



Interconnection past, present, future

Rob Gramlich
ESIG October 2023

Queues are another form of congestion

- Intra-regional congestion →
- Inter-regional congestion ↘

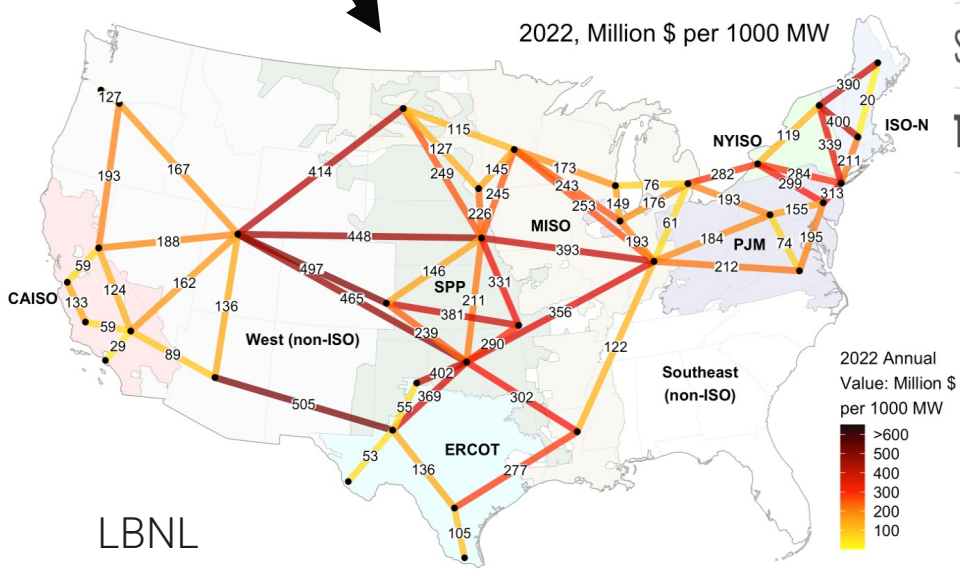


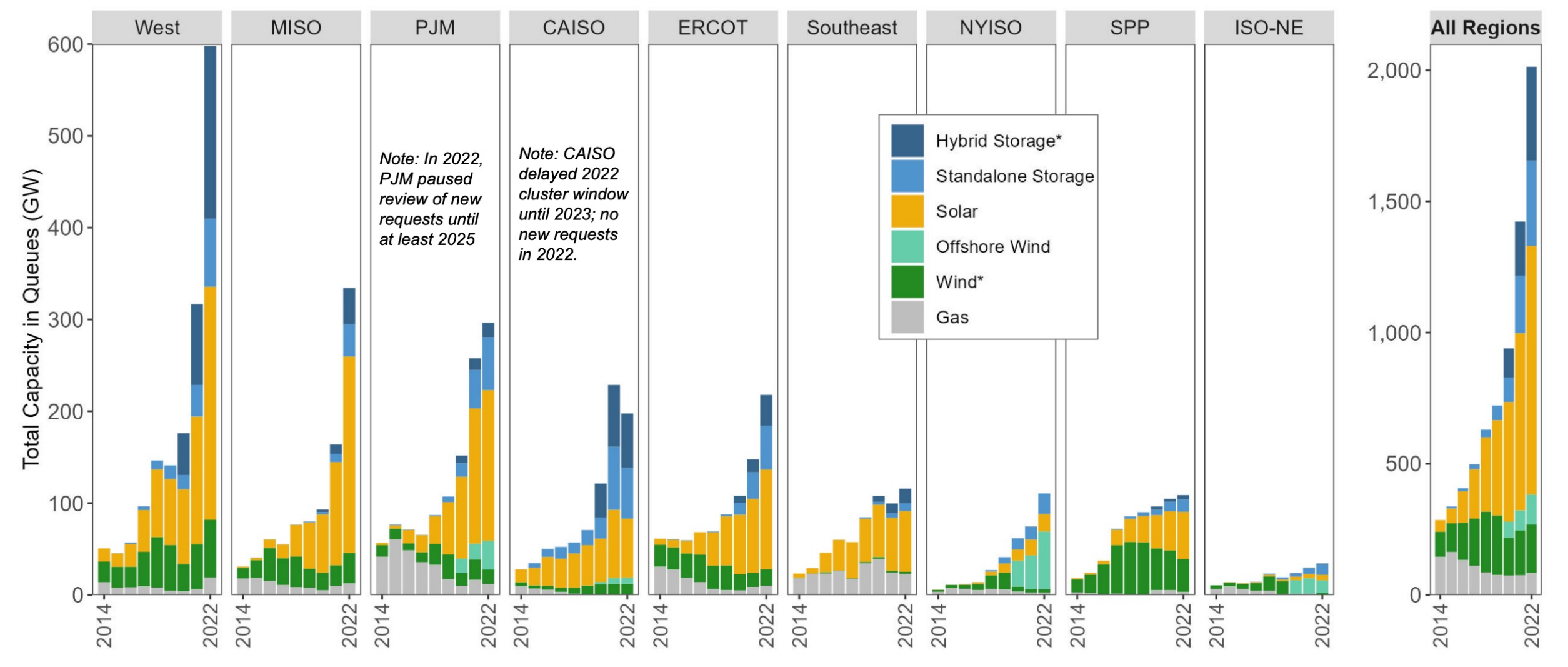
TABLE 1. Total Transmission Congestion Costs (\$ millions) for RTOs from 2016-2022

