Grid Strategies

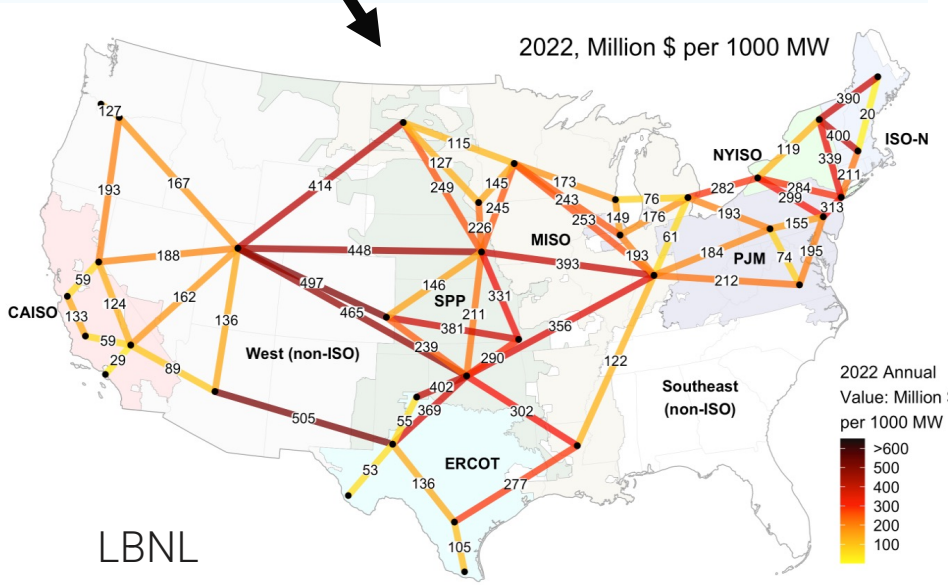
Interconnection past, present, future

Rob Gramlich

ESIG October 2023

Queues are another form of congestion

- Intra-regional congestion
- Inter-regional congestion



LBNL

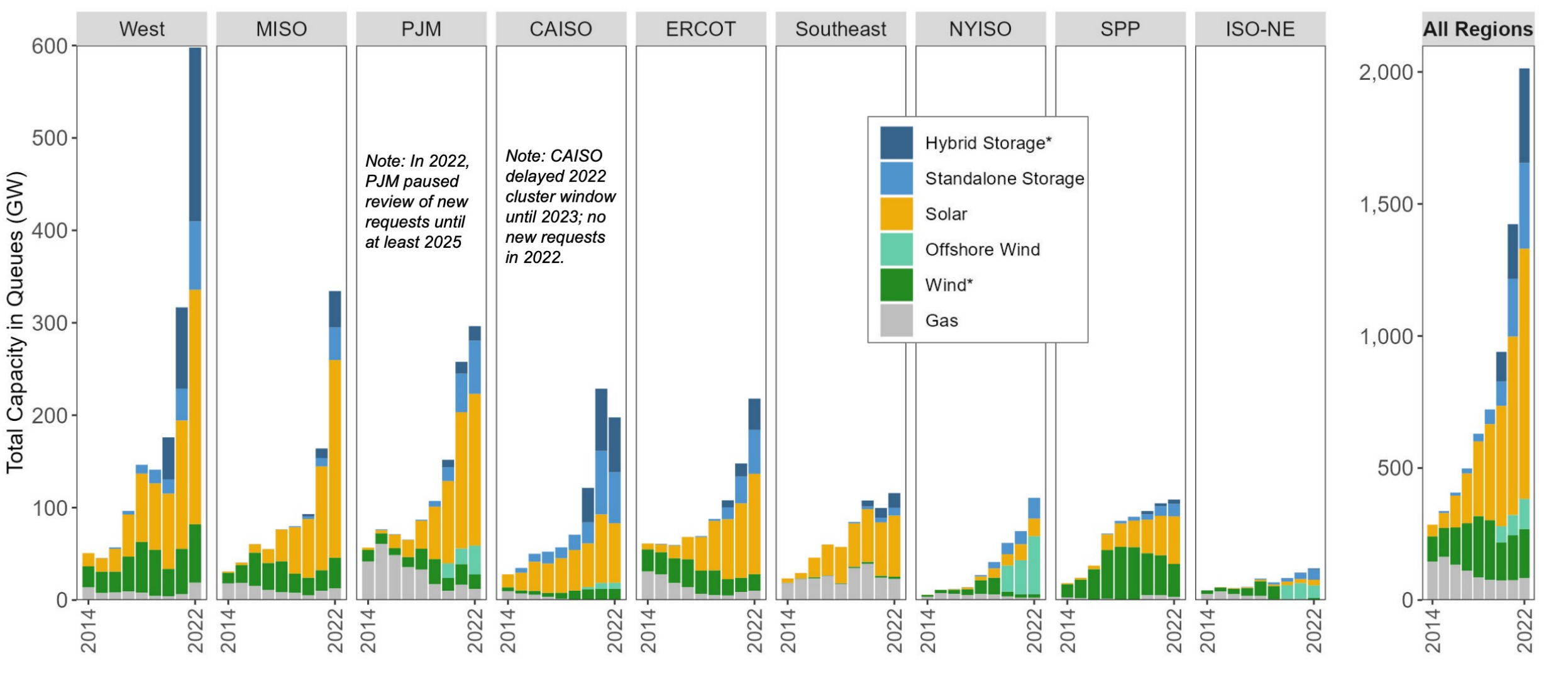
TABLE 1. *Total Transmission Congestion Costs ($ millions) for RTOs from 2016-2022*

