Transmission: the key to clean, reliable and affordable energy

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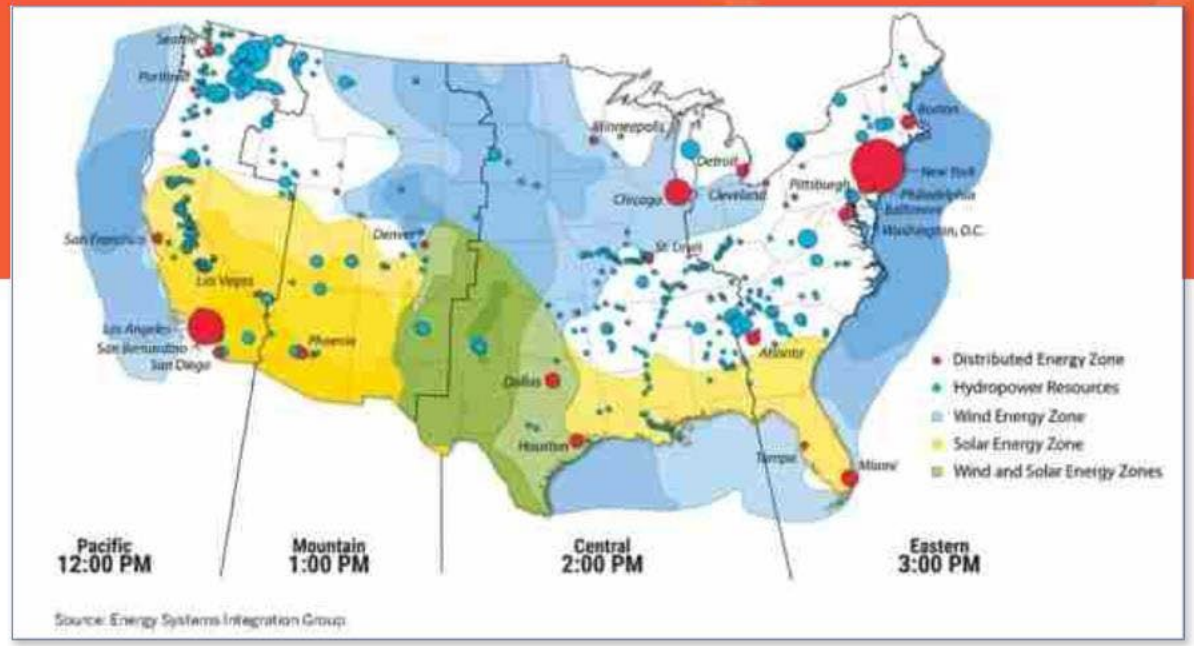
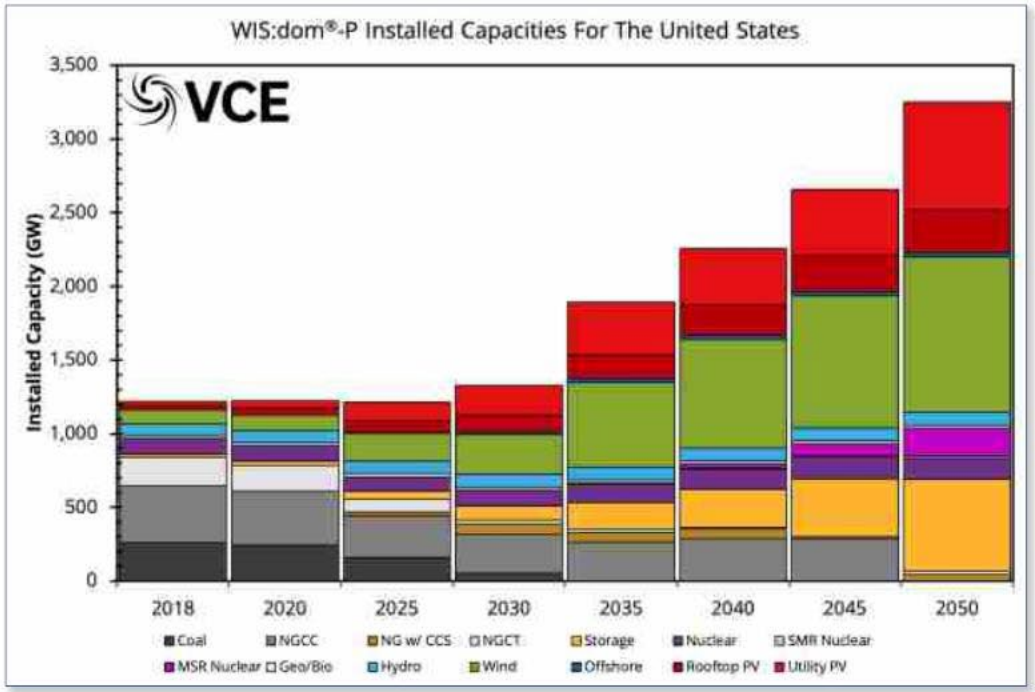
ESIG
ENERGY SYSTEMS INTEGRATION GROUP

July 31, 2022

We need transmission to deliver significant resources

- **We may need 1000 GW+ of new wind and solar to meet 100% clean electricity goals**
- **Electrification will lead to significantly increased demand**
- **Distributed energy resources will contribute but are not sufficient on their own**
- **We have over 930 GW of zero carbon generating resources in interconnection queues**

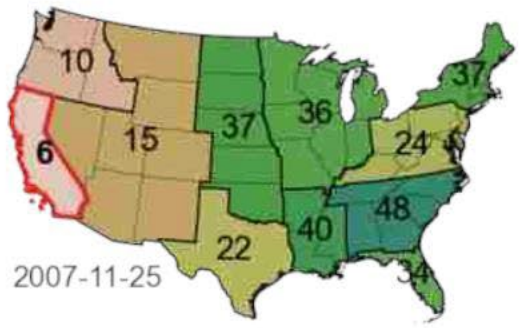


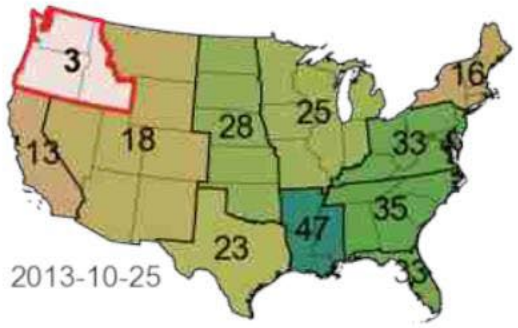


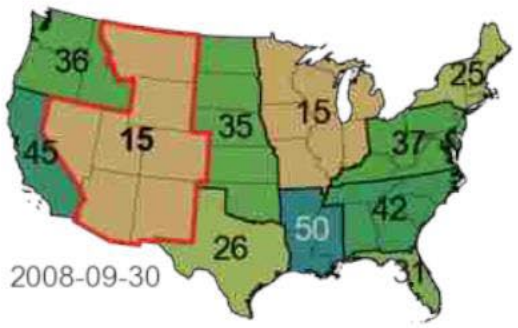
Vibrant Clean Energy, see Lew, et al, Transmission Planning for 100% Clean Electricity, IEEE PES Magazine, Nov/Dec 2021

