Transmission Planning for the Future

April 2020

Rob Gramlich

Grid Strategies (electricity economics and policy)

WATT Coalition (grid operations incentives)

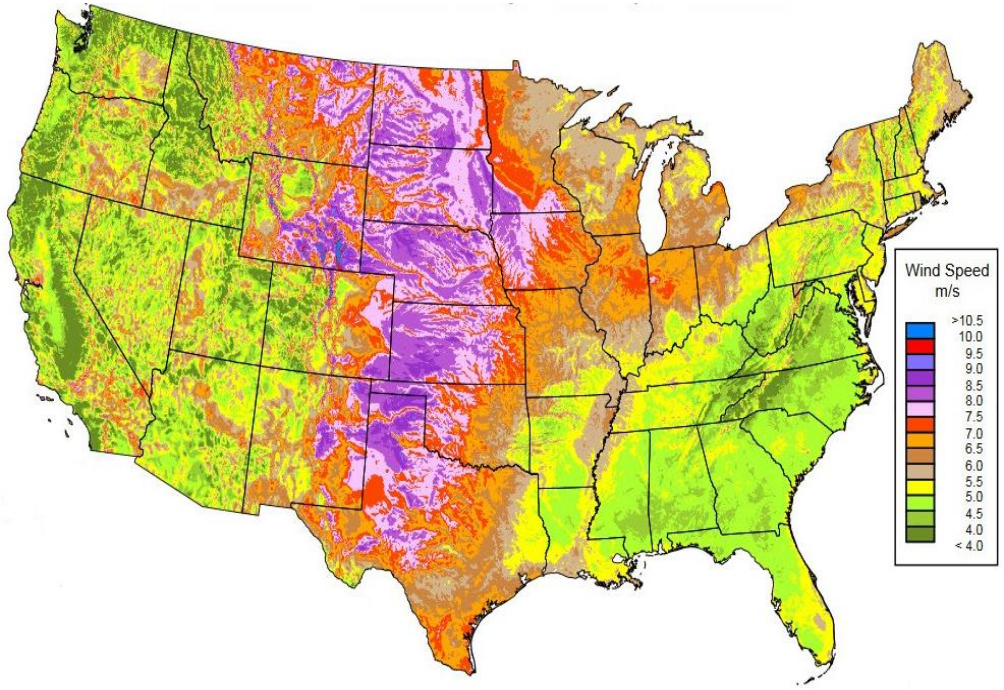
Americans for a Clean Energy Grid (grid expansion)