RTO	2016	2017	2018	2019	2020	2021	2022
ERCOT	497	976	1,260	1,260	1,400	2,100	2,800
ISO-NE	39	41	65	33	29	50	51
MISO	1,402	1,518	1,409	934	1,181	2,849	3,700
NYISO ²	529	481	596	433	297	551	1,000
PJM	1,024	698	1,310	583	529	995	2,500
SPP	280	500	450	457	442	1,200	2,000
TOTAL	3,771	4,214	5,090	3,700	3,878	7,745	12,051

https://gridstrategiesllc.com/wp-content/uploads/2023/07/GS_Transmission-Congestion-Costs-in-the-U.S.-RTOs1.pdf

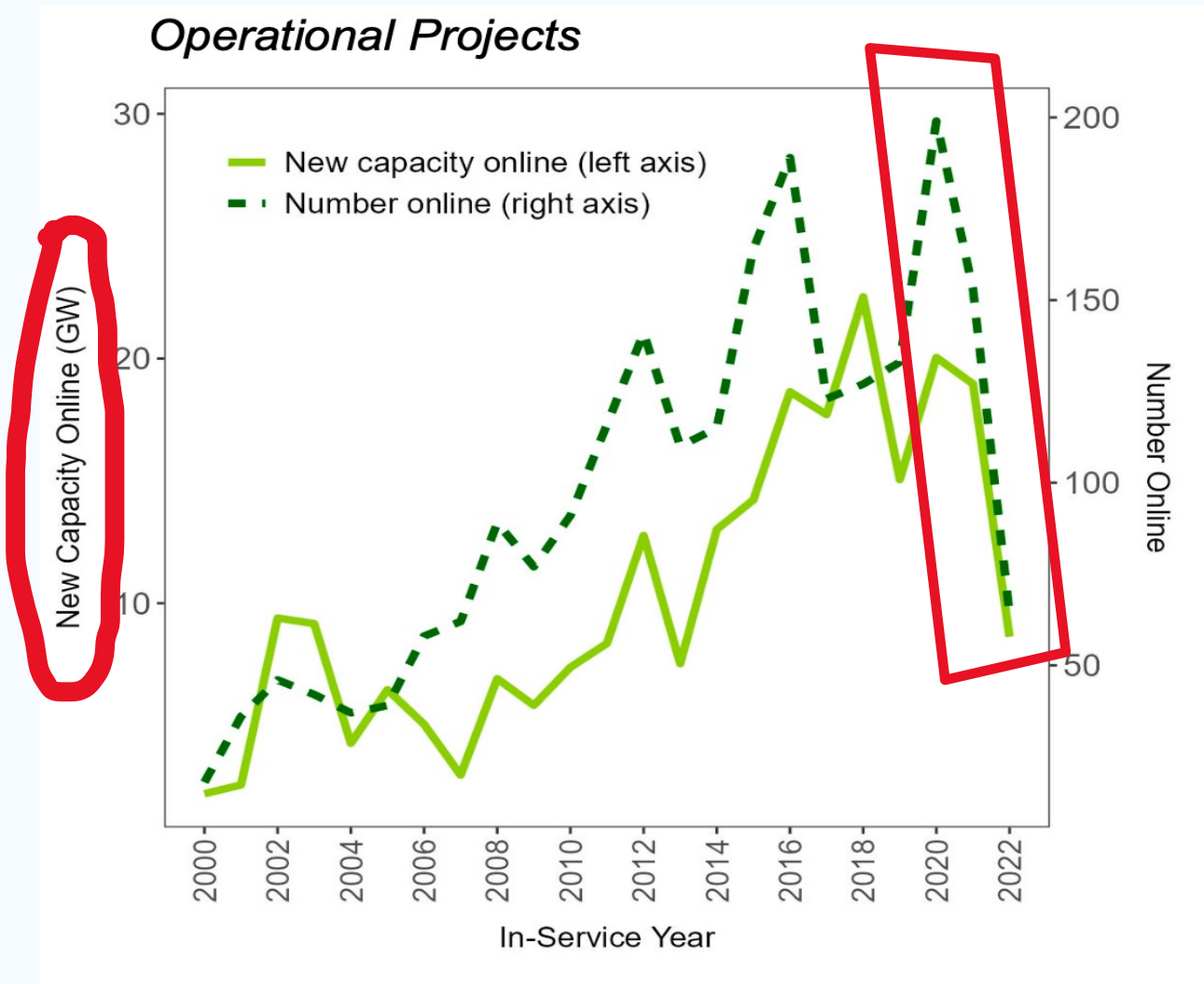
