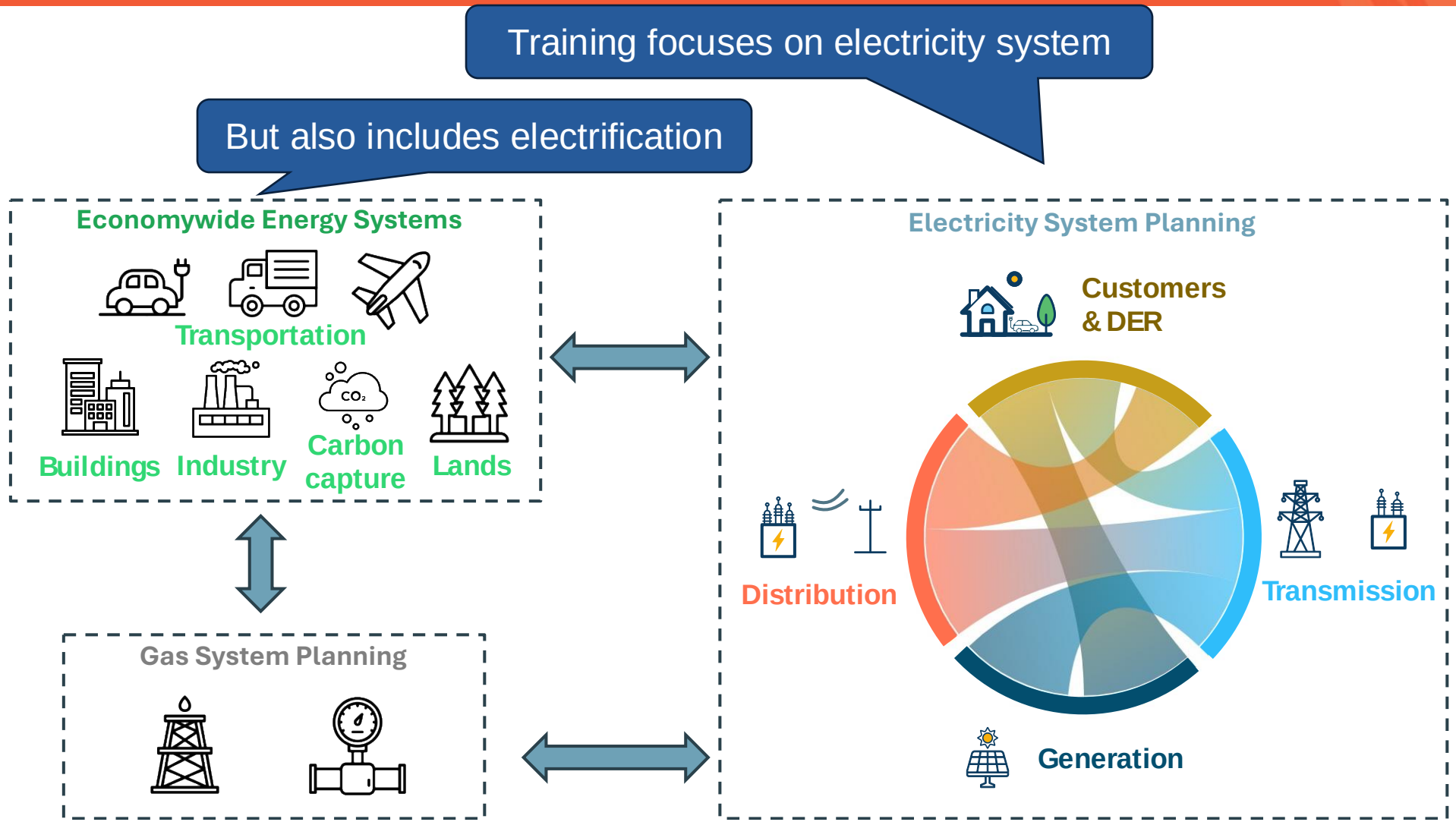
About CPI

- The NARUC Center for Partnerships & Innovation (CPI) builds relationships, develops resources, and delivers training to assist state commissions contending with complex current and emerging issues.
- CPI is funded by cooperative agreements with the U.S. Department of Energy (DOE) and the U.S. Department of Commerce's National Institute of Standards and Technology (NIST).
- NARUC CPI conducts work across five key energy areas and many topics within each: generation; transmission; distribution; customers; and critical infrastructure preparedness, response, and resilience.
- For more information, visit: https://www.naruc.org/cpi/cpi-home/

Energy Systems Integration Group (ESIG)

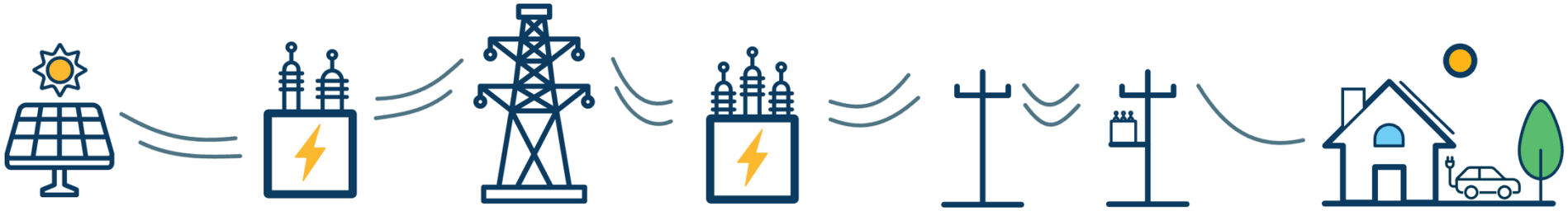
- ESIG is a member-driven organization that addresses technical challenges for transforming energy systems. We do this through collaboration, education and knowledge sharing.
- >250 members worldwide broadly focused on decarbonization and integration of energy systems
- Workshops, webinars, reports available freely on our website (https://www.esig.energy/) and on YouTube (@EnergySystemsIntegrationGroup). Join our mailing list!
- We create task forces to address topics such as multi-value transmission benefits or grid-forming technology or electrification and these task forces do analysis, run simulations, synthesize best practices, etc. **One of these task forces is on integrated planning!**

Integrated Planning Means Different Things to Different People



Graphic: Aaron Burdick, E3, “ESIG Integrated Planning Introduction”, to be published, 2025