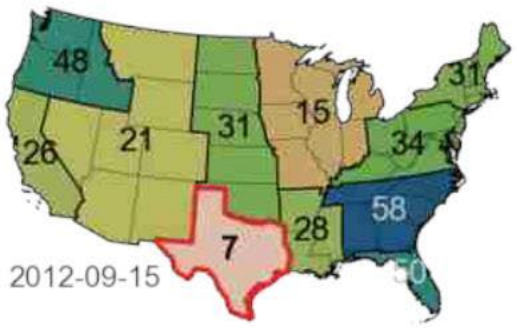
It's always windy or sunny somewhere

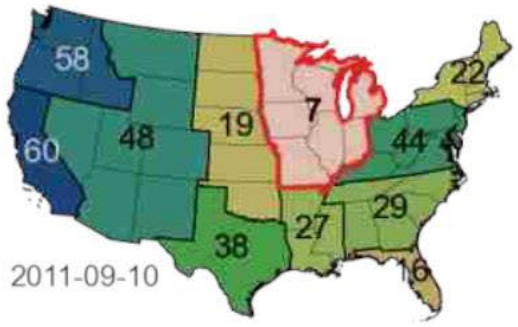
Take the least-windy day in each planning area from 2007–2013.
How windy are each of the other planning areas on that day?