Generator Interconnection Requests Ballooning

Limited transmission capacity slows interconnection



Which Metric Matters Most?

(On what should transmission providers focus?)



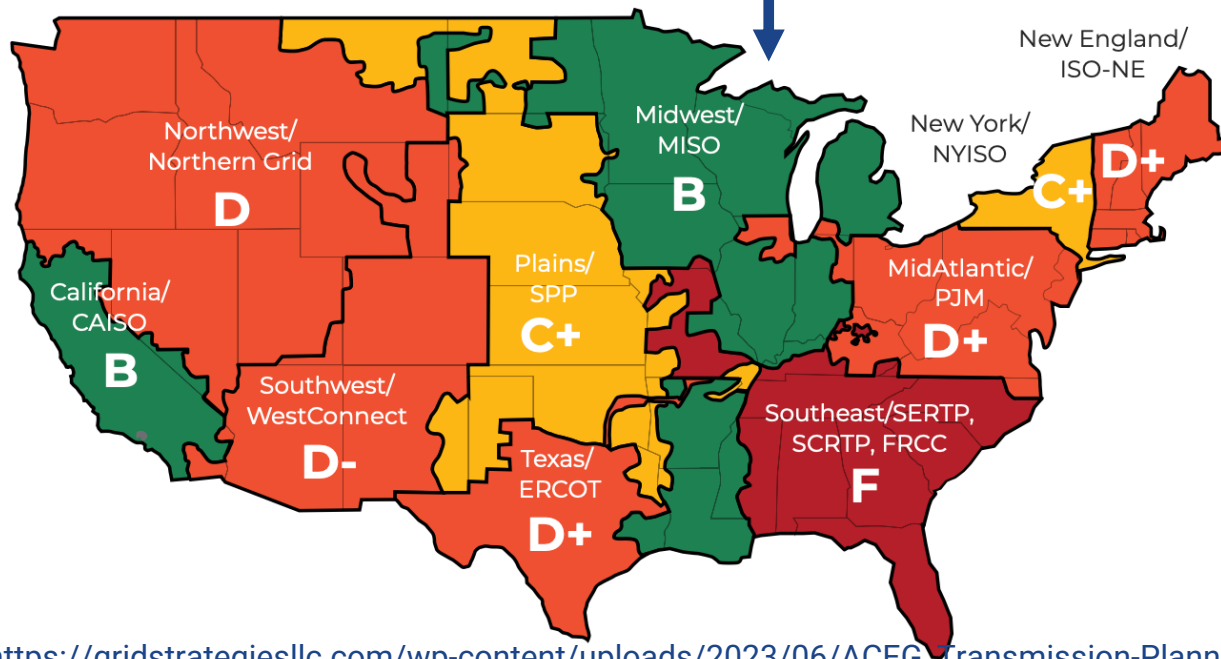
- **New Capacity Online (GW)** is arguably more important than completion rate, GWs in queue, GW added, or GW withdrawn.
- Unfortunately, New Capacity Online fell precipitously 2020-2022 to below 10 GW/year.
- CA alone needs 7 new GW/year.