What is integrated planning?
Traditional electricity system planning is siloed

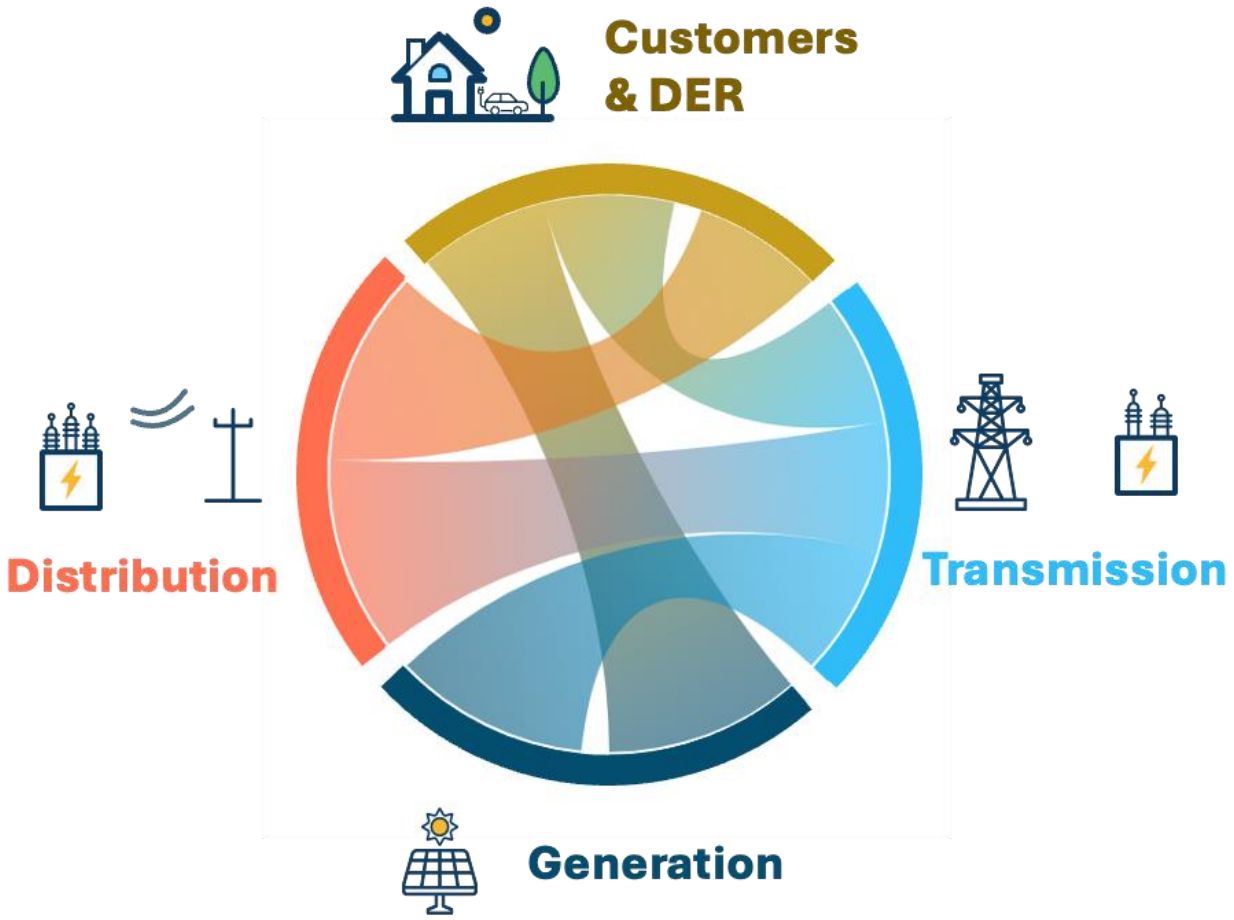


Generation	Transmission	Distribution	Customers & DERs
Resource development plan – least cost resource plan; procurement needs; RFPs	Transmission investment plan – transmission infrastructure needs for reliability, regional and interregional needs	Distribution investment plan – asset health; distribution infrastructure needs for reliability and safety; grid modernization	Customer/DER programs – customer program evaluation and design; rate design

Graphic: Aaron Burdick, E3, “ESIG Integrated Planning Introduction”, to be published, 2025

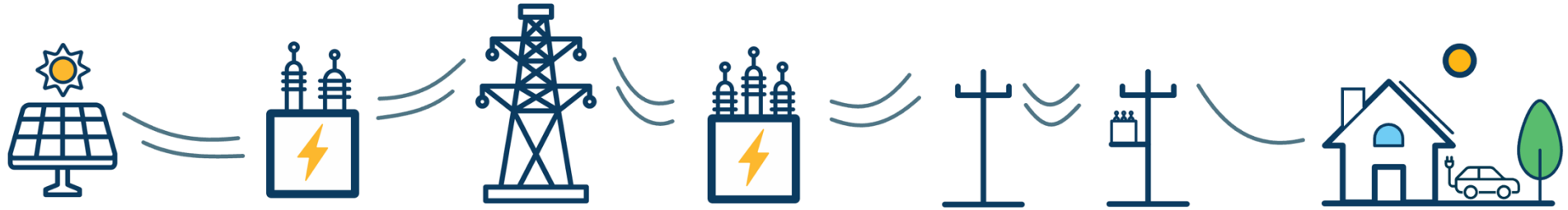
Integrated Planning captures synergies, constraints, redundancies

- Retail rates or DERs can reduce the need for generation.
- Two-way flows on the distribution system can affect transmission planning.
- Storage can reduce the need for transmission or distribution upgrades.
- If you need storage, should you site it on the transmission or distribution system?
- Generation resources such as wind and solar need greater coordination with transmission planning.
- High levels of inverter-based resources (wind/solar/batteries) can lead to stability issues on the transmission system.



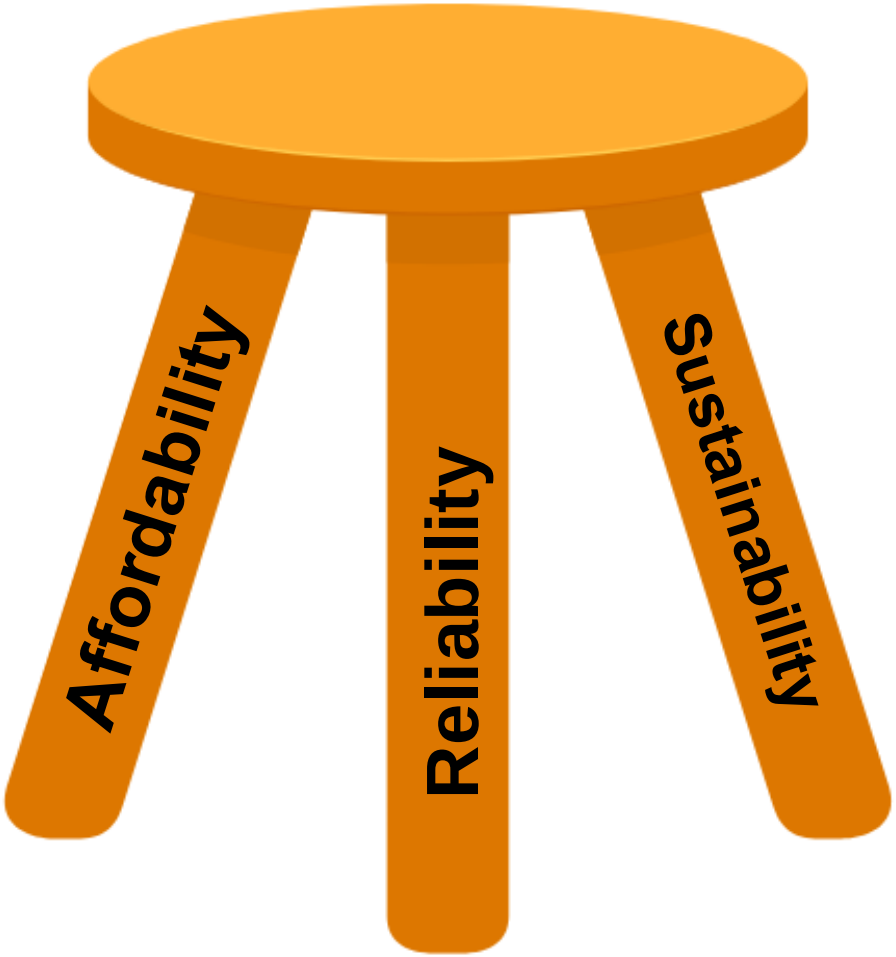
Graphic: Aaron Burdick, E3, “ESIG Integrated Planning Introduction”, to be published, 2025

