

Capacity Expansion Modeling and Transmission Planning – the E3 Experience

ESIG Webinar

October 24, 2022



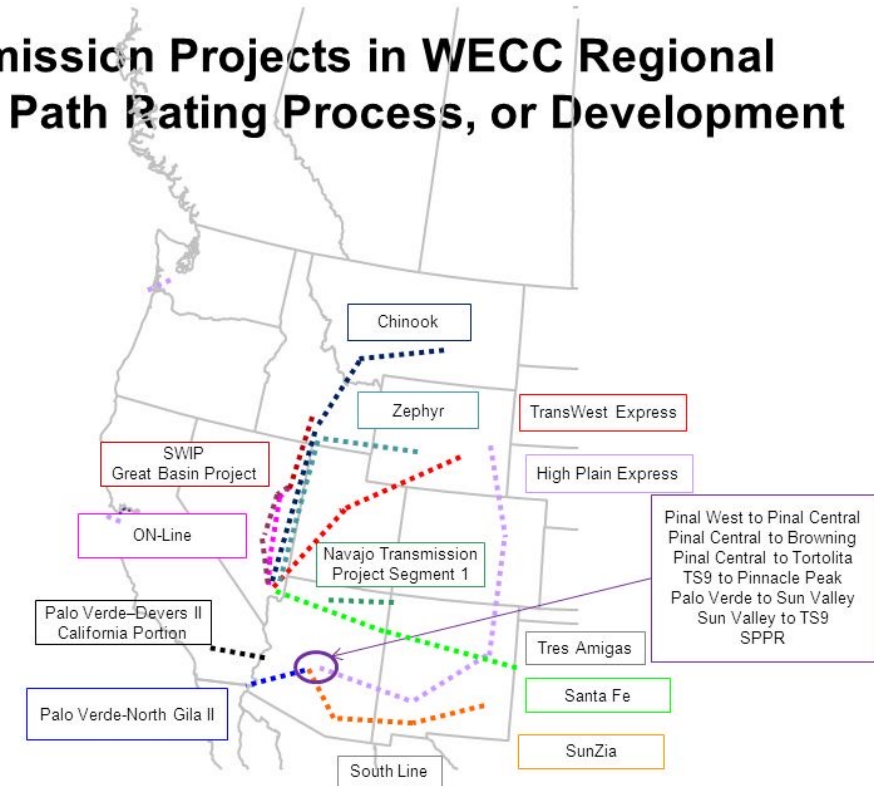
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Arne Olson, Senior Partner

Long-line transmission planning in the West: a condensed history

- + **1950s-1980s: regional projects built through multilateral agreement to connect remote resources to loads and interconnect large regions**
 - Large hydro and mine-mouth coal
- + **1990s-2000s: gas as marginal resource shifted regional action to gas pipeline expansion**
- + **2000s-2010s: Many clean energy-based projects proposed – and many abandoned**
 - Frontier Line, BC-NW-CA, Chinook, Zephyr, High Plains Express
 - Mostly designed to bring wind to the coast
- + **Early 2010s: regional transmission planning institutionalized first through WECC/TEPPC then Regional Entities**

Transmission Projects in WECC Regional Planning, Path Rating Process, or Development