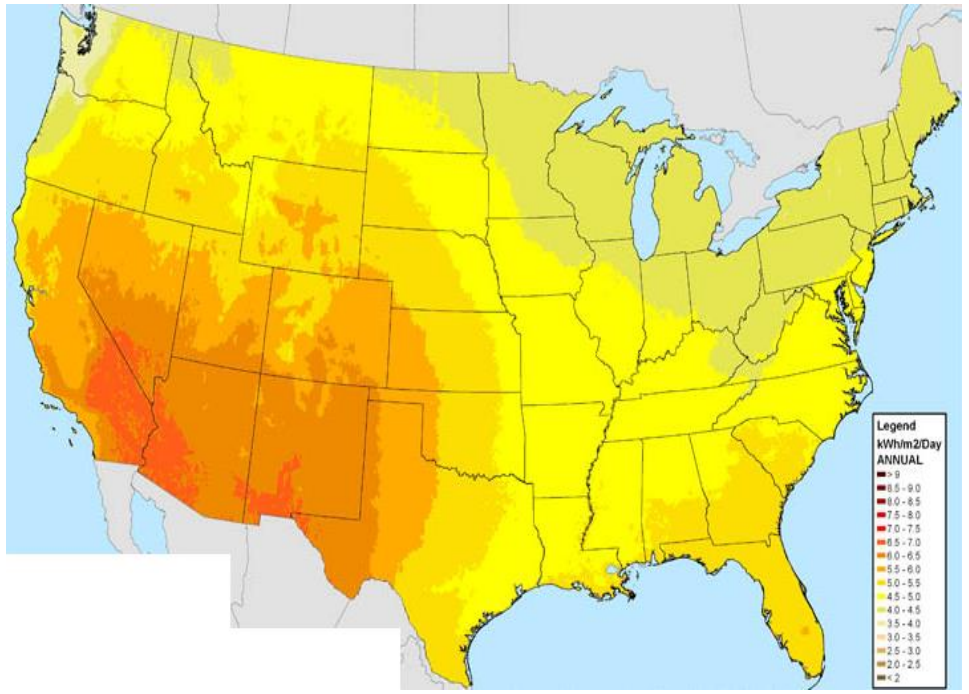
Grid Strategies LLC

Transmission and Renewable Energy

Two universal physical properties

1. Best wind and solar far from load
2. Regional exchange allows system balancing with higher penetration





NREL Wind (left) and Solar (right) Resource Maps

https://windexchange.energy.gov/maps-data/319 , https://www.nrel.gov/gis/images/map_pv_us_annual10km_dec2008.jpg

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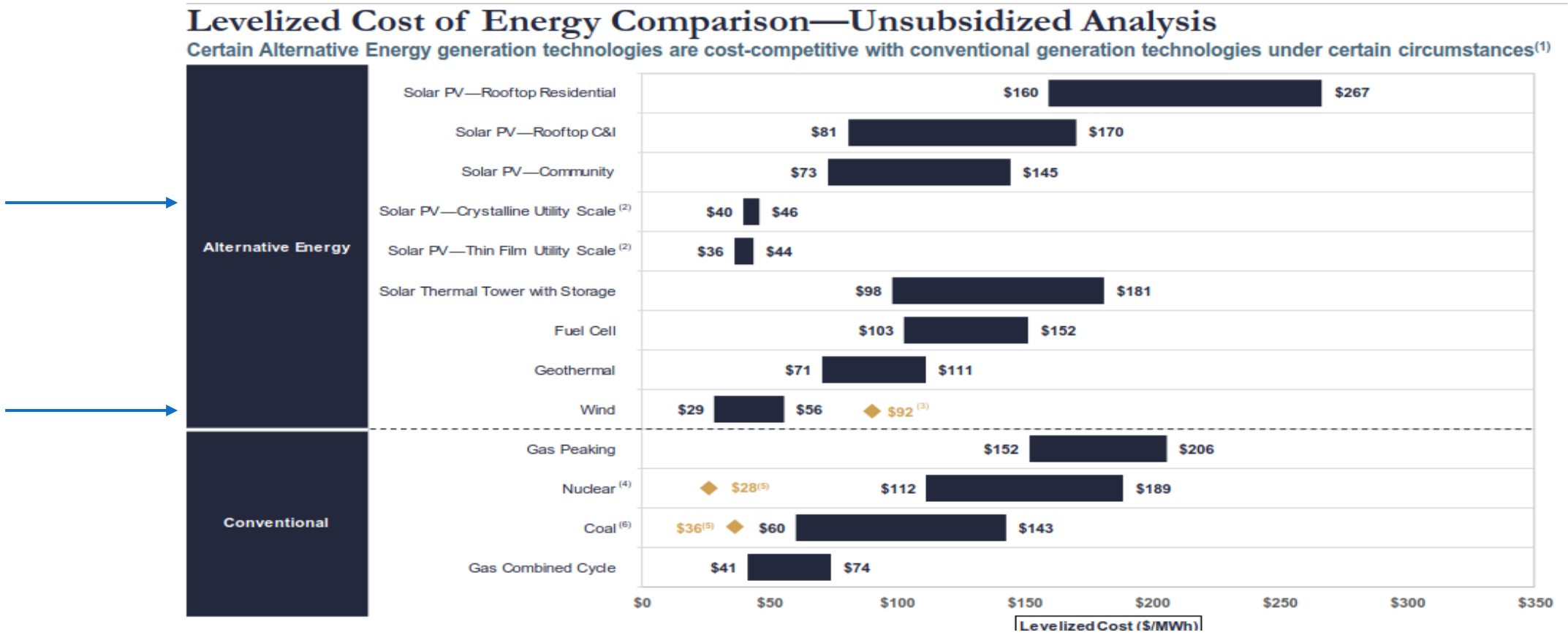
Growing Value of Transmission