Traditional planning processes



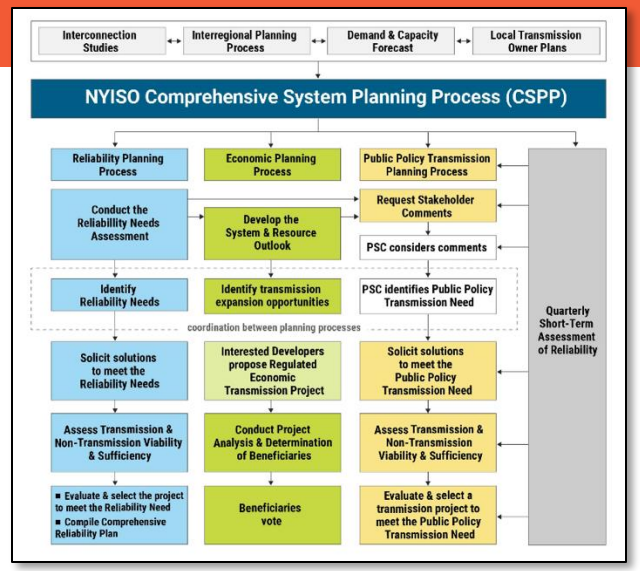
	Generation	Transmission	Distribution	Customers & DERs
Planning constraints	Least-cost economics; resource adequacy; operational flexibility; policy goals	Thermal; voltage; stability; contingencies	Thermal; voltage/power quality; operational reliability; protection	Cost-effectiveness; low-income customers; market transformation; policy goals
Tools and Methods	Capacity expansion, production cost, loss of load probability	Steady-state power flow; nodal production cost; dynamic stability; short circuit	Steady state power flow; short circuit; protection	Avoided costs; cost/benefit analysis; programs; rates/tariffs

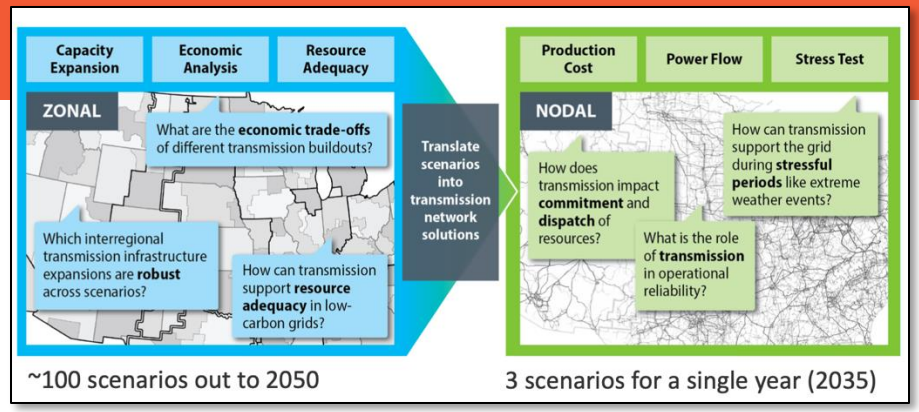
Another way to think about integrated planning is the integration of the goals

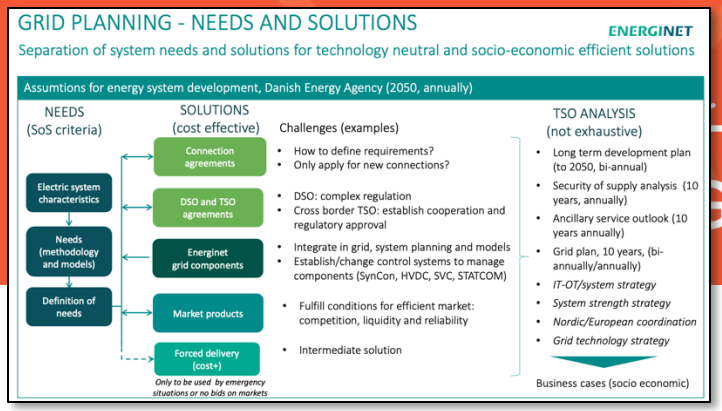


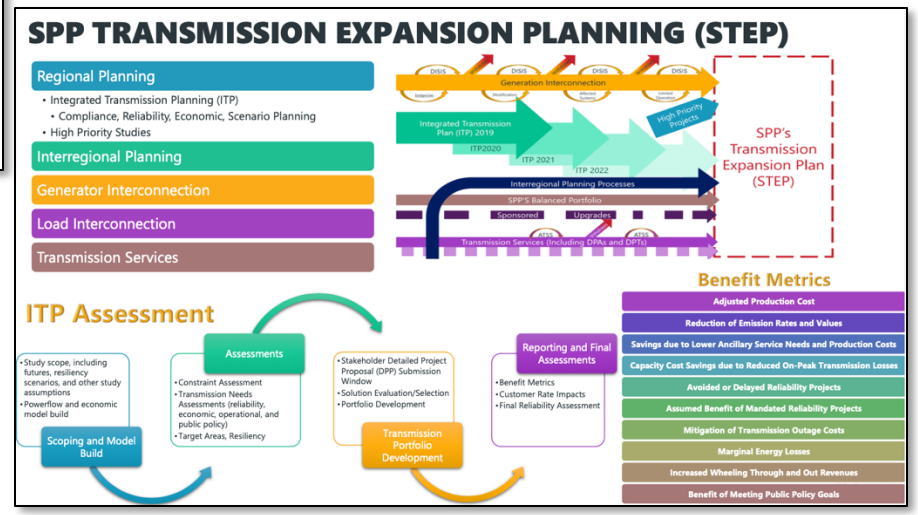
There is no supermodel. Just a continuous improvement of methods, tools, and data.