https://emp.lbl.gov/sites/default/files/queued_up_2022_04-06-2023.pdf

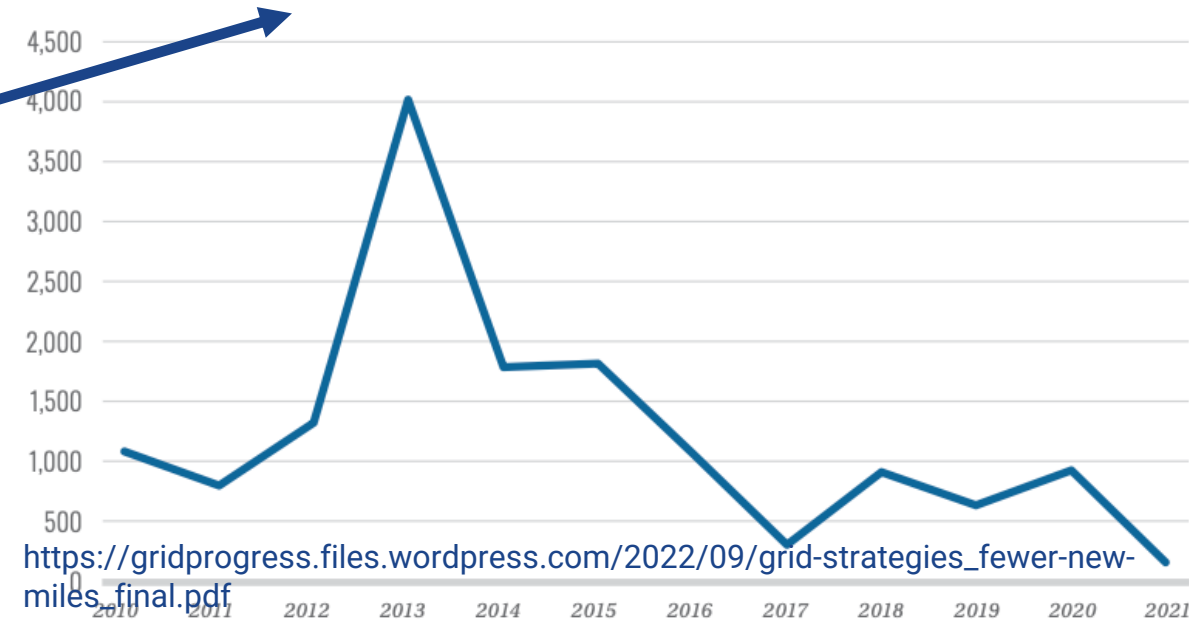
slide 17

Source of congestion and queue logjams: We have not been building for a decade

- Miles of new transmission on pace in 2013, then fell back to a trickle
- Most regions failing to plan for future resource mix