Renewables + Transmission = Low-Cost Delivered Energy



Source: Lazard https://www.lazard.com/media/450773/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

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US Transmission Congestion Costs Rising (Again)

Transmission Congestion Costs ($ millions) for RTOs from 2016-2018

RTO	2016	2017	2018
ERCOT	497	976	1,260
ISO-NE	38.9	41.4	64.5
MISO	1,400	1,500	1,400
NYISO	529	481	596
PJM	1,023.7	697.6	1,310
SPP	273.7	405.3	380.9
Total	**3,762.3**	**4,101.3**	**5,011.3**

First, Use the Existing Grid More Efficiently

"In retrospect, it is apparent that ignoring transmission while introducing market reforms to other components of power systems may have been expedient but has produced a transmission system that is operated as a fixed asset; fixed in space and time."

Dr. Richard Tabors

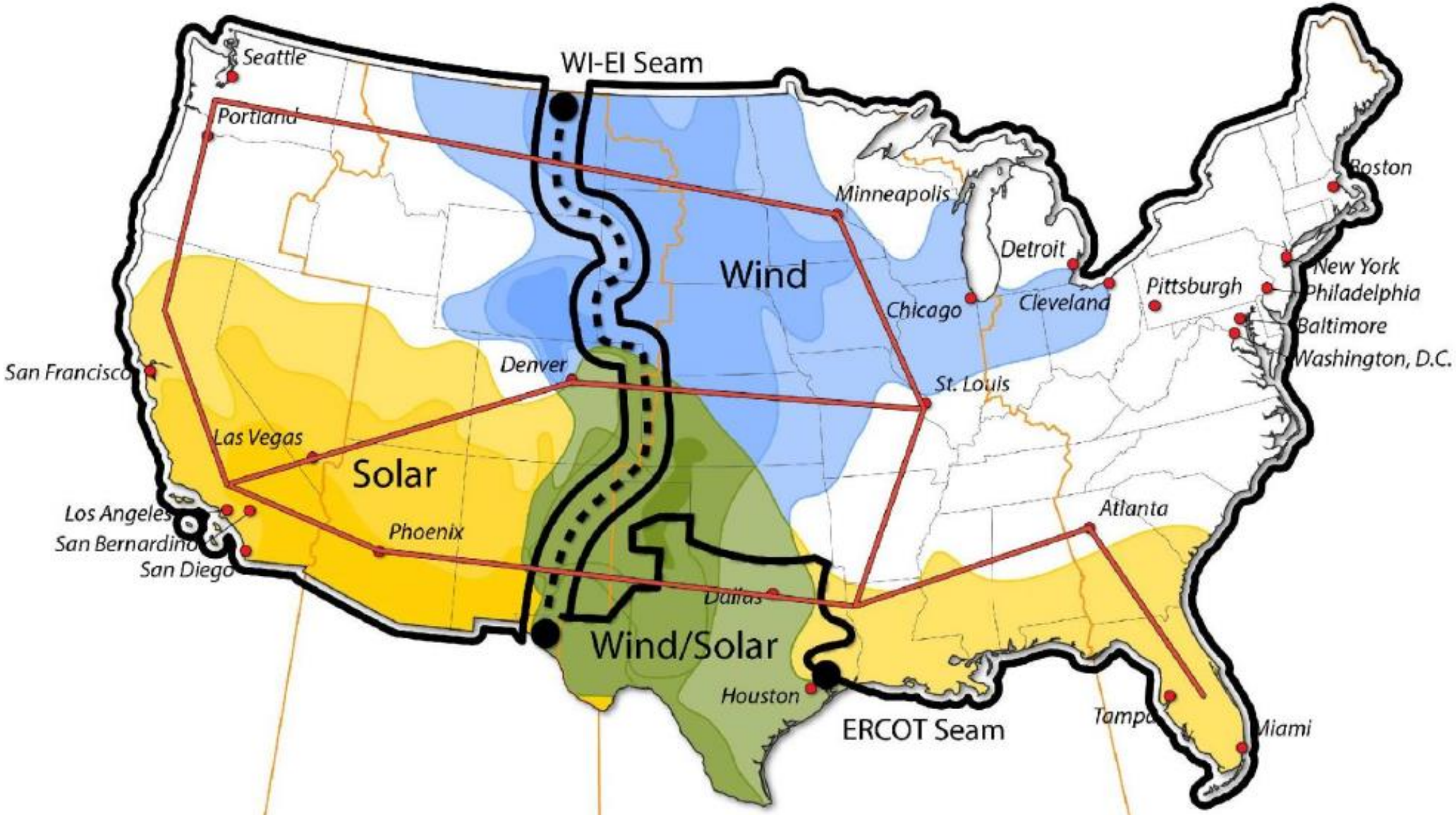
(MIT, co-author of Spot Pricing for Electricity)