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

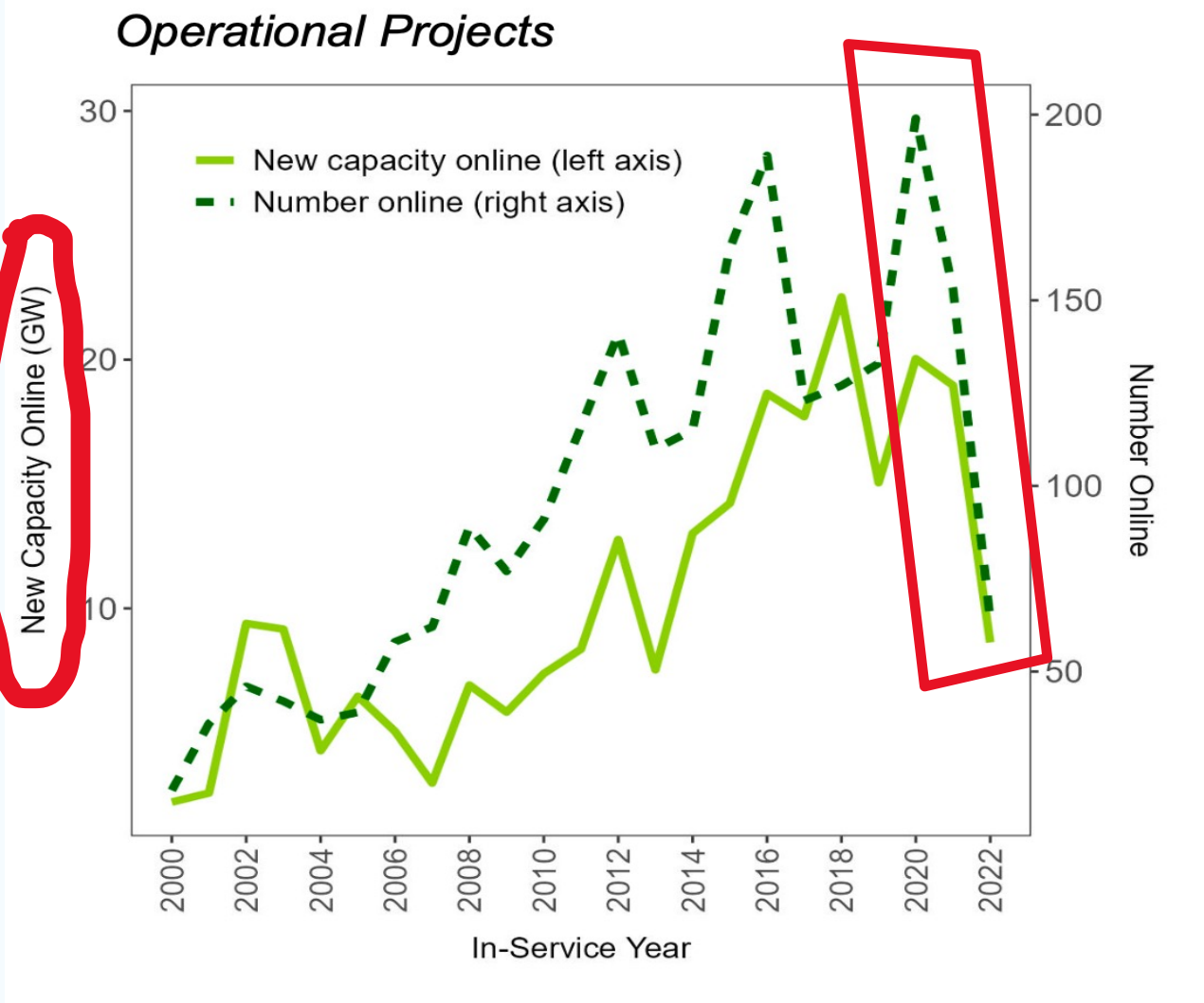
Limited transmission capacity slows interconnection