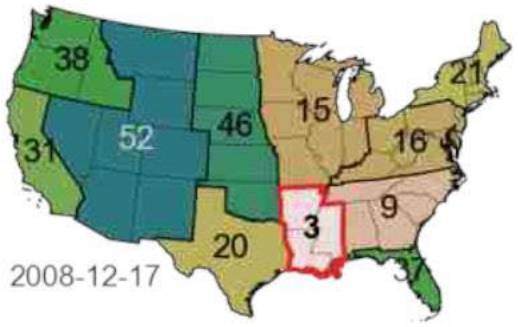


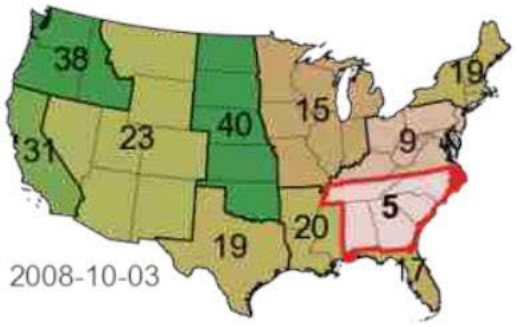


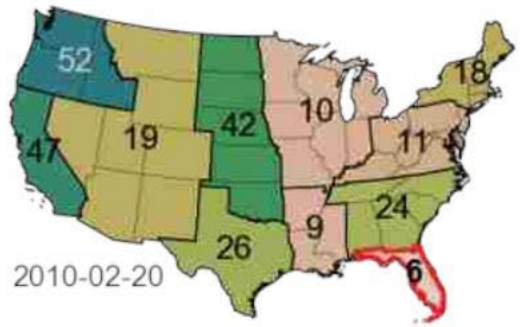


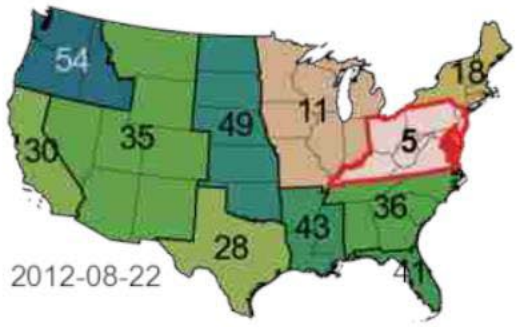


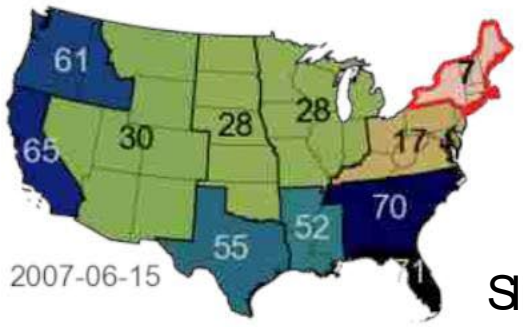












Single-day wind capacity factor [%] at top quintile of sites

Slide: Patrick Brown, NREL 2022

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Take the least-sunny day in each planning area from 2007–2013.
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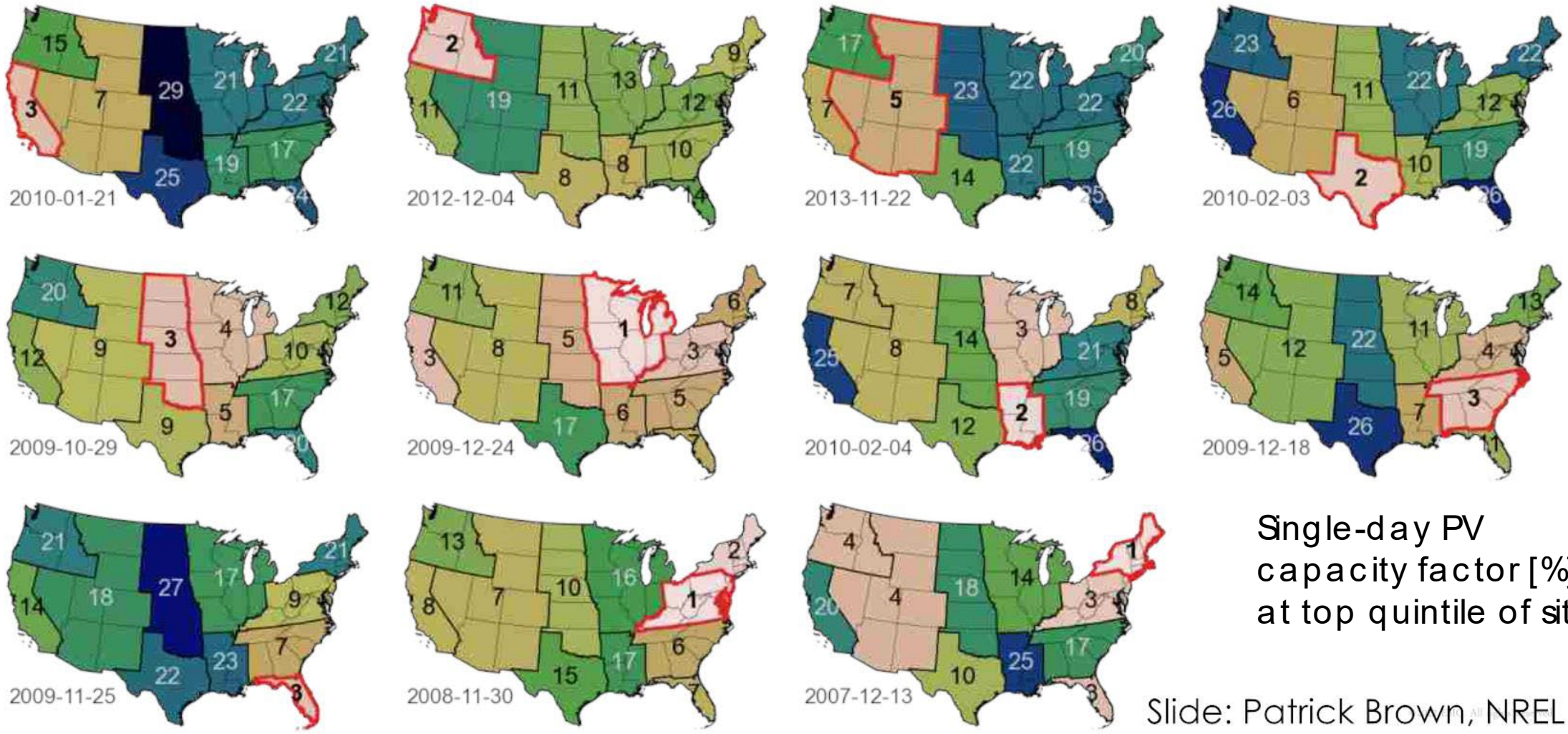
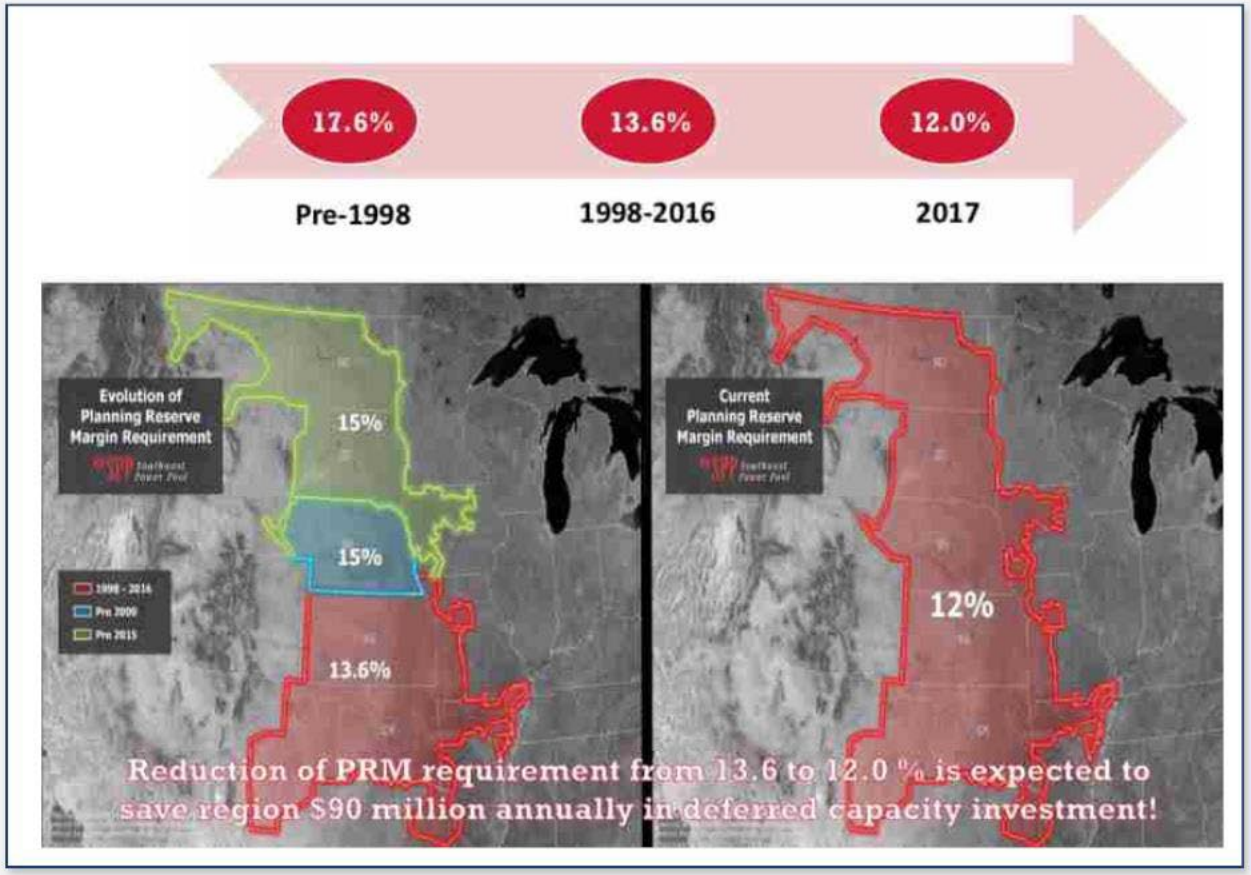
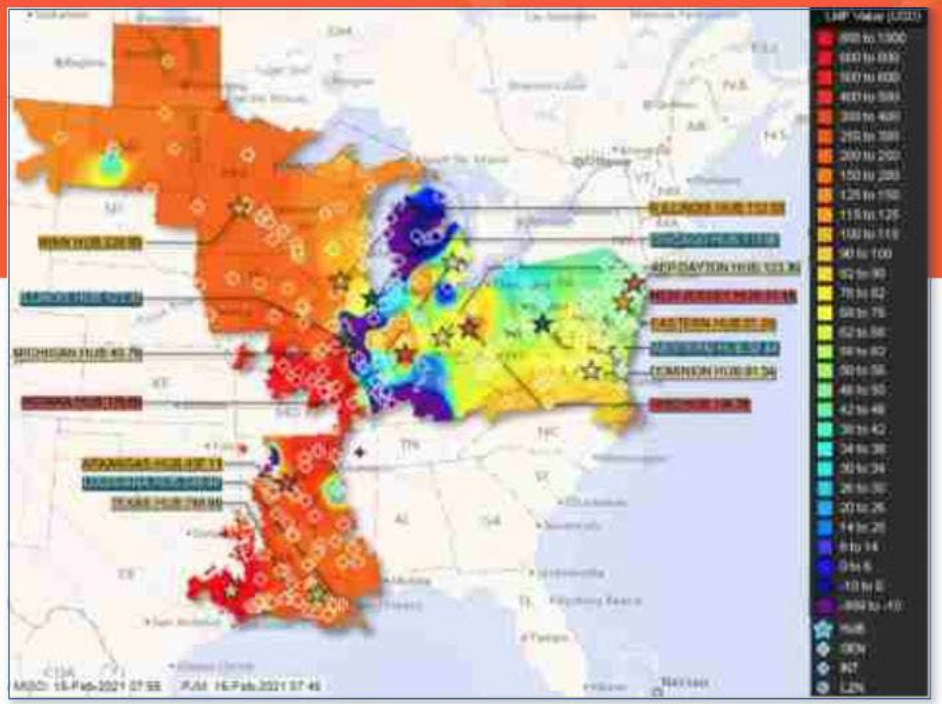