https://watttransmission.files.wordpress.com/2019/06/watt-noi-comments-with-brattle-grid-strategies-paper.pdf Appendix A

Grid-Enhancing Technologies
FERC NOPR March 2020

- **Power Flow Control**
  - Push and pull power, modular, scalable, movable
- **Dynamic Line Ratings**
  - Adjust path rating based on ambient conditions, allows capacity forecasting
- **Topology Optimization**
  - Software to optimize transmission assets, eg circuit breakers
- **Storage as Transmission**

Grid Expansion Opportunities



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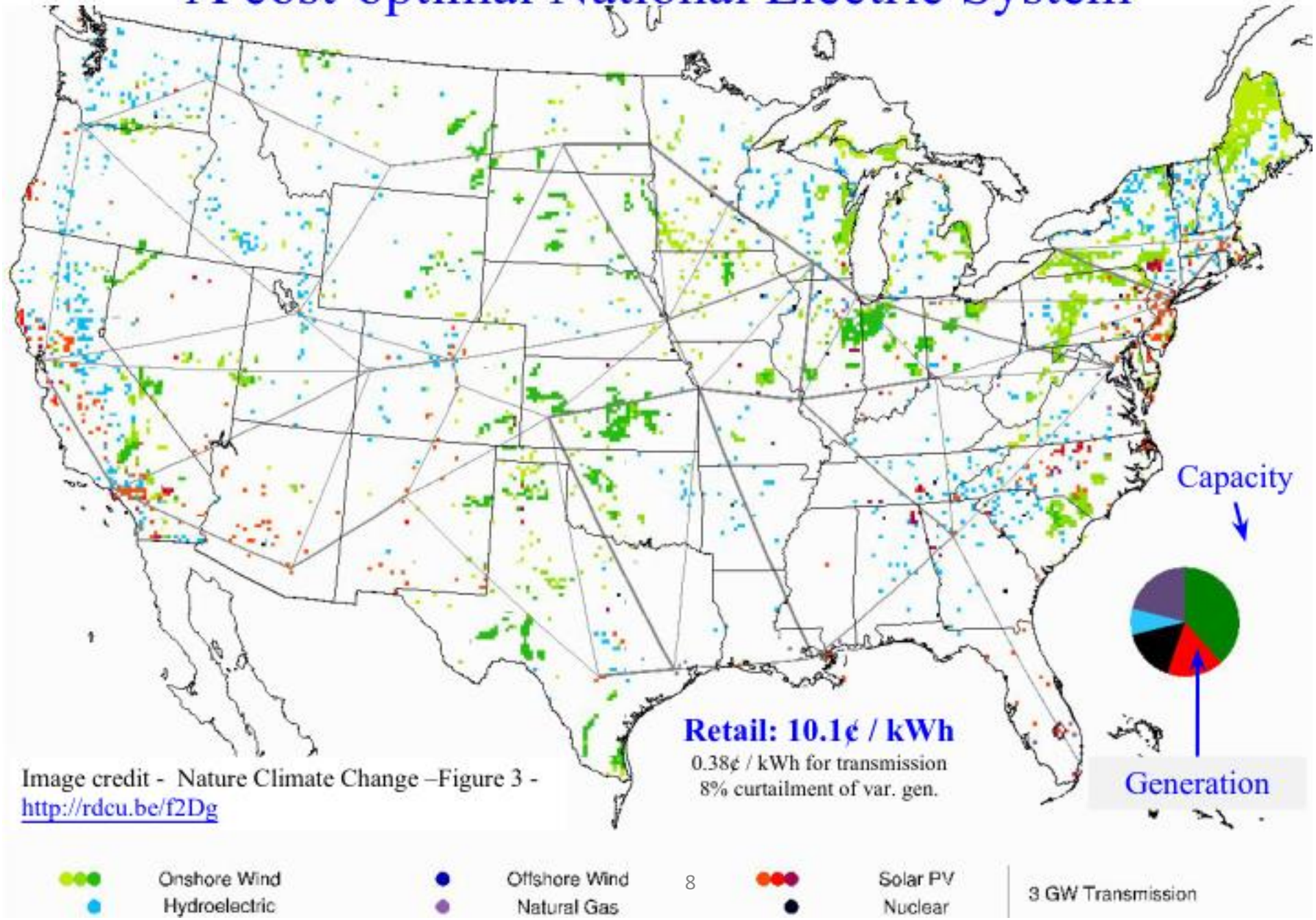
A cost-optimal National Electric System