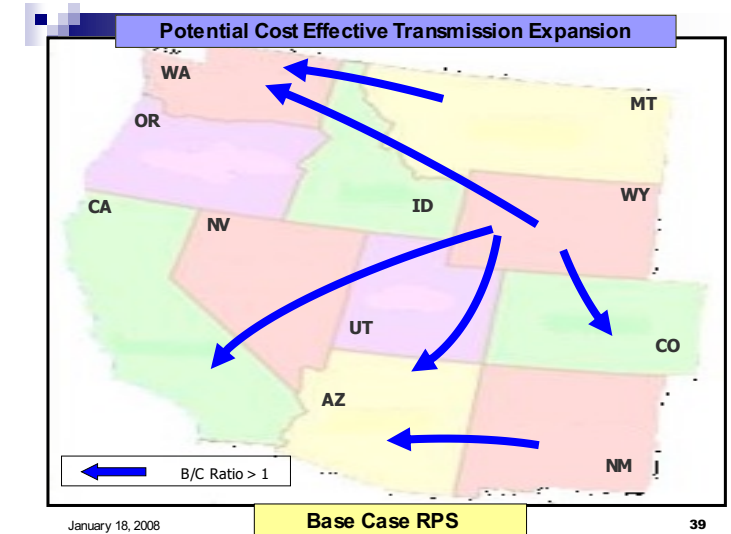
TEPPC 11-19-09

SWAT Summary - R. Kondziolka

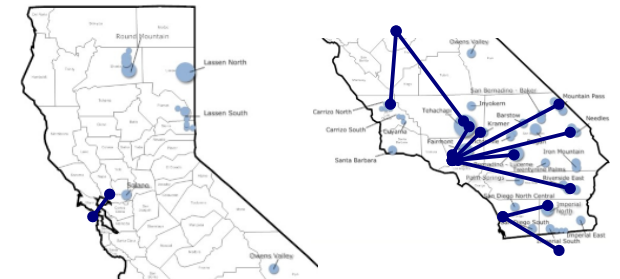
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Evolution of E3 transmission planning models

- + Sunrise Powerlink (2006): Spreadsheet model evaluating benefits of delivering renewable energy and RA capacity from Imperial Valley to San Diego
- + WEIL Group Towards 2020 (2007): West-wide spreadsheet model comparing clean energy supply curves across multiple regions
- + CPUC RPS Calculator (2009-2018): West-side spreadsheet model comparing clean energy supply curves for delivery to California
- + RESOLVE (2015-present): Zonal capacity expansion model with renewable energy zones



New Transmission Required for 33% RPS Reference Case



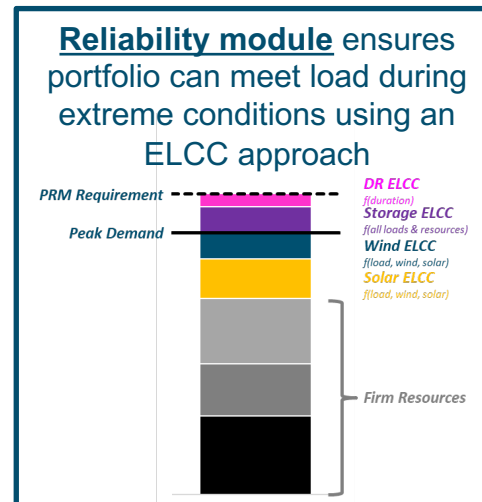
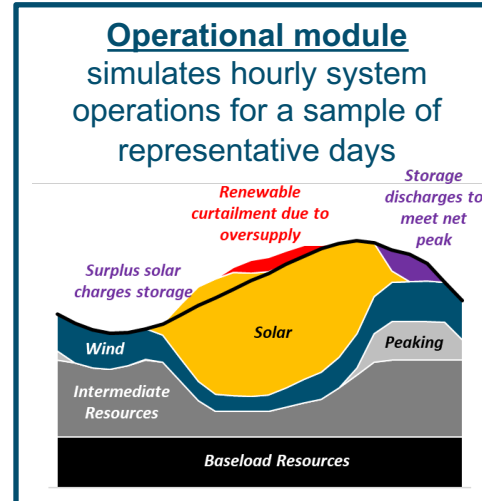
RESOLVE