MILES OF 345 KV + TRANSMISSION LINES ADDED EACH YEAR



Planning practice improvements needed

TABLE 2. PLANNING AUTHORITIES CURRENT USE OF EFFICIENT PRACTICES

	Proactive Generation & Load	Multi- Value	Scenario- Based	Portfolio- Based ³⁰	Joint Interregional Planning
ISO-NE ³¹	×	×	×	✓	×
NYISO ^{32,33} – PPTPP only	×	×	×	×	×
PJM ^{34,35}	×	×	×	×	×
Florida	×	×	×	×	×
Southeastern Regional	×	×	×	×	×
South Carolina Regional	×	×	×	×	×
MISO (excl. MVP, RIIA) ³⁶	×	×	×	×	×
SPP (ITP) ^{37,38}	×	✓	×	✓	×
CAISO ^{39,40} – TEAM only	✓	×	✓	×	✓
WestConnect	×	×	×	×	×
NorthernGrid ⁴¹	×	×	×	×	×

Transmission
planning
best
practices

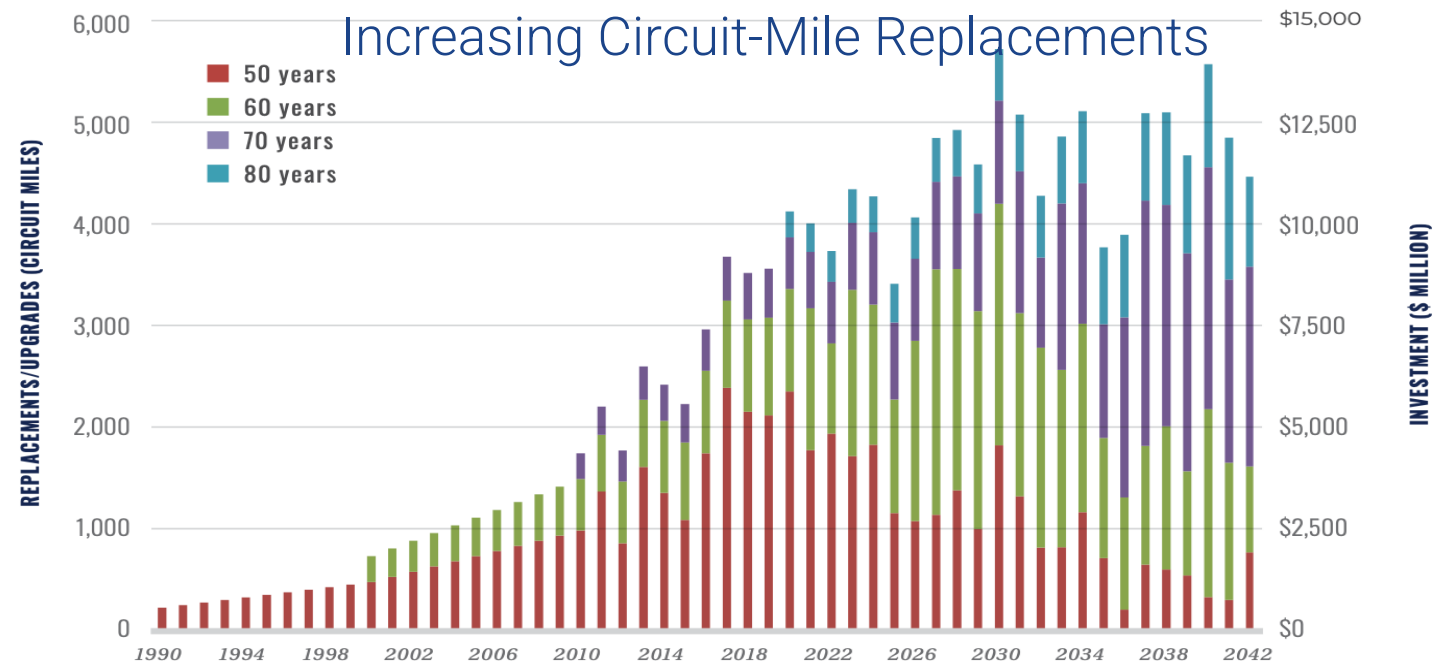
First, Get the Most Out of the Existing Grid