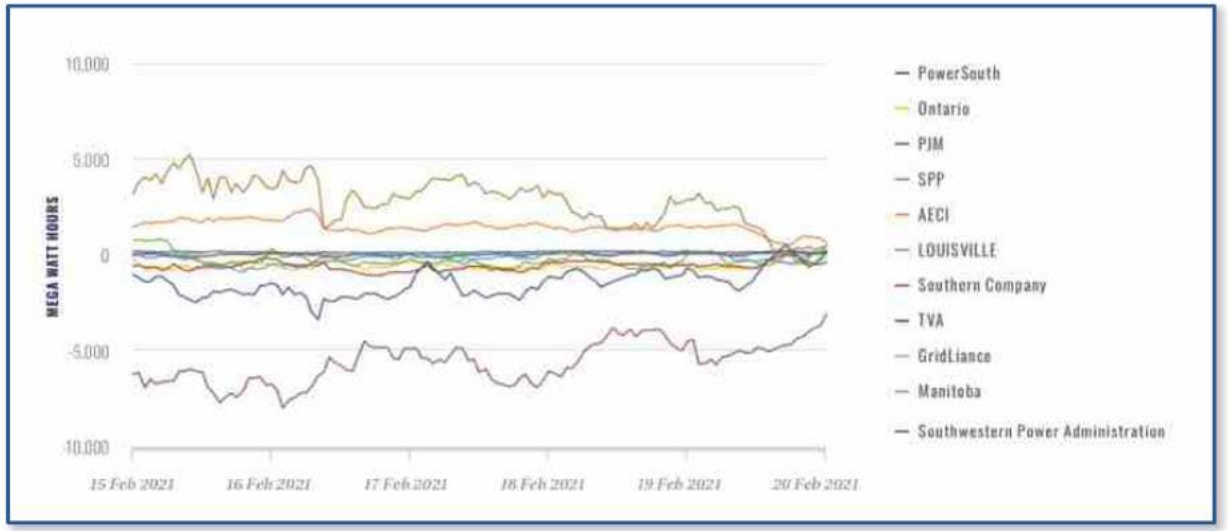
Single-day PV capacity factor [%] at top quintile of sites

Slide: Patrick Brown, NREL 2022

We need transmission for resource adequacy and resilience

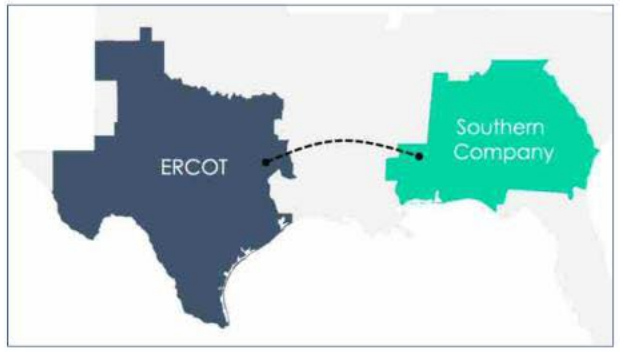


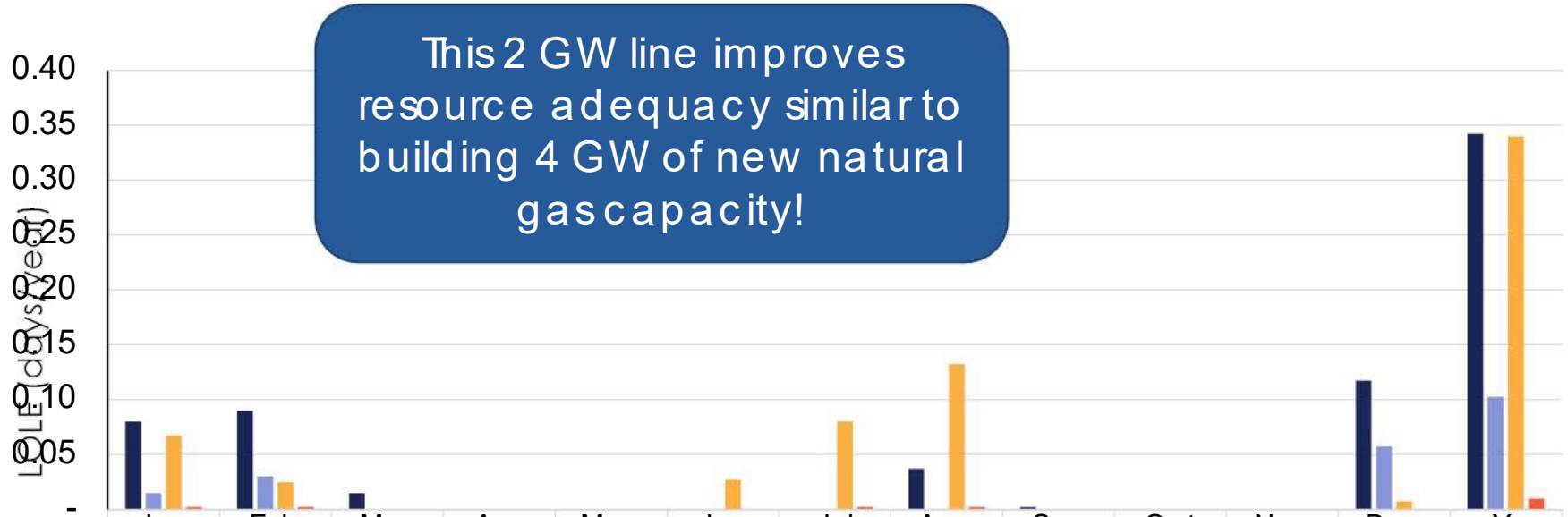




Nickell, SPP, WIEB CREPC Spring meeting, 2017; Joint and Common Market contour map, see Goggin, Transmission Makes the Power System Resilient to Extreme Weather, July 2021