Proactive capacity expansion to meet decarbonization goals

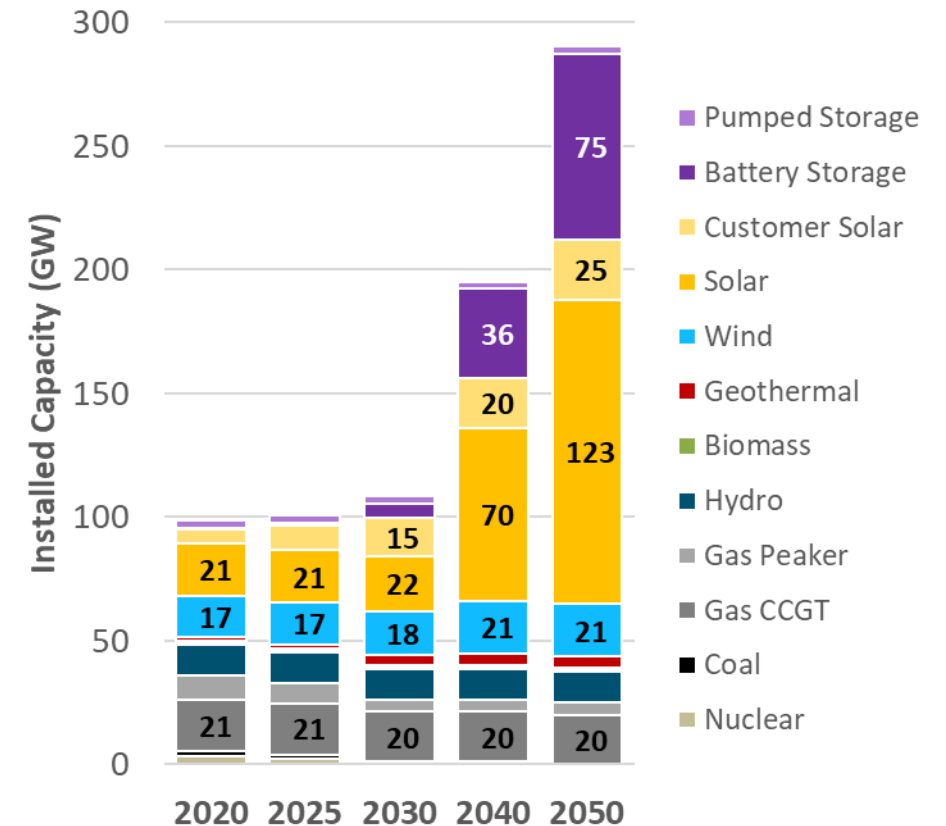
+ **RESOLVE** grew out of E3's work on California's RPS Calculator to support generation portfolio plans to inform transmission needs

+ **Zonal optimization** co-optimizes investments and operations to minimize total net present value (NPV) of electric system costs

- Portfolios are designed to meet planning constraints (RPS, emissions, resource adequacy)
- Investments are made with perfect foresight, proactively expanding generation & transmission at least-cost over modeling horizon



Least-cost plan co-optimizes investments and operations to meet clean energy policy targets, selecting from a diverse set of potential resources including wind, solar, storage, DSM, and natural gas



Example RESOLVE result from [Long-Run Resource Adequacy under Deep Decarbonization Pathways for California](#) (Calpine, 2019)