Dr. Christopher Clack
VCE

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Transmission in other countries: China case

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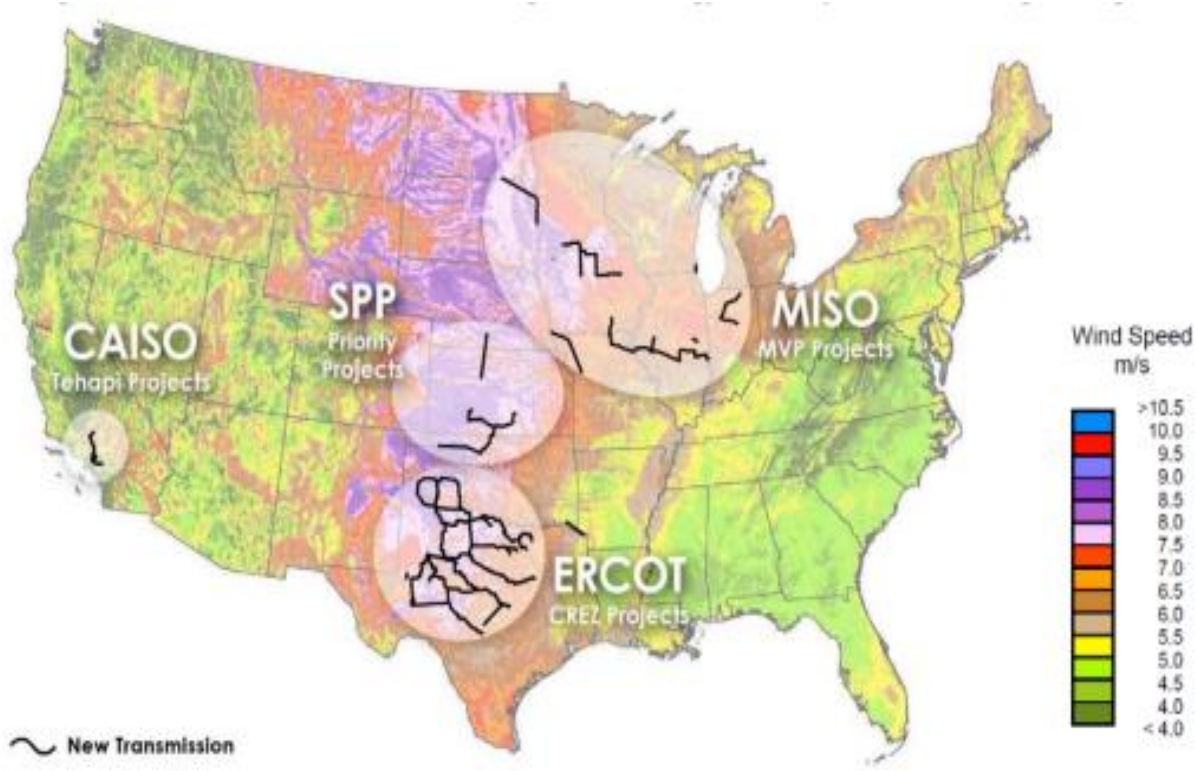
Europe Renewables and Transmission