Inter-regional transmission provides reliability at low cost



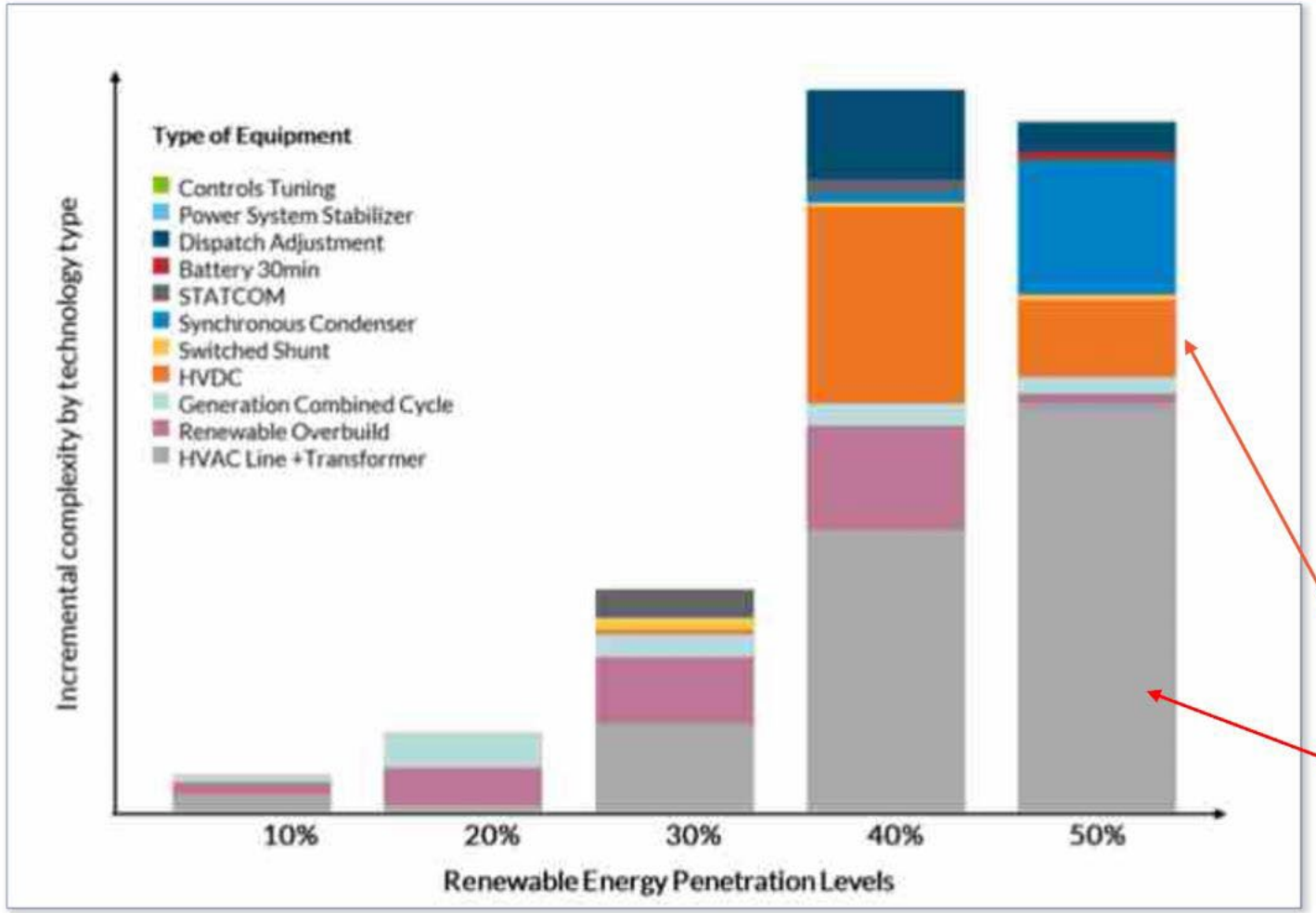


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
ERCOTOnly	0.08	0.09	0.02	-	-	-	-	0.04	0.00	-	-	0.12	0.34
ERCOT(Combined w/ Retires)	0.02	0.03	-	-	-	-	-	-	-	-	-	0.06	0.10
SOCO Only (w/ Retires)	0.07	0.03	-	-	-	0.03	0.08	0.13	-	-	-	0.01	0.34
SOCO (Combined w/ Retires)	0.00	0.00	-	-	-	-	0.00	0.00	-	-	-	-	0.01

Note that you need trading/market mechanisms and ability to share resource adequacy

ESIG, 2022, https://www.esig.energy/wp-content/uploads/2022/07/ESIG-Multi-Value-Transmission-Planning-report-2022a.pdf

We need transmission for a host of other reliability benefits



MISO's RIIA study found that transmission was the key enabler to meet reliability standards at 50% wind/solar