Using RESOLVE to support CPUC IRP and CAISO TPP

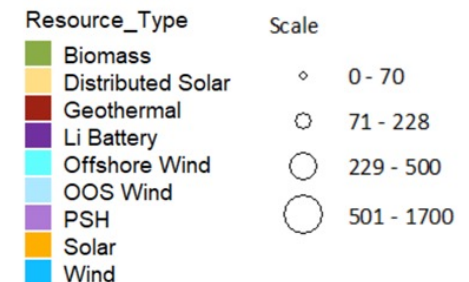
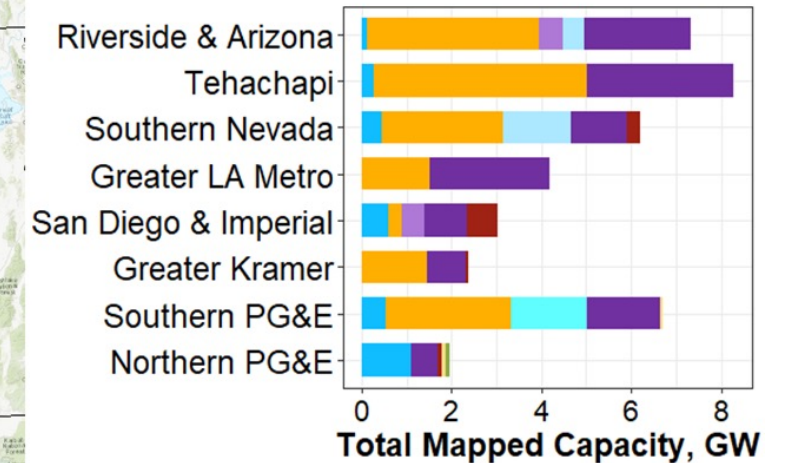
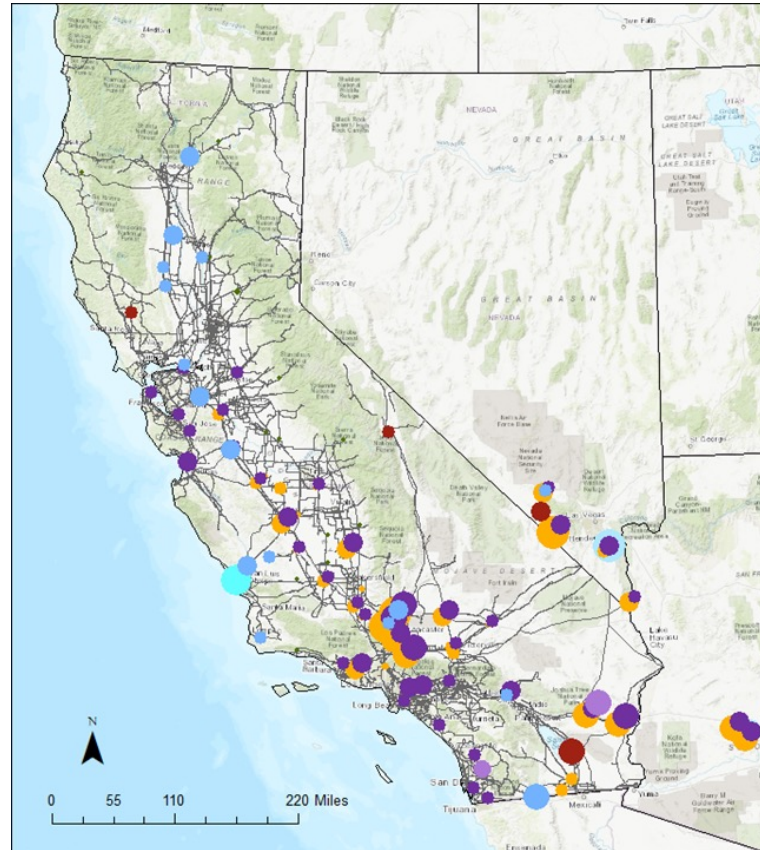
+ E3's RESOLVE model for California Public Utilities Commission uses the **cost adder** approach to capture transmission costs

- Cost adders are provided by CAISO to capture tx upgrade costs **beyond the available tx capacity**

+ CPUC IRP RESOLVE builds resource portfolio and feeds back into the CAISO's Transmission Planning Process (TPP):

- Busbar mapping** analysis maps RESOLVE's zonal resource build decisions to CAISO transmission busbars
- TPP identifies and approves transmission investments to support the generation portfolio