Grid-Enhancing Technologies

- Power Flow Control
- Dynamic Line Ratings
- Topology Optimization

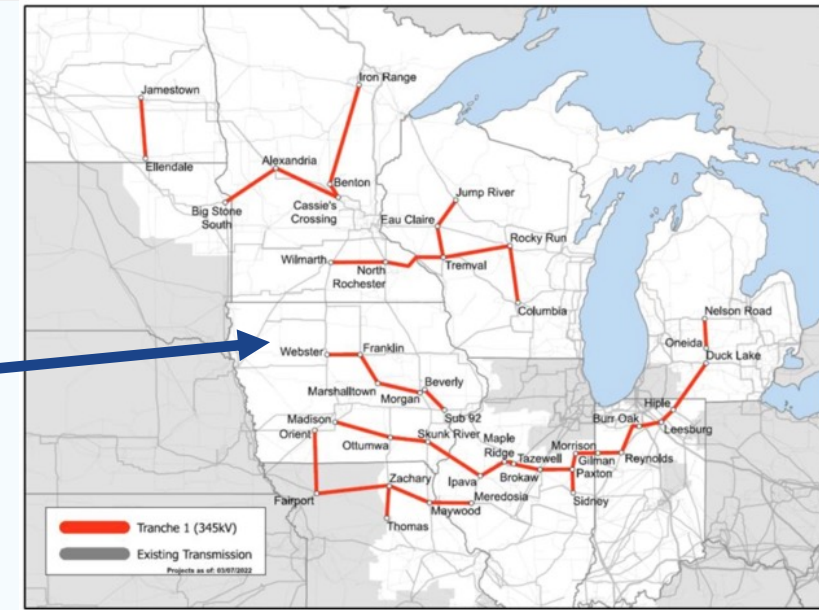
High-Performance Conductors

- Replace aging wires
 - Composite core
 - Superconductors

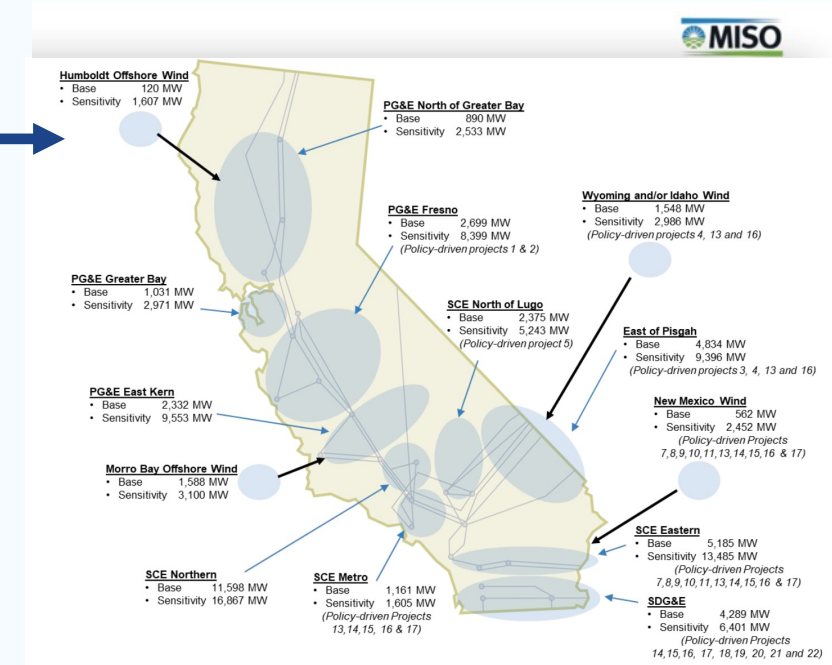


Good recent plans

- MISO Long Range Transmission Plan
- 53 GW of new renewables
- ~\$10 billion



- California ISO 2022-23 Transmission Plan
 - 4-7 GW of new power needed annually through 2032
 - 4.8 GW of out-of-state wind needed—helps resource adequacy
 - 45 projects
 - \$7.3 billion