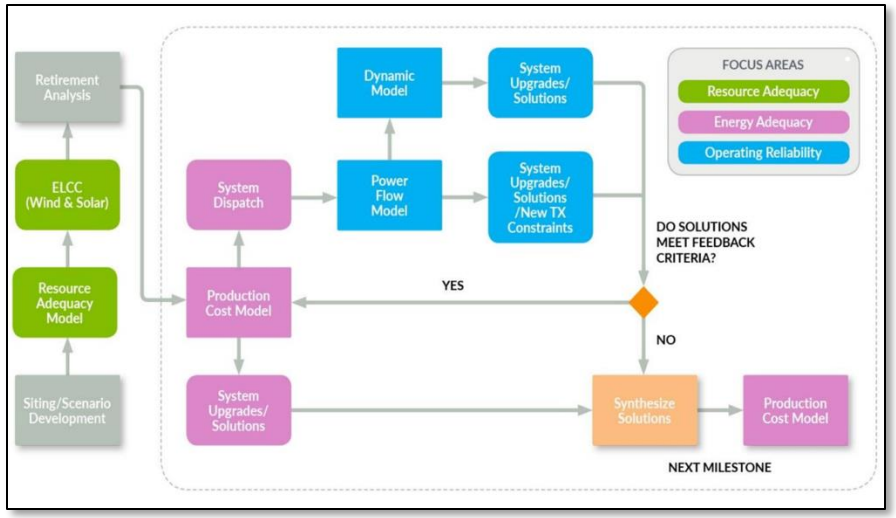
Planning just got more complicated

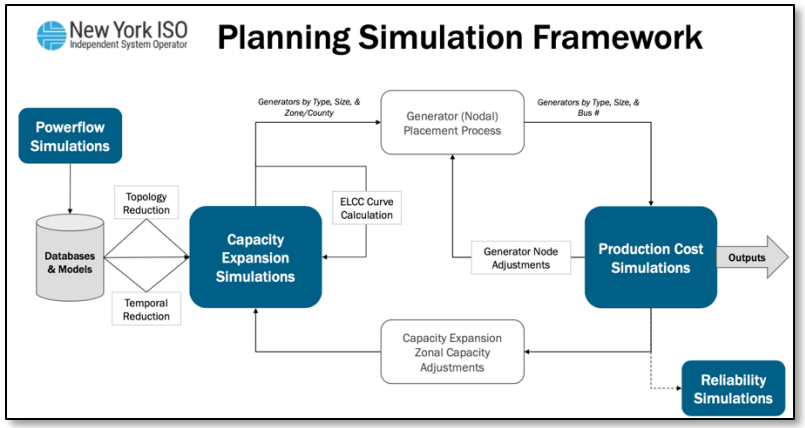






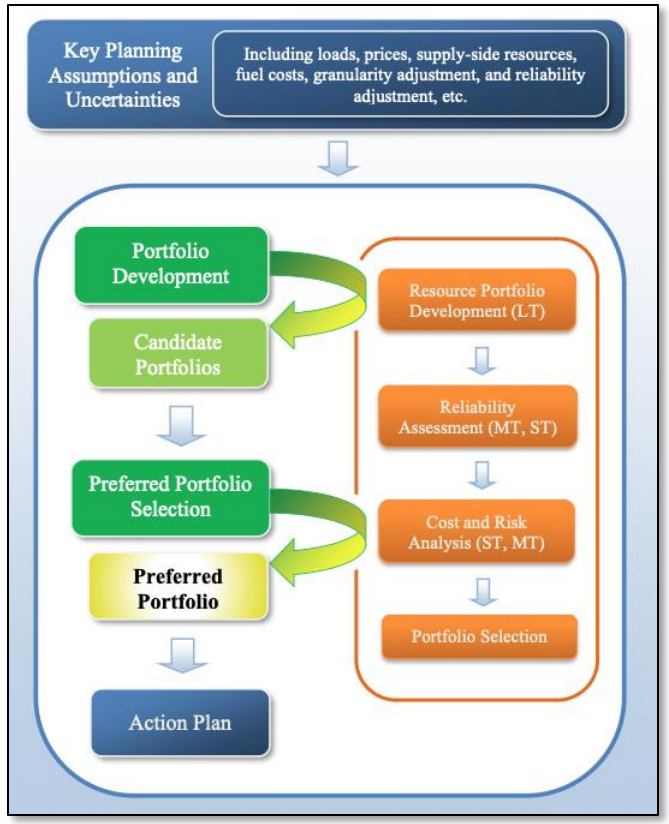


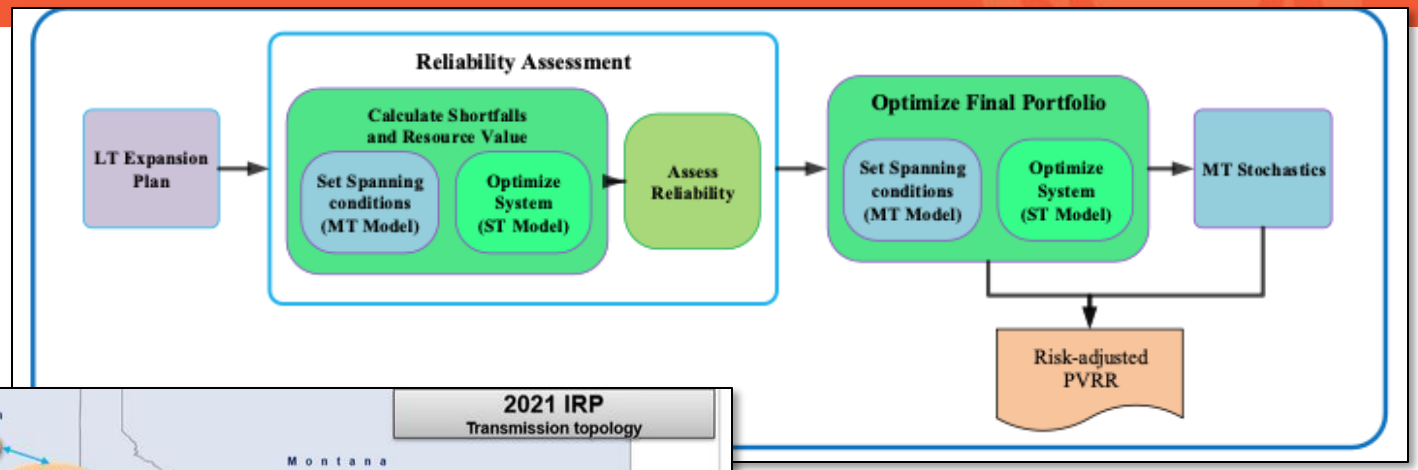


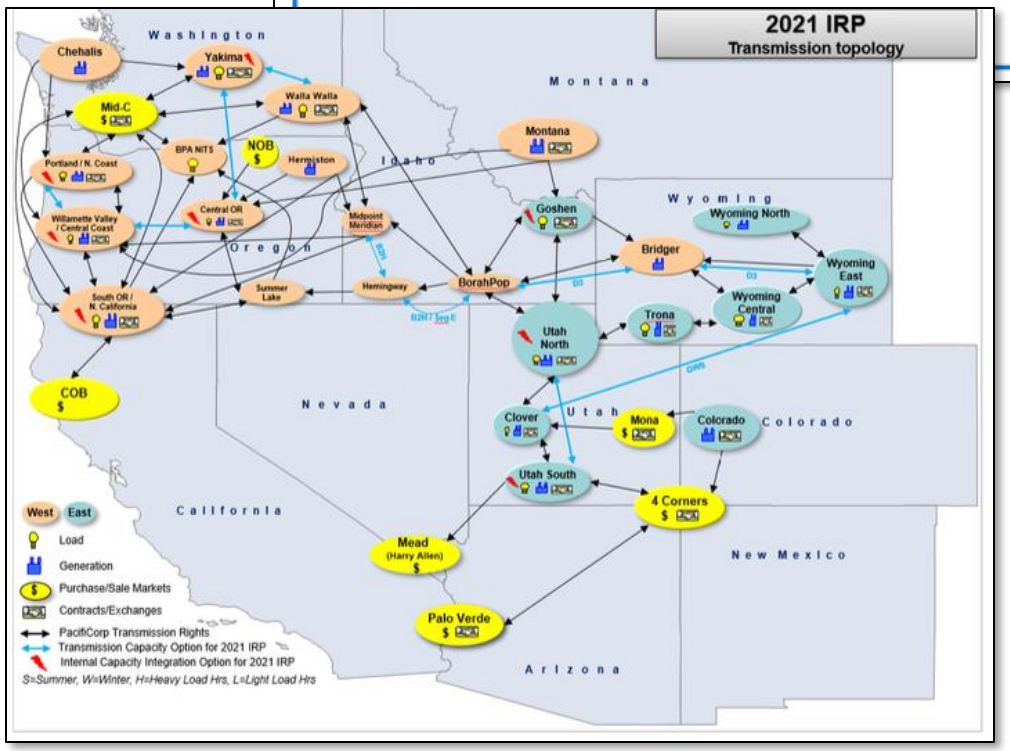


J. Frasier, NYISO, J. Bakke, MISO, P. Markussen, Energinet, Xiaoyao Zhou, NESO, Kelsey Allen, SPP, ESIG Integrated Planning Workshop 10/21/24; D. Palchak, NREL ESIG Spring Workshop 3/26/24