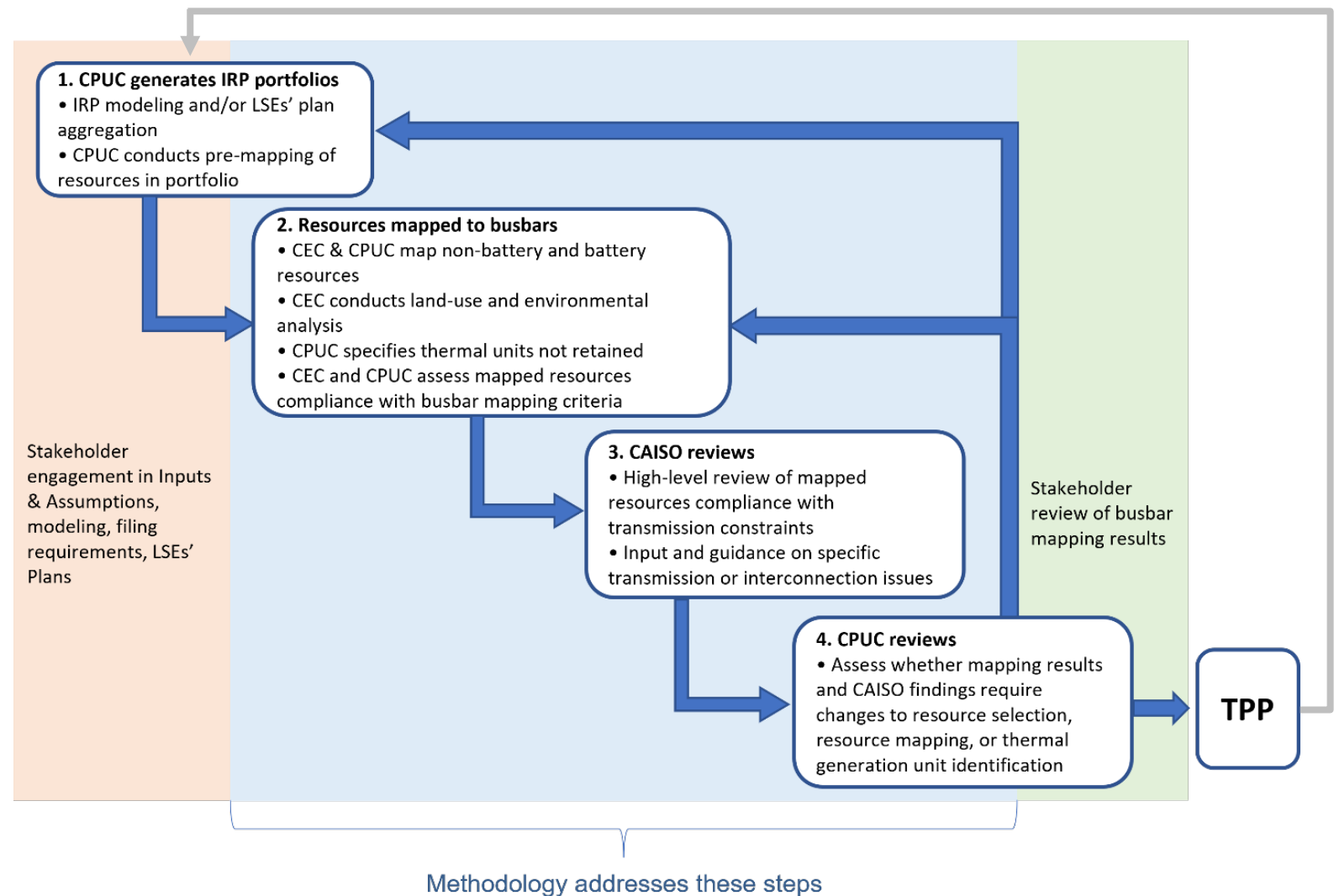
+ Generation & transmission plans from previous IRP cycles are seeded as inputs to next IRP cycle



Role of Busbar Mapping in IRP and TPP

+ **Busbar Mapping refines geographically coarse portfolios developed through IRP to specific interconnection locations (i.e. substations) for analysis in the CAISO's annual Transmission Planning Process (TPP).**

- Conducted by working group comprised of CPUC, CEC, and CAISO staff
- Busbar allocations should generally represent the expected outcome of LSE procurement activity in response to the three key elements
- The allocations should strive to minimize transmission congestion by respecting transmission constraint limits
- Process should result in IRP portfolios that minimize post-processing in the CAISO's TPP analysis
- Consistency with prior years' mapping results for equivalent TPP cases



Challenges with using capacity expansion models to co-optimize generation and transmission planning

1. **Imprecision** – capacity expansion models typically require simplification of operations and network topology
 - Simulate a vast range of operating and investment decisions over many years
2. **Uncertainty** – value streams are subject to a significant uncertainty and risk as key value drivers change over very long lifetimes
 - Sensitivity analysis is needed to understand when the optimal solution might be wrong
3. **Agency** – transmission and generation decisions are made at different times, by different entities, in different processes
 - Modeling needs to be designed to inform key decisions

Where do we go from here?

1. Develop forward-looking transmission planning processes that identify beneficial projects far ahead of actual need

- Use capacity expansion modeling to identify solutions that are **robust under a range of uncertainties**
- Scenario based load projections
- Incorporate land use into resource supply
- Supplement with production simulation, power flow & LOLP models to identify full range of potential project benefits

2. Focus is to inform **transmission**

- *“If you build it, he will come...”*



Thank You

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