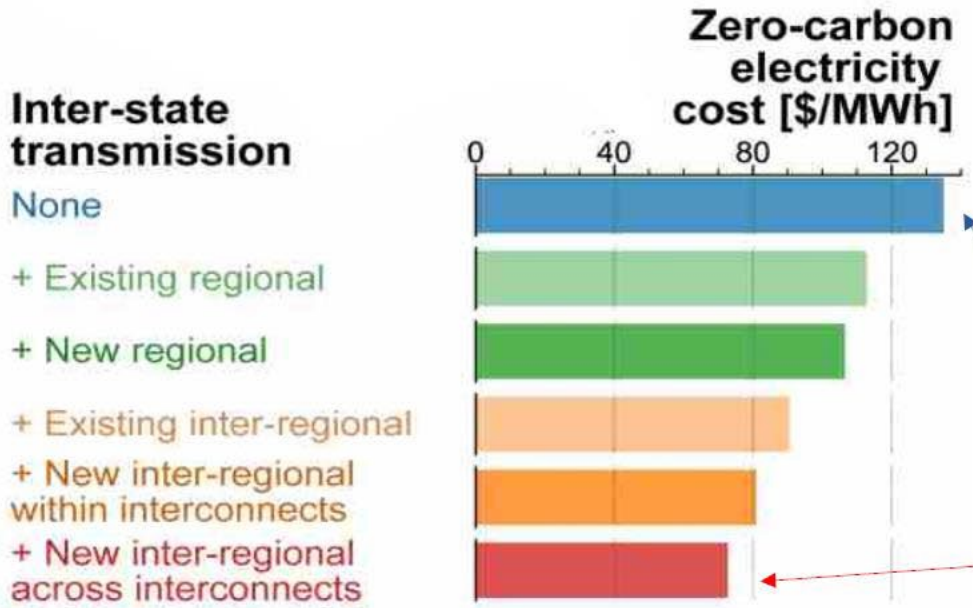
DC TRANSMISSION

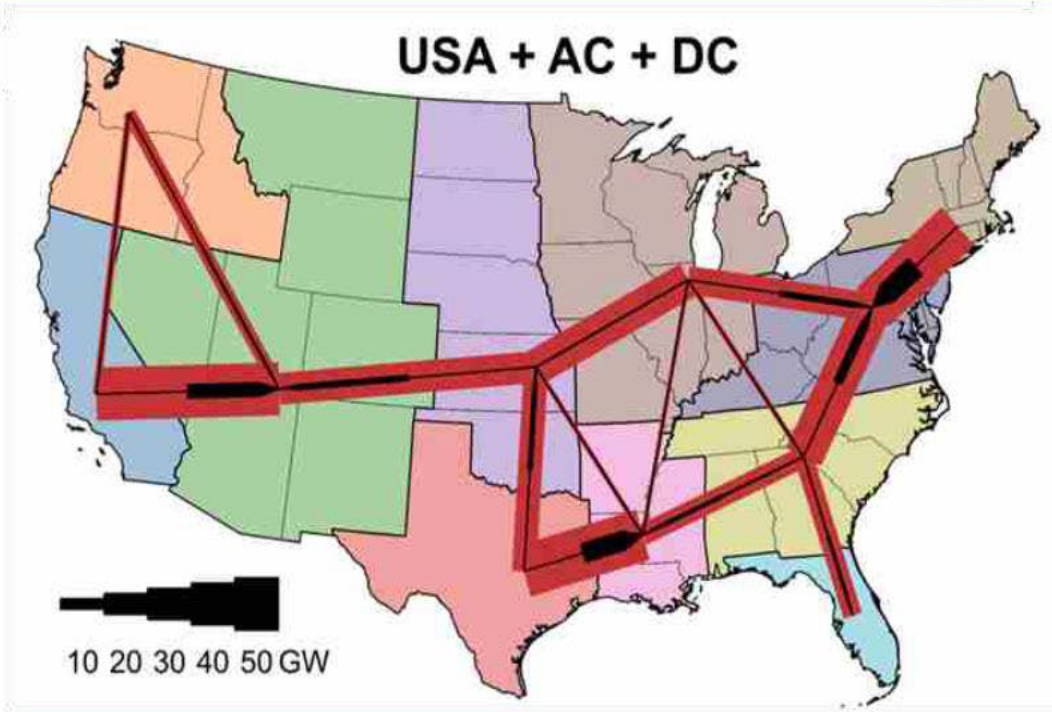
AC TRANSMISSION

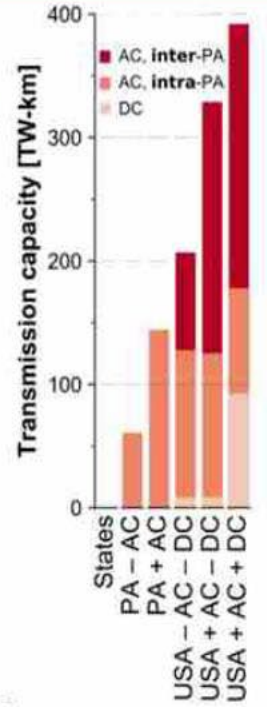
MISO, Renewable Integration Impact Assessment, Feb 2021

National transmission planning is needed

This study examines 100% clean electricity in the US under scenarios with increasing geographic levels of transmission expansion and operations





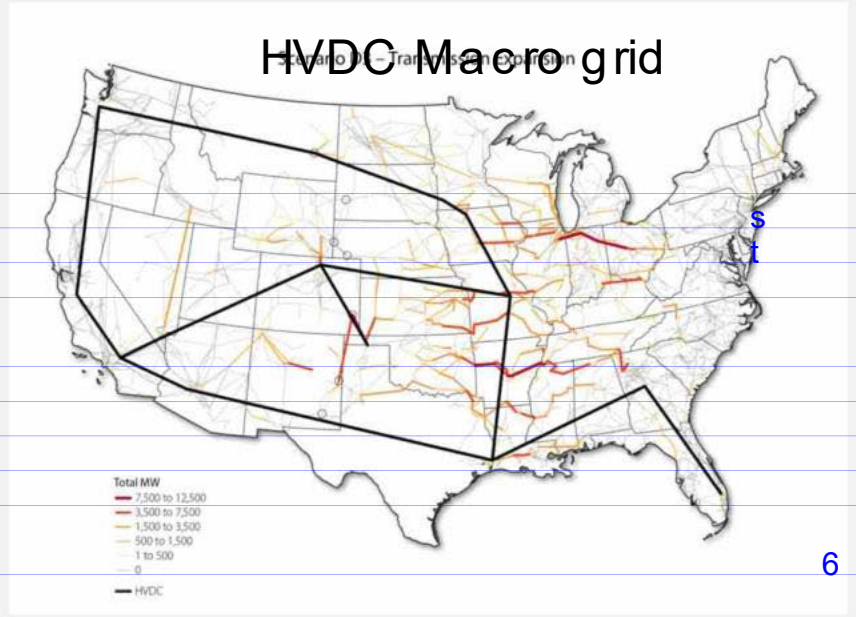


"Every state for itself" costs twice as much ($135/MWh) as the nationally optimized and coordinated approach ($73/MWh)

Brown and Botterud, "The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System," Joule 5, 1-20, Jan 20, 2021

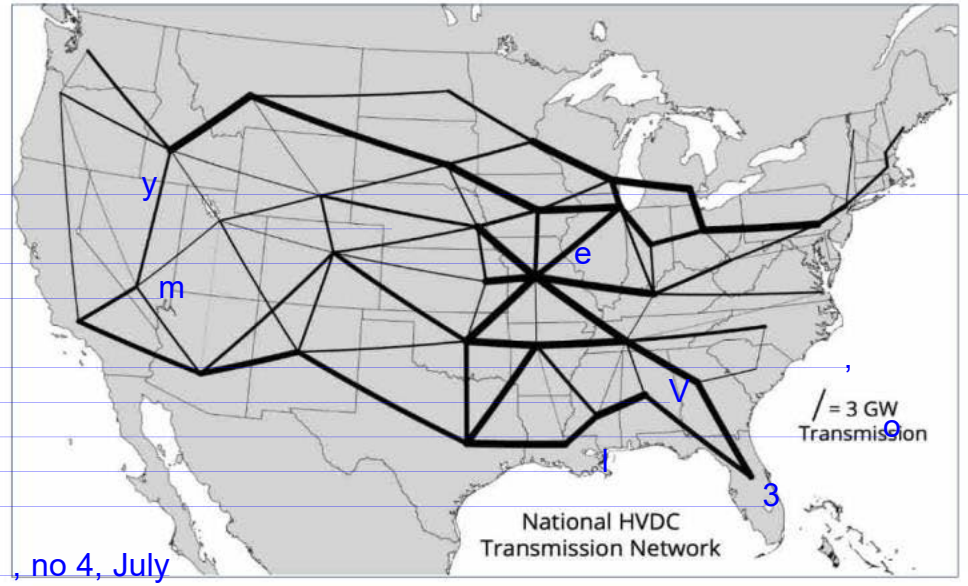
Stronger interconnection across the country saves money – especially with decarbonization

NREL Interconnection Seams Study



- With a 50% renewables goal, this HVDC macro grid has a benefit-to-cost ratio of 2.5
- With a 85% renewables goal, this HVDC macro grid has a benefit-to-cost ratio of 2.9