Pacificorp co-optimizes generation and transmission in resource planning





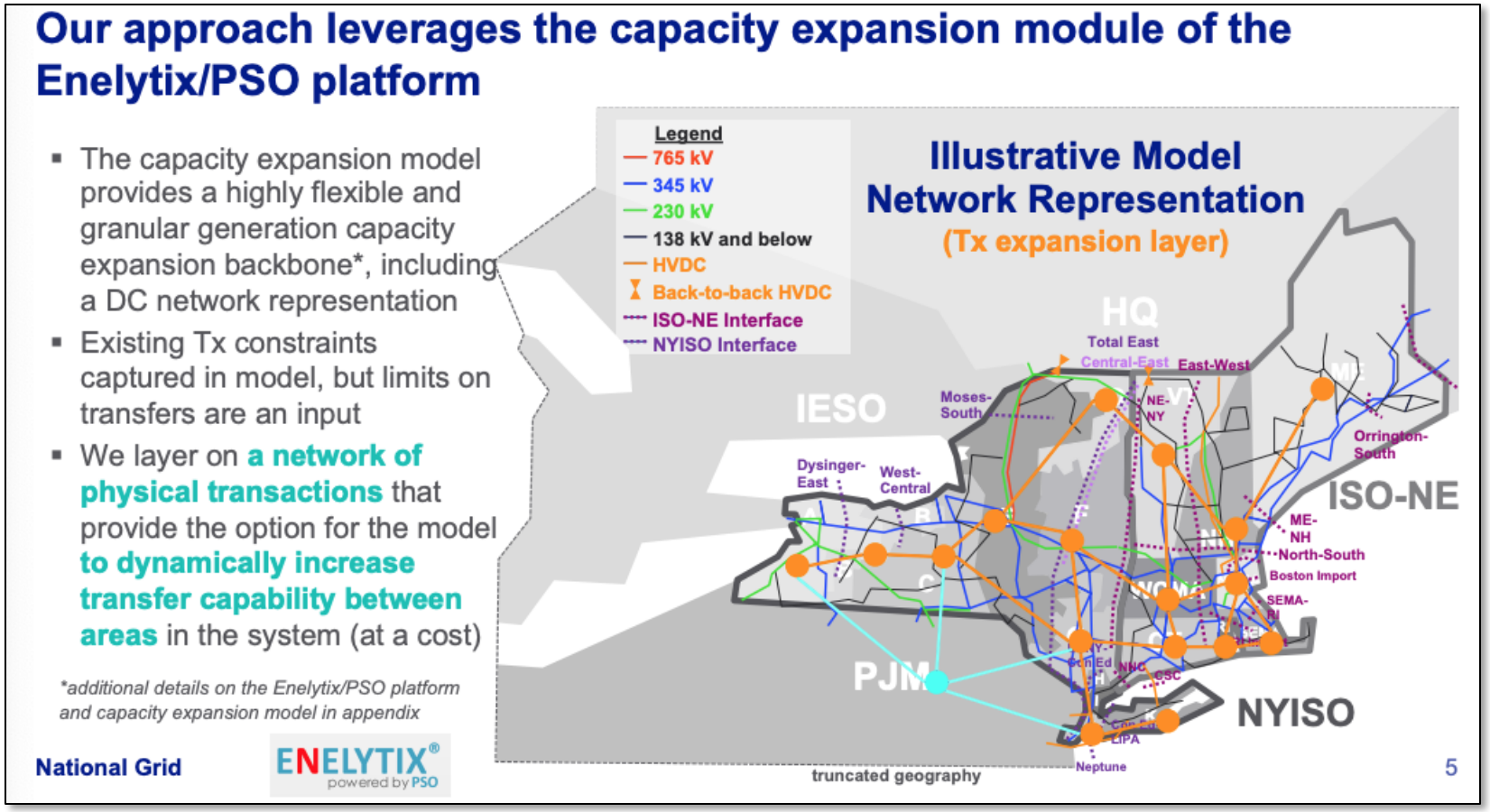


[Pacificorp, 2021 IRP Volume 1, 9/15/21]

National Grid finds that nodal capacity expansion modeling gives you better answers

How much generation and what generation you build depends on what you assume when you model transmission.

The answer changes significantly if you don't include transmission constraints. Or if you don't co-optimize generation and transmission expansion.

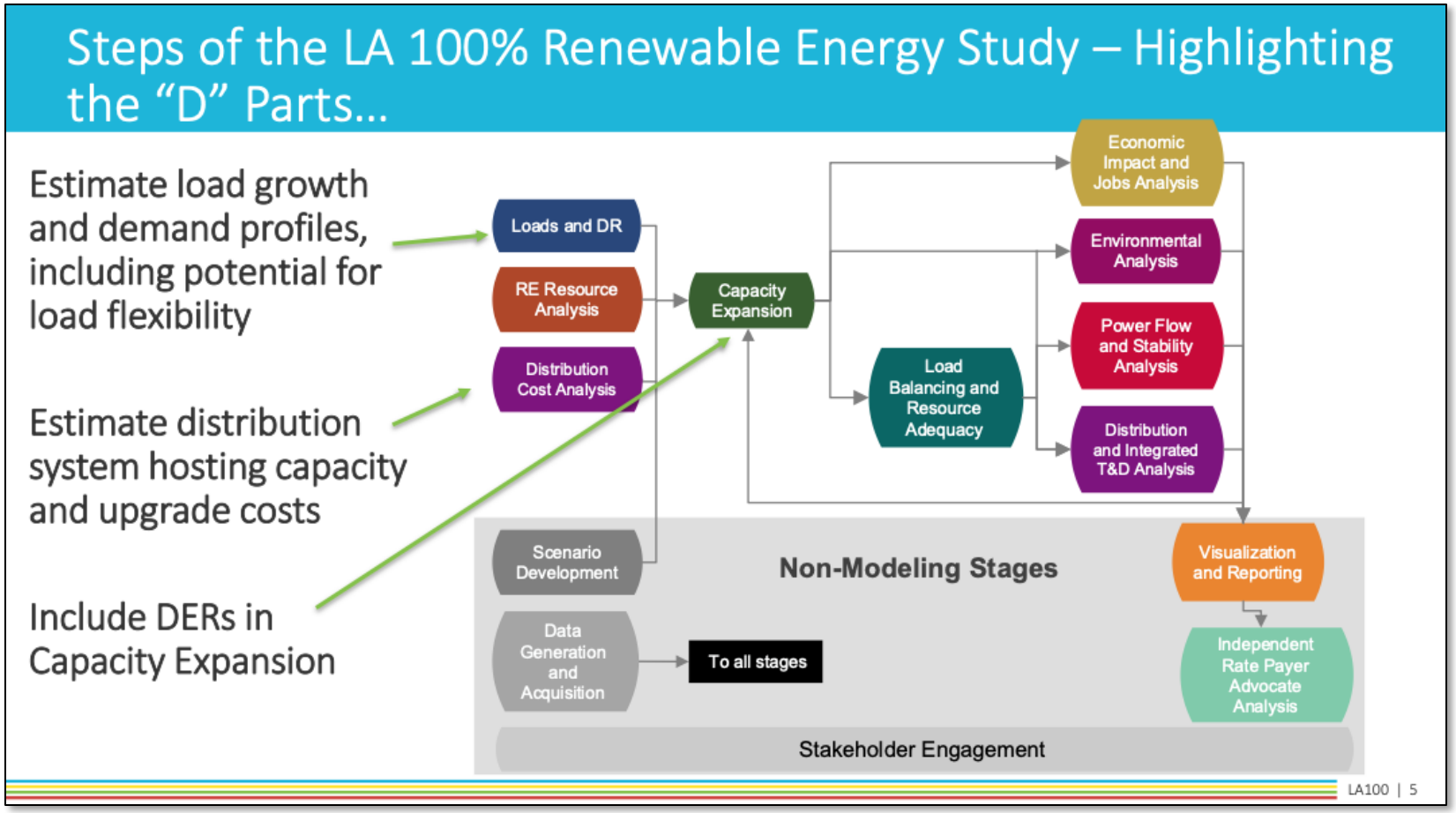


Kai Van Horn, National Grid, ESIG Fall Workshop 10/25/22

NREL examines loads, distribution system constraints, and DERS as a resource

LA100 includes detailed bottom-up analysis of loads including electrification, customer adoption models for rooftop solar and storage, distribution grid upgrades.