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

Which Metric Matters Most?

(On what should transmission providers focus?)



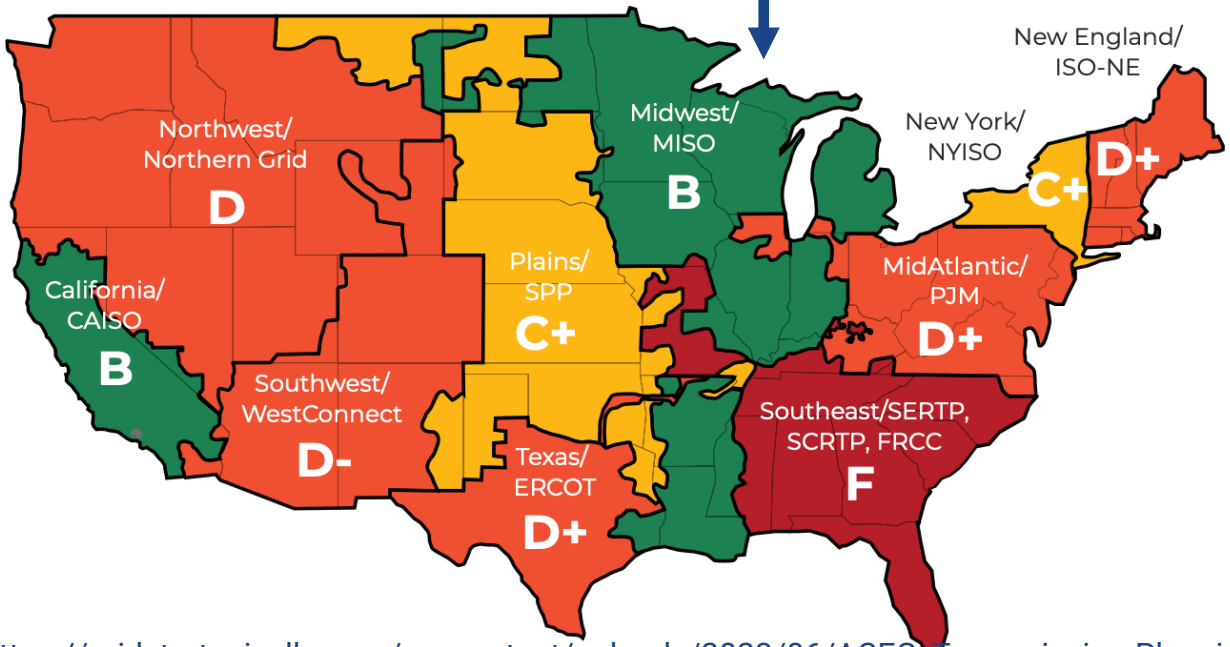
- New Capacity Online (GW) is arguably more important than completion rate, GWs in queue, GW added, or GW withdrawn.
- Unfortunately, New Capacity Online fell precipitously 2020-2022 to below 10 GW/year.
- CA alone needs 7 new GW/year.