Interconnection approaches

1990s-2020s

- Pre 2003
 - Non-standard terms and conditions, frequent litigation, opaque, time-consuming
 - Vertical market power concerns (use transmission to favor own generation)
- 2003-2008
 - Order 2003 (2003): standard terms and conditions
 - Large Generator Interconnection Procedures (LGIP), Large Generator Interconnection Agreements (LGIA)
 - Sequential, first-come, first-served.
 - Allows participant-funding in ISO/RTO areas
 - Worked fine for fewer, large plants placed on strong parts of the network.
 - Many smaller and geographically distributed wind plants entered 2005-8, enlarging queues.
 - Order 661 (2005): Interconnection for wind generators

Interconnection approaches

1990s-2020s, cont'd

- 2008, 2012 Reforms
 - Two rounds of FERC- and RTO-led ratcheting up requirements on generators—site control, deposits, etc.
 - Massive growth of smaller and widely distributed solar, storage, and wind plants 2018-23.
- 2018 Order 845
 - Greater flexibility on types of interconnection service.
 - Added transparency

Present day

Order 2023 (2023)

- Cluster approach to reduce needed studies and re-studies
 - Commercial readiness--financial deposits and site control
 - Withdrawal penalties
- Speed: transmission provider enforceable deadlines.
- Technology updates
 - Co-location allowed
 - More realistic modeling assumptions re storage
 - Consider alternative transmission technologies
- Grid code: inverter-based resource ride-through standard

Further reforms

General directions

- Limit scope to shallow network impacts (Prepare, connect, and manage)
 - Less focus on deep network upgrades which necessarily benefit many others
 - Plan the network through the planning process, not the interconnection process
- Integrate interconnection with separate processes:
 - Transmission planning
 - Resource adequacy
 - Resource procurement

Further reforms

Specific changes

- **Flexibility**—more options
 - Advanced technologies
 - Energy-only service aligned with expected usage
 - Transfer of rights
 - Curtailment and redispatch options
- **Certainty**—take the guessing out
 - Post the price (see Jacob Mays)
 - Adherence to estimates & schedules
- **Rationing** and prioritizing
 - First-ready/first-served readiness factors, well-designed auction.
- **Transparency**
- **Study assumptions**
- **Automation**



- **SO MANY PROJECTS!** How are scarce processing and physical capacity resources rationed? Lessons from economics:
 - Price-based, eg, auction
 - Non-price
 - First come, first-served, waiting lists
 - Coupons
 - Quotas
 - Assessment of need

Zonal approach

“Central to the proposal is the zonal approach, which encourages interconnections in transmission zones with available and approved transmission capacity.” –CAISO Track 2 Straw Proposal September 2023

- Pro-actively plan transmission to certain zones
- CPUC direct procurement to those zones
- Align zones with resource adequacy needs and capacity market
- Capacity procurement, capacity prices, zonal energy prices influence generators’ choice of zone
- Generators that connect outside of designated zones are slower and more expensive. (“Option B”)
- Auction zonal capacity—for the right to connect, or the right to be studied.
- Greater certainty for generators on time and cost

<https://gridprogress.files.wordpress.com/2021/12/resolving-interconnection-queue-logjams-lessons-for-caiso-from-the-us-and-abroad-1.pdf>,
<https://www.caiso.com/InitiativeDocuments/Straw-Proposal-Interconnecton-Process-Enhancements-2023-Sep212023.pdf>