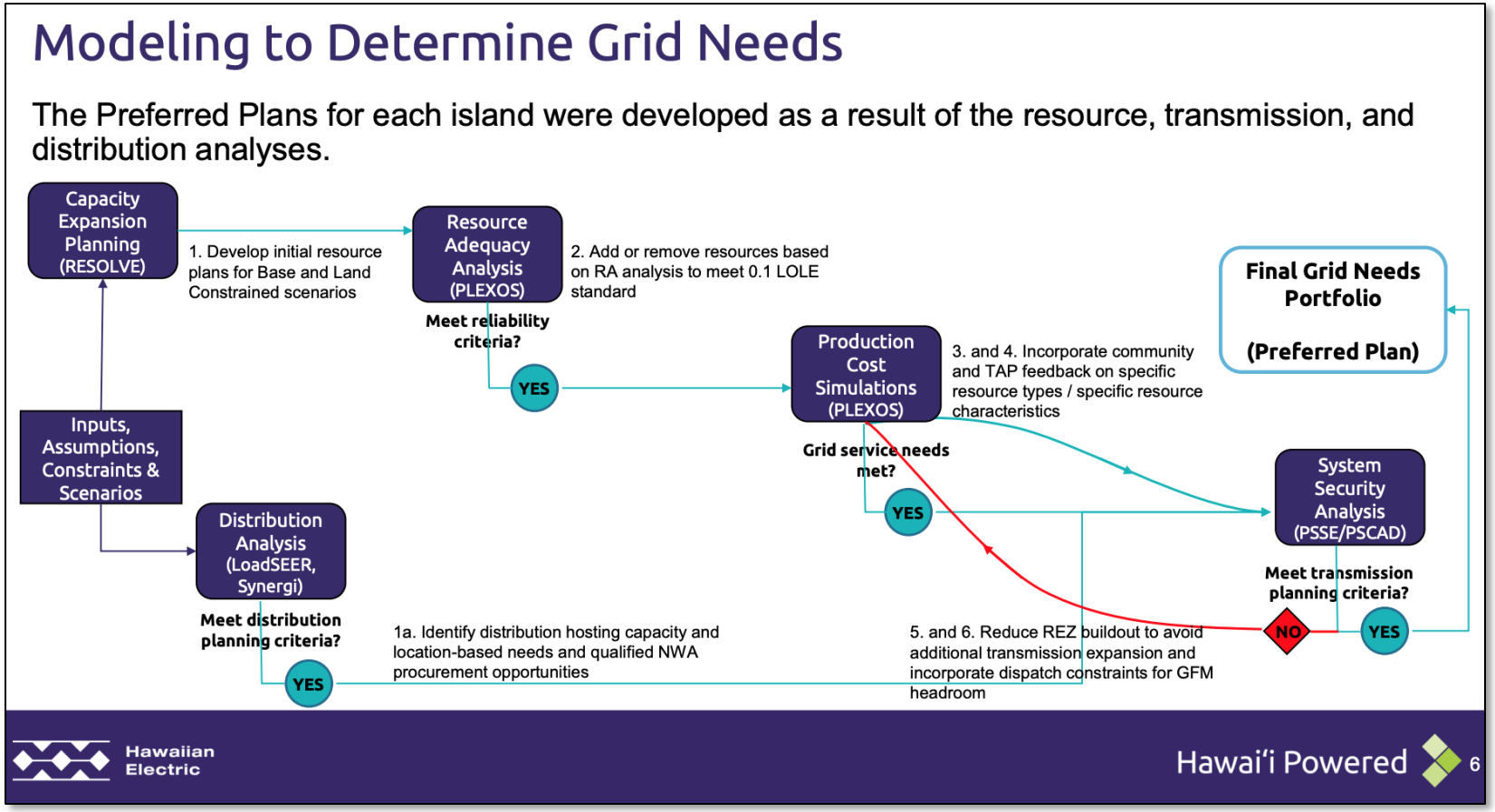
It also includes DERs as a solution in resource planning.



P. Denholm, NREL, ESIG Fall Workshop, Oct 21, 2024

HECO's integrated economic and reliability assessments address stability issues holistically

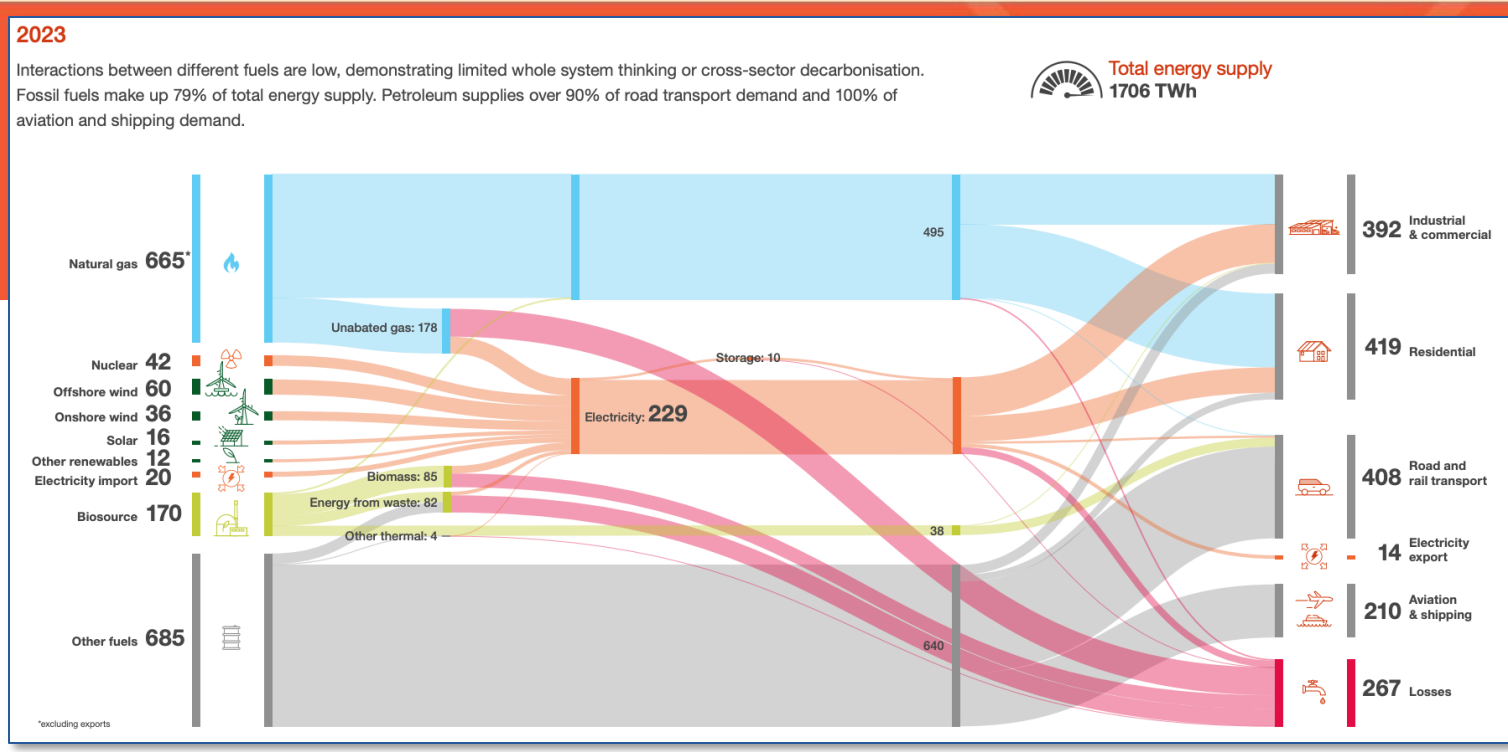
The Integrated Grid Plan harmonizes generation, transmission and distribution planning. Includes NWA, grid mod, stability, hosting capacity. Transmission and security analysis examines the role of grid-forming battery energy storage in maintaining stability with high levels of inverter-based resources (wind/solar/battery).