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

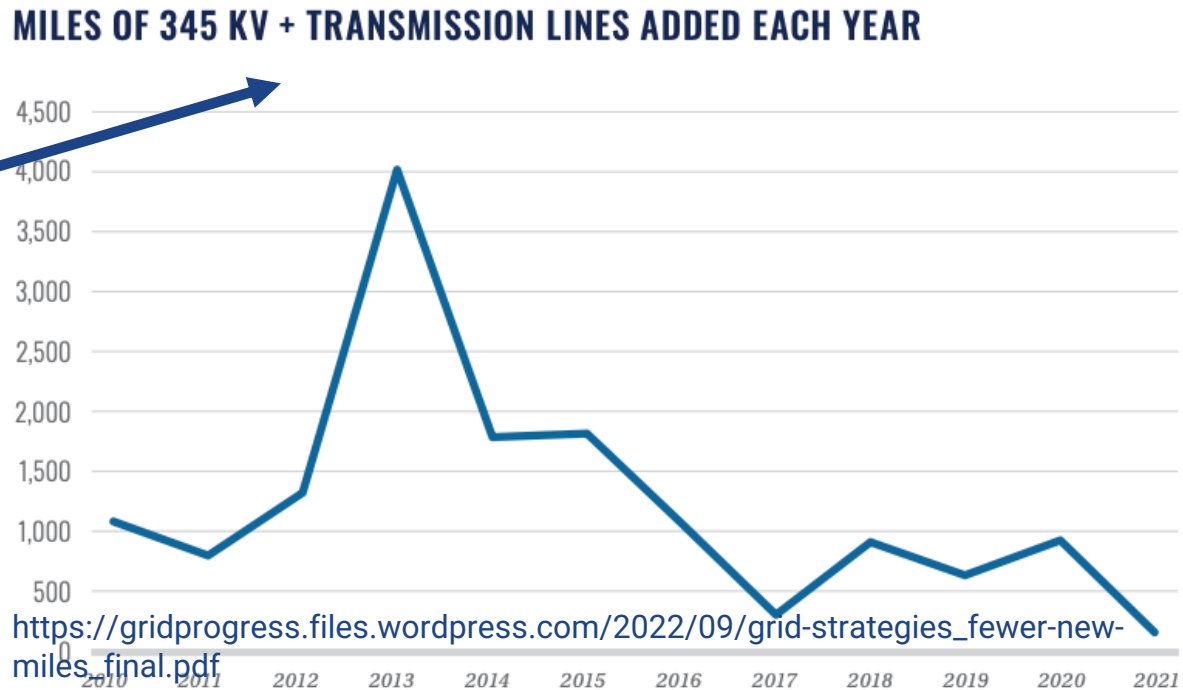
slide 17

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



https://gridstrategiesllc.com/wp-content/uploads/2023/06/ACEG_Transmission-Planning-and-Development-Report-Card.pdf



https://gridprogress.files.wordpress.com/2022/09/grid-strategies_fewer-new-miles_final.pdf