Vibrant Clean Energy ZeroByFifty

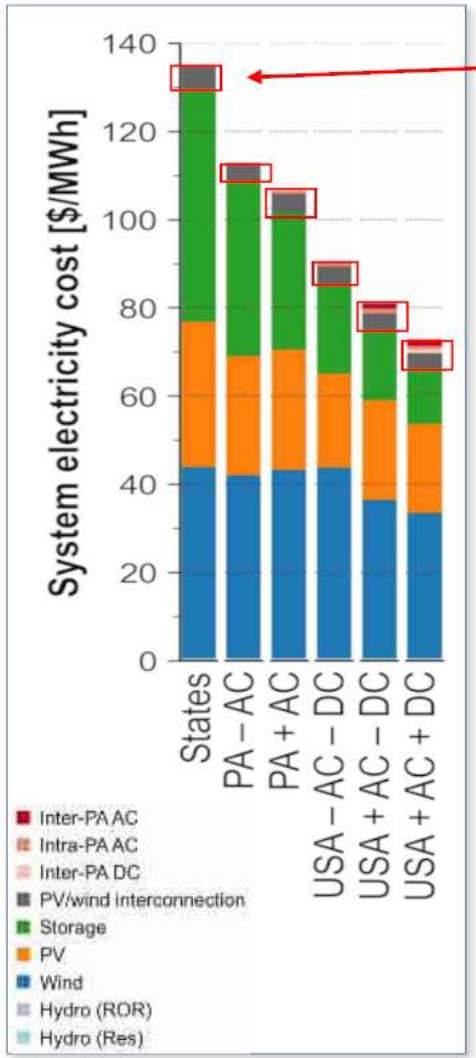


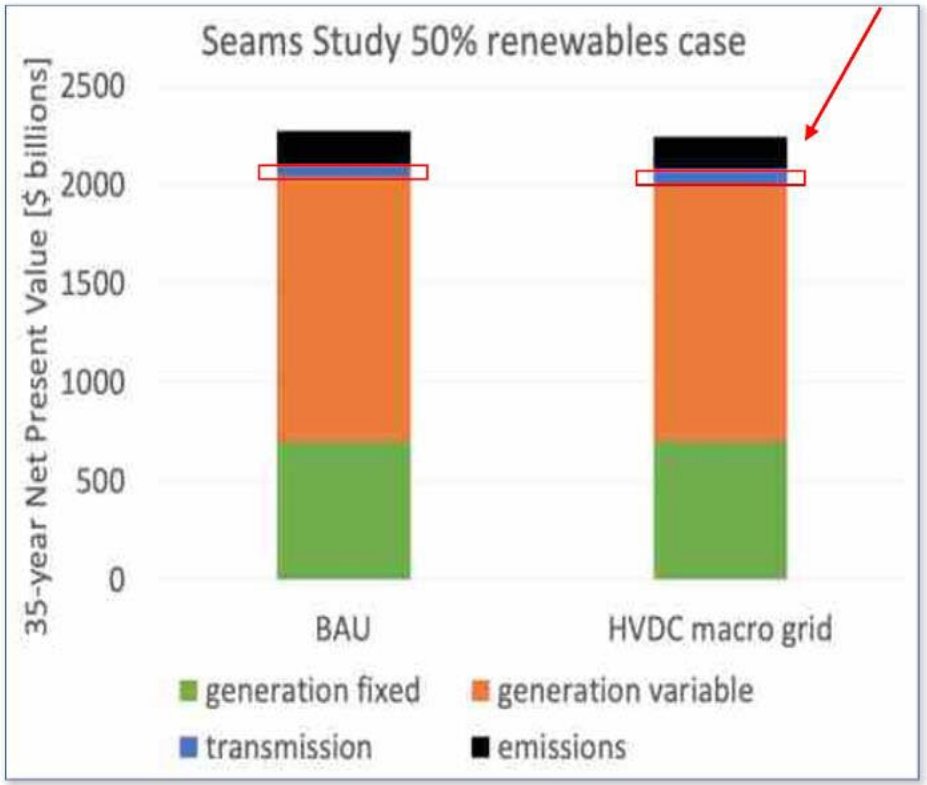
- Transmission expansion costs are $200B and $350B for 100% clean electricity and 100% clean energy, respectively
- If a macrogrid is not built, it costs $1T more to get to 100% clean energy by 2050

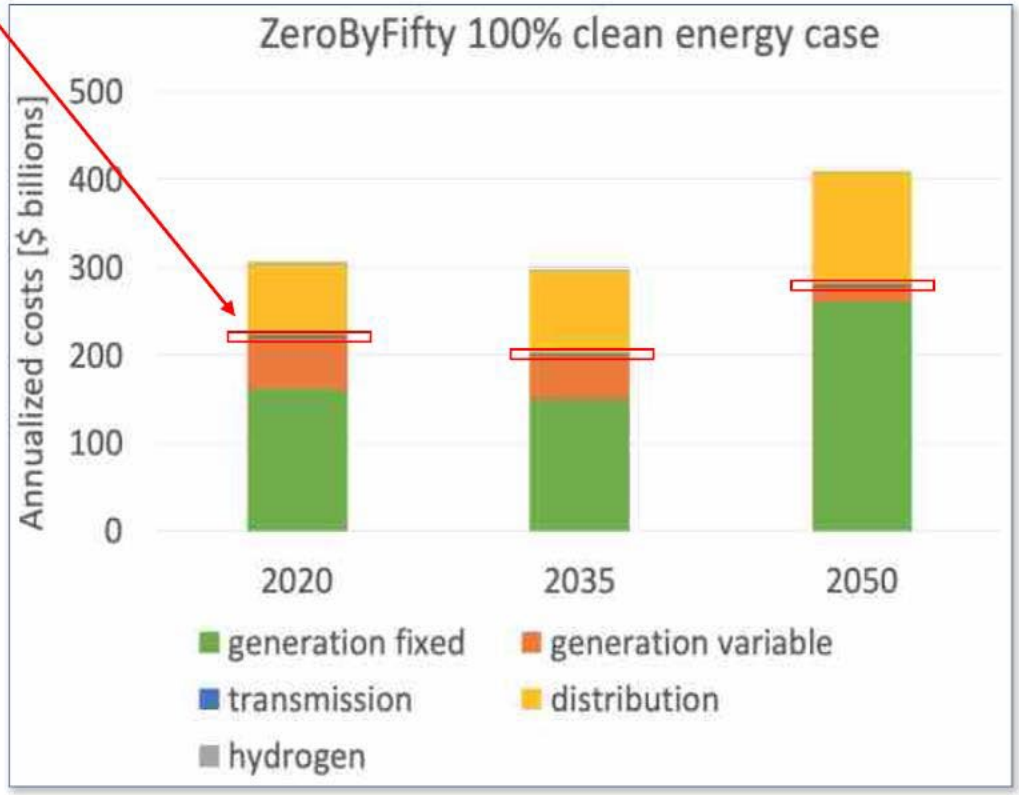
Figueroa Acevedo, et al, Design and Valuation of High-Capacity HVDC Macrogrid Transmission for the Continental US, IEEE Transactions on Power