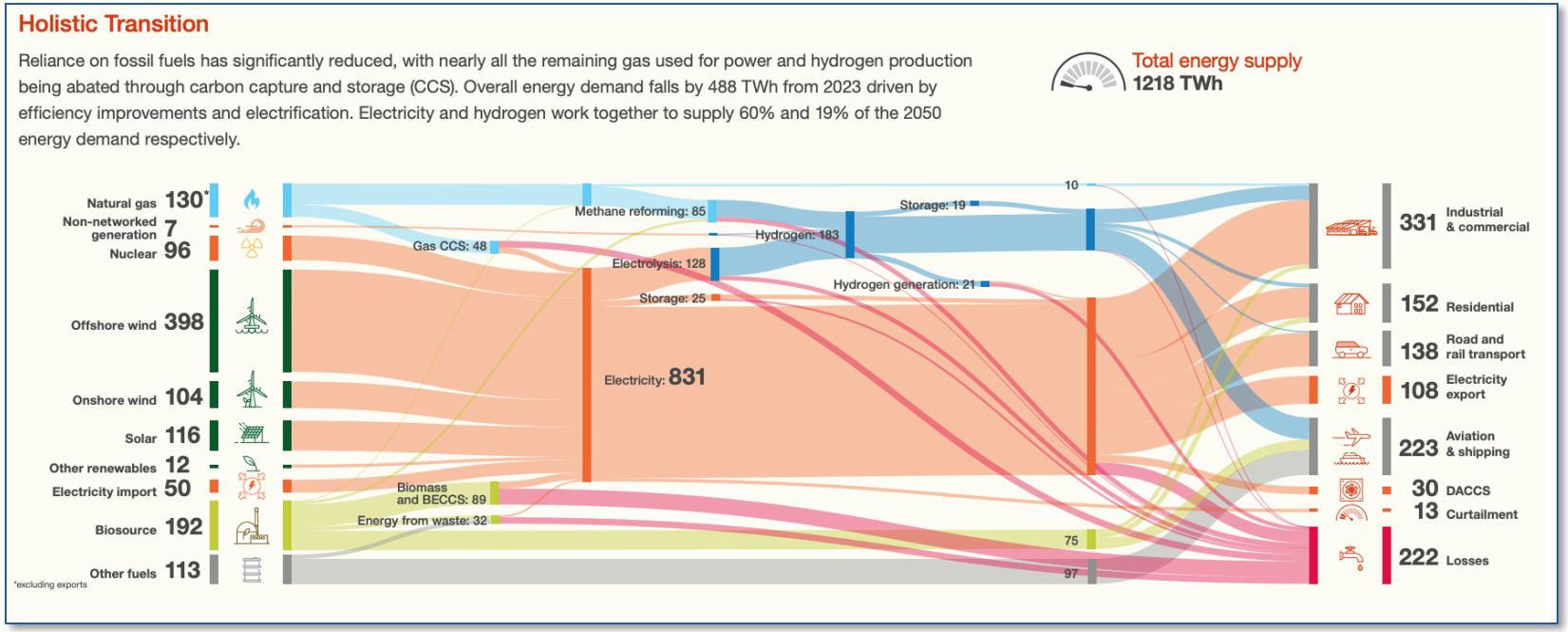


K. Aramaki, HECO, ESIG Fall Workshop, 10/23/24

NESO integrates across the energy economy

Future Energy Scenarios examine gas, hydrogen, CCS, BECCS, and demand flexibility





NESO, Future Energy Scenarios, July 2024

ESIG resources

- Integrated Planning Workshop 2024 – first session focuses on integrating RTO study processes across economic and reliability tools; second session focuses on vertically-integrated utilities integrating across the dimensions of generation, transmission, distribution and customer/DERs.
  - Presentations https://www.esig.energy/event/2024-fall-technical-workshop/
  - Videos https://youtu.be/QT9nB7eYFdU?si=2TTQIFrXRfO7nGnd
- System Expansion Modeling Workshop 2024 – how do capacity expansion models or processes need to evolve to consider holistic planning across generation, transmission, distribution and customer/DERs?
  - Presentations https://www.esig.energy/integrated-planning-forum/
  - Videos https://youtu.be/mlRwTK6uOiA?si=OsjXgGgNTXeF66I3
- Integrated generation and transmission planning 2022 – co-optimizing generation and transmission in capacity expansion models. Summary of tools, summary of workshop, videos of tool capabilities can be found at:
  - https://www.esig.energy/capacity-expansion-modeling-for-transmission-planning/

Tools have significant capabilities that are often under-utilized

ESIG held a workshop in 2022 on integration of generation and transmission: looking at the capabilities of capacity expansion models and found that there were many capabilities that users didn't know about or utilize.

Category	Co-optimizations
NREL ReEDS	• Generation, transmission, storage and reserves for bulk power system.
EPRI US REGEN	• Generation, transmission, storage and reserves for bulk power system. • Fuel production/conversion, gas/CO2/H2 pipeline expansions and flows. • Also includes 8760 hour end-use demand module which is run in iteration with the energy production model to convergence.
Optimal Capacity Expansion Planning Model v2	• Generation, transmission, storage, and reserves for bulk power system • Adjacent energy infrastructure (e.g., hydrogen production, transport and storage).
EnCompass v6.2	• Generation, transmission, storage and reserves, and environmental policies for bulk power system.
CGT-Plan (Expansion Planning Modeling System EPMS)	• Generation, transmission, storage and DERs. • DERs are modeled using a single three-segment, three-bus feeder at each load bus. • Each feeder bus represents rooftop solar, microturbines, energy efficiency and DR which can be selected.
RESOLVE v2.0 (beta)	• Generation, transmission, storage and reserves for bulk power system. • Includes electrolyzer operations.
Aurora v14.2	• Generation, transmission, storage and reserves for bulk power system.
PLEXOS v9.1	• Generation, transmission, storage and reserves for bulk power system. • Adjacent energy infrastructure (e.g., hydrogen, natural gas, heat, water).
Power System Optimizer 3.1 / ENELYTIX	• Generation, transmission, storage and reserves for bulk power system. • Adjacent energy infrastructure, fuel networks, fuel storage and fuel supply and conversions. (methane, hydrogen, heat, water) • Co-optimized expansion of generation, transmission, storage (including impact of duration (MWh vs MW), fuel systems (including impacts of reliability on capacity expansion)

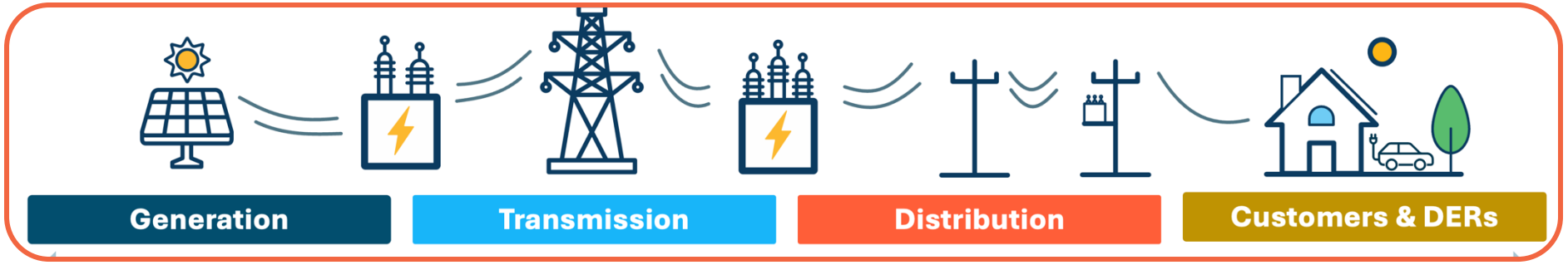
https://www.esig.energy/wp-content/uploads/2022/10/ESIG-CEM-Developer-Survey-Summary-Table.pdf