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

GridStrategies

Brattle, Grid Strategies: https://www.brattle.com/insights-events/publications/transmission-planning-for-the-21st-century-proven-practices-that-increase-value-and-reduce-costs/

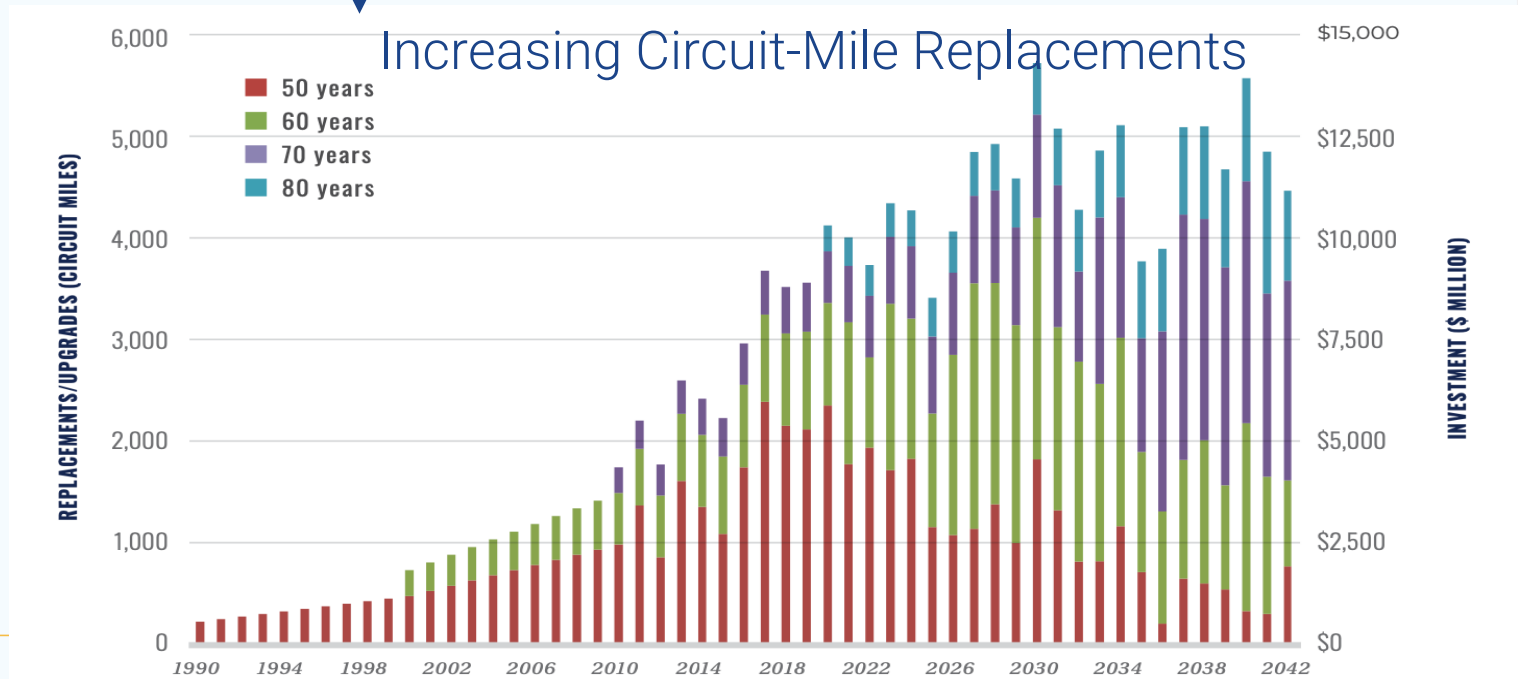
First, Get the Most Out of the Existing Grid

Grid-Enhancing Technologies

- Power Flow Control
- Dynamic Line Ratings
- Topology Optimization

High-Performance Conductors

- Replace aging wires
  - Composite core
  - Superconductors



https://usea.org/sites/default/files/event-/AEPBoldTransmissionDescription11.13.2015.pdf