https://globalchange.mit.edu/sites/default/files/MITJPSPGC_Reprint_16-9.pdf

Recent Large-Scale Expansions

- MISO MVP, SPP priority projects, ERCOT CREZ
- 3:1 Benefit-Cost ratios
- Winning formula:
  - Pro-active multi-benefit planning
  - Broad, beneficiary pays allocation



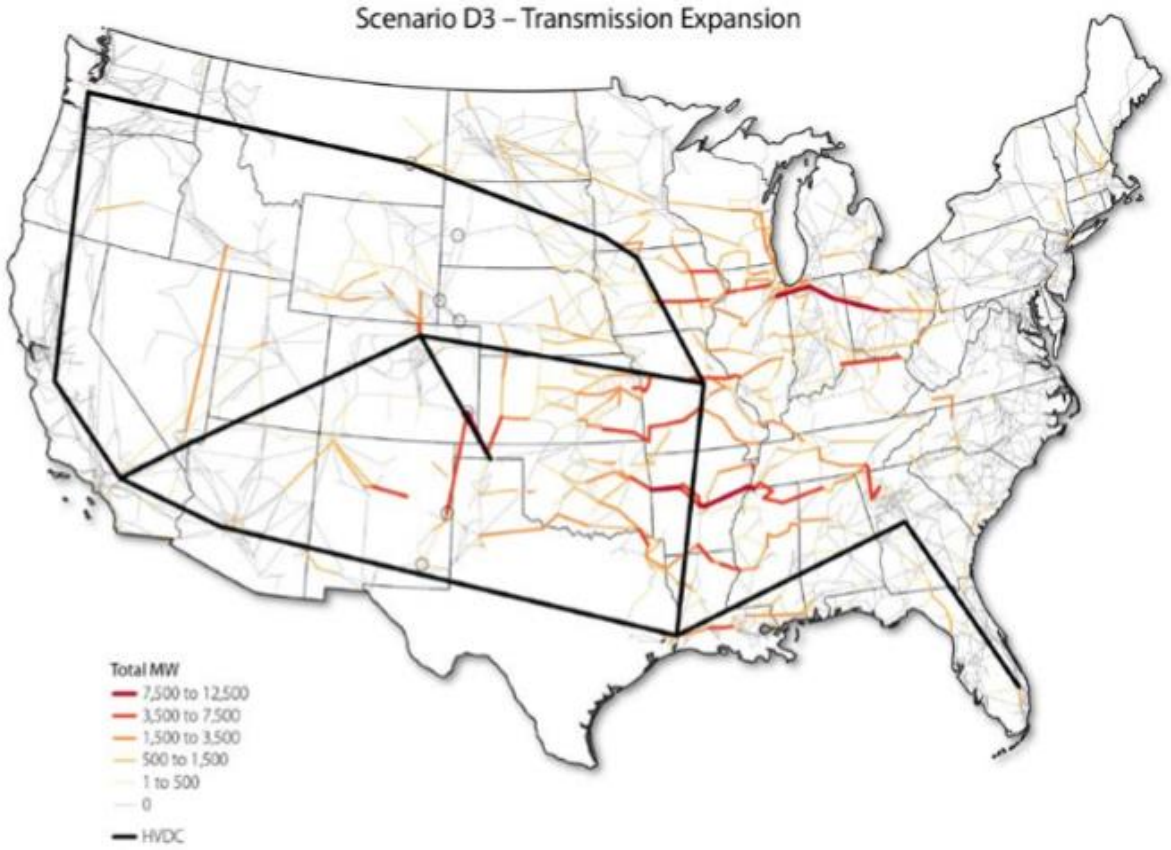
Transmission Enabled ½ of US Wind Capacity