Integrated Planning Modules

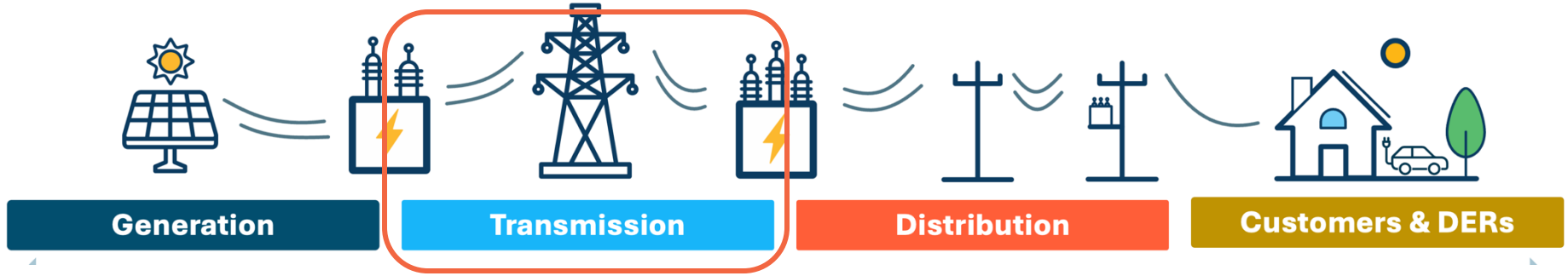
- Focus is on generation, transmission, distribution and customer load/DERs.
- Not focusing on gas-electric coordination or hydrogen or other energy sectors beyond electrification of heating/transport.
- Schedule
  - Feb 13 – Integrated Planning for Different Types of Entities
  - Feb 20 – System Expansion Modeling: Considering transmission and distribution in capacity expansion modeling
  - Mar 6 – Tools, Data and Processes for Integrated Planning

Integrated planning is different depending on what type of entity you are

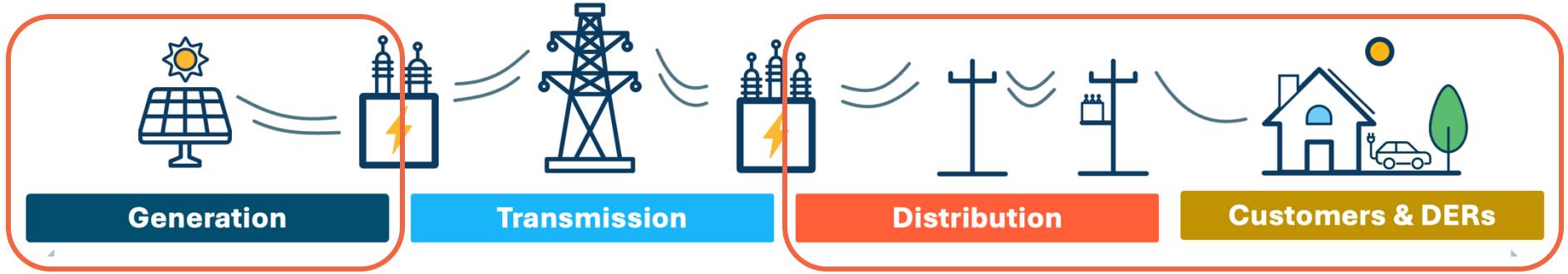
Vertically integrated utility



RTO/ISO



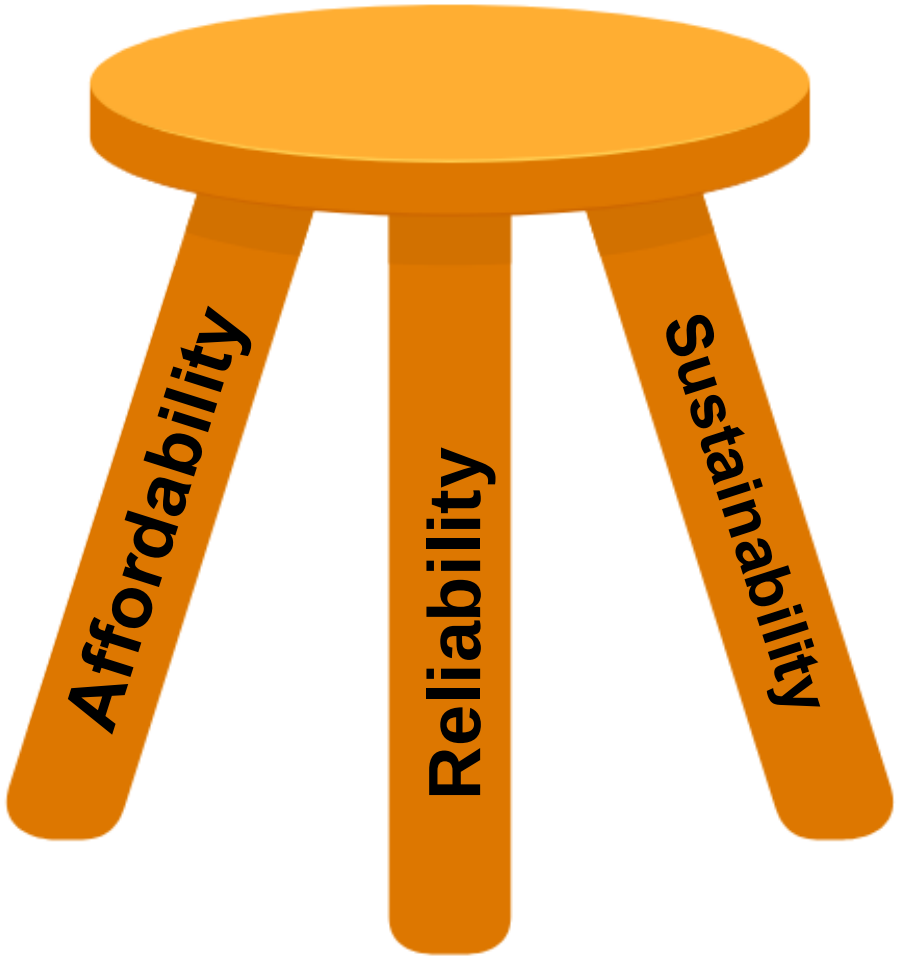
Distribution cooperative



Integrated planning is different depending on what type of entity you are

Single-state entity

Multi-state entity with differing policy goals



Today's speakers

Feb 13 – Integrated Planning for Different Types of Entities

- 2:30p-3pm ET Integrated Planning in a Vertically-Integrated Utility – Xcel's Grid of the Future
  - **Zach Pollock**, Director of Grid Strategy and Emerging Technology, and **Brenda McDermott**, Sr. Director of Integrated Distribution System Planning and Strategy, Xcel Energy
- 3-3:30pm ET Integrated Planning in a Single-state ISO – CAISO's transmission plan
  - **Neil Millar**, VP of Infrastructure and Operations Planning, CAISO
- 3:30-4pm ET Integrated Planning in a Multi-state ISO – MISO's Renewables Integration Impact Assessment and futures work
  - **Jordan Bakke**, Director of Strategic Insights and Assessments, MISO
- 4-4:30pm ET Breakout rooms with each speaker
- 4:30pm ET Adjourn

THANK YOU

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