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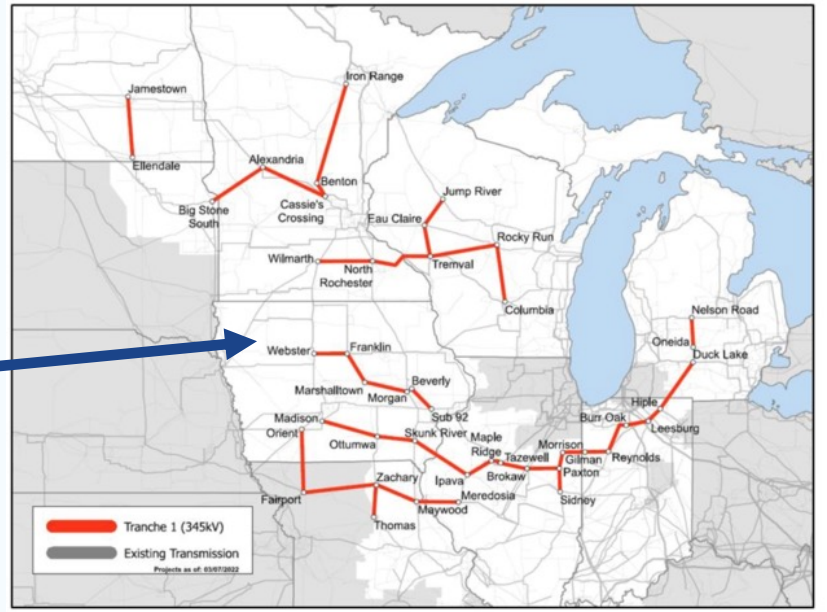
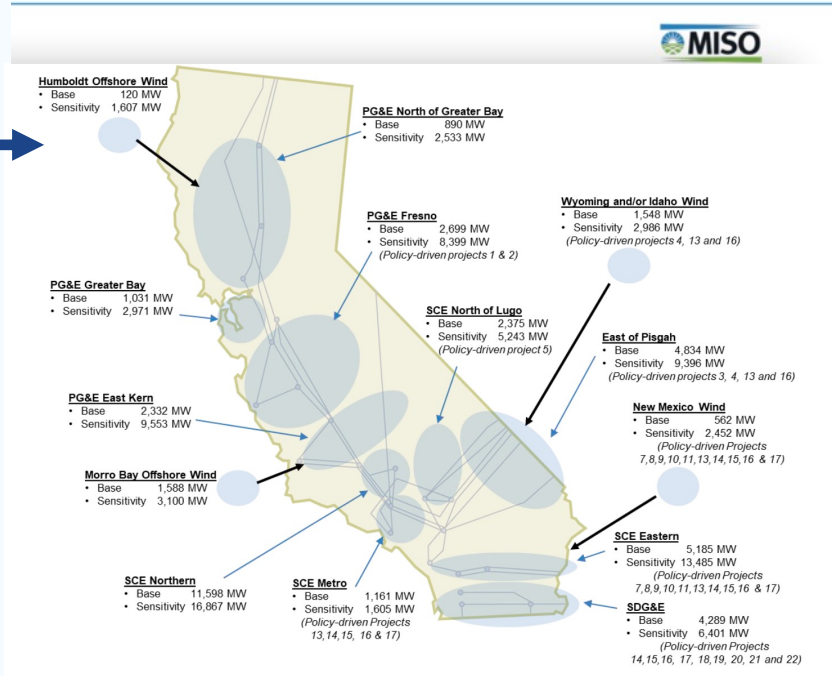
Good recent plans

- 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)

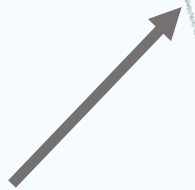
- Cluster approach to reduce needed studies and re-studies
  - Commercial readiness--financial deposits and site control
  - Withdrawal penalties
- Speed: transmission provider enforceable deadlines.
- Technology updates
  - Co-location allowed
  - More realistic modeling assumptions re storage
  - Consider 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