~105 GW installed in US

Transmission plan	Wind Capacity Enabled (GW)
Tehachapi CA	4.5
Texas CREZ	14.5
MISO MVP	14
SPP Priority Projects, Balanced Portfolio	6
CO+ME+NV+PAC+BPA	10
Total	49

Transmission Barriers: the 3Ps

- Planning
- Permitting
- Paying



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FERC planning orders increasing regionalization

- Policy Statement on Regional Transmission Groups (RTGs) (1993)
- Order No. 888 (1996)
- Order No. 2000 (1999)
- Order No. 890 (2007)
- Order No. 1000 (2011)
- Order No. ??? (2021?)

FERC Order No. 888 (1996)

- Transmission Provider "will plan, construct, operate and maintain its Transmission System…in order to provide the Network Customer with Network Integration Transmission Service over the Transmission Provider's Transmission System"
- Encourage ISOs: "An ISO or an RTG of which the ISO is a member should conduct such studies as may be necessary to identify operational problems or appropriate expansions."
- "…give deference to the planning…of an RTG."
- If redispatch is not economical, the transmission provider is obligated to expand or upgrade its system (OATT Section 15.4)
- Encouraged regional planning (Order No. 888-A at 30,311)

Order No. 2000 (1999)

- Encourage Regional Transmission Organizations (RTOs)
- Required function: “Planning and Expansion”
  - “the RTO must have ultimate responsibility for both transmission planning and expansion within its region”
- Required function: inter-regional coordination
  - “Develop mechanisms to coordinate its activities with other regions”

FERC Order No. 890 (2007)

- "Require coordinated, open, and transparent transmission planning on both a local and regional level."
- Principles: coordination, openness, transparency, information exchange, comparability, dispute resolution, regional participation.
- "coordinate with interconnected systems to… identify system enhancements that could relieve congestion or integrate new resources."
- Transmission Owners "can have a disincentive to remedy transmission congestion when doing so reduces the value of their generation."
- Planning "must consider both reliability and economic considerations" and "encompass the study of upgrades to integrate new generation resources or loads on an aggregated or regional basis."
- Requires studies "for purposes of planning for the alleviation of congestion through integration of new supply and demand resources into the regional transmission grid …such as areas that can support substantial wind generation."

FERC Order No. 1000 (2011)

- Requires: “Each public utility transmission provider participate in a regional transmission planning process that produces a regional transmission plan”
- Requires “consideration of transmission needs driven by public policy requirements in the local and regional transmission planning processes”
- “removes federal right of first refusal for certain new transmission facilities”
- “improves coordination between neighboring transmission planning regions for new interregional transmission facilities.”
- “a regional cost allocation method for the cost of new transmission facilities selected in a regional transmission plan for purposes of cost allocation; and an interregional cost allocation method”

Current transmission deficiencies

- Almost no inter-regional lines being planned
- Evolving resource mix, consumer demand, public policies, interconnection queues not being considered
- Competitive process can hinder as much as help development
- Narrow purpose planning reigns
- Reactive, not pro-active
- Grid-Enhancing Technologies ignored
- Deterministic
- Almost all transmission investment is local

Next FERC Planning Order?

- Multi-benefit planning
- Public policies
- Utility resource plans
- Consumer resource plans
- Gen. interconnection queues
- Electrification estimates
- Carbon regulation estimates
- Multi-region RTO/process
- Congestion reduction
- Efficiencies across seams
- Resilience (low probability high impact scenarios)
- Scenarios and probabilities
- Grid operations as well as infrastructure
- Oversight of local transmission upgrades

Questions

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