Transmission costs are **tiny** compared to other resource/infrastructure costs

TRANSMISSION COSTS







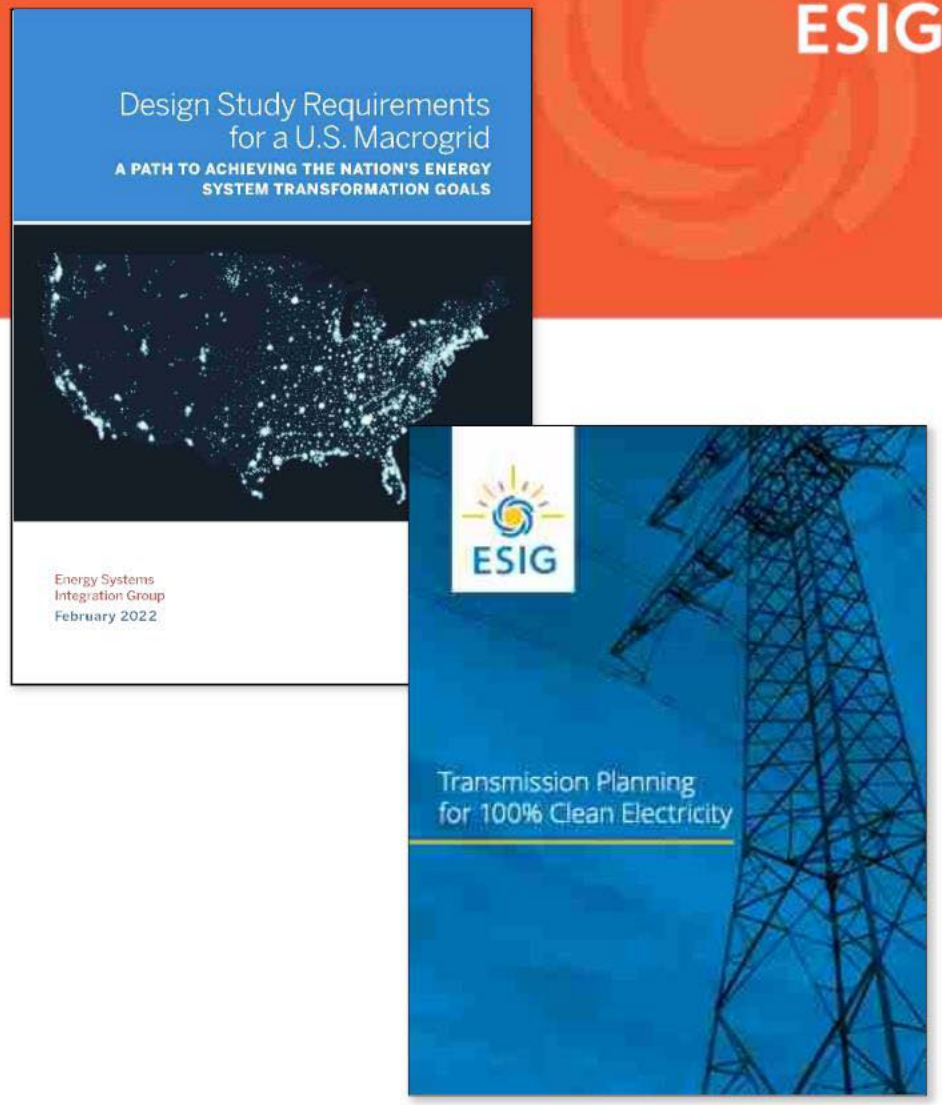
Brown and Botterud, "The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System," Joule 5, 1-20, Jan 20, 2021; data from NREL Interconnection Seams Study; data from VCE's ZeroByFifty Study

ESIG recommendations

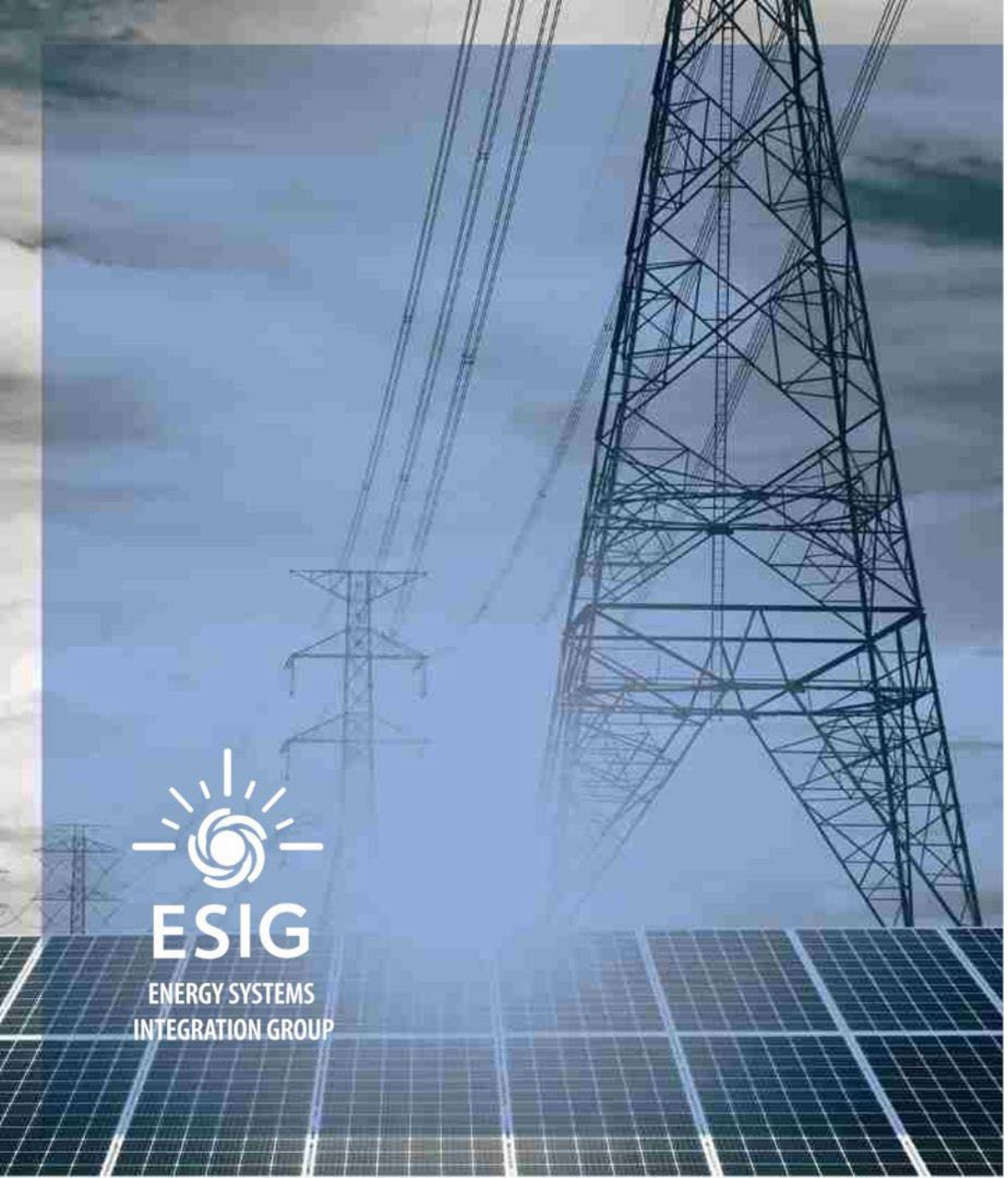
We need ongoing national transmission planning, not just a one-off study

We need to proactively plan and build transmission to high quality clean energy zones

We need to design and evaluate performance of a national macro grid for reliability, resilience, operations and economics



https://www.esig.energy/design-study-requirements-for-a-u-s-macrogrid/
https://www.esig.energy/transmission-planning-for-100-clean-electricity/



THANK YOU

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