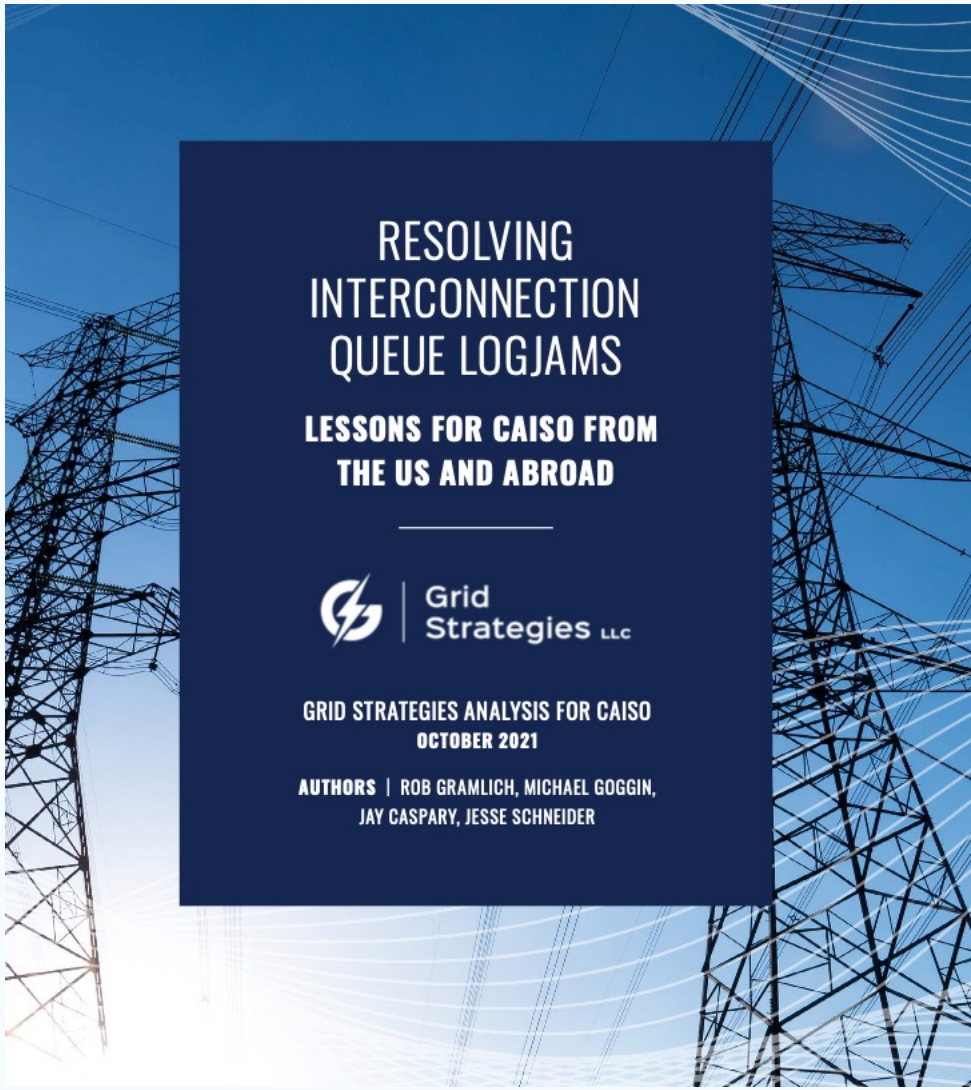
- Flexibility—more options
  - Advanced technologies
  - Energy-only service aligned with expected usage
  - Transfer of rights
  - Curtailment and redispatch options
- Certainty—take the guessing out
  - Post the price (see Jacob Mays)
  - Adherence to estimates & schedules
- Rationing and prioritizing
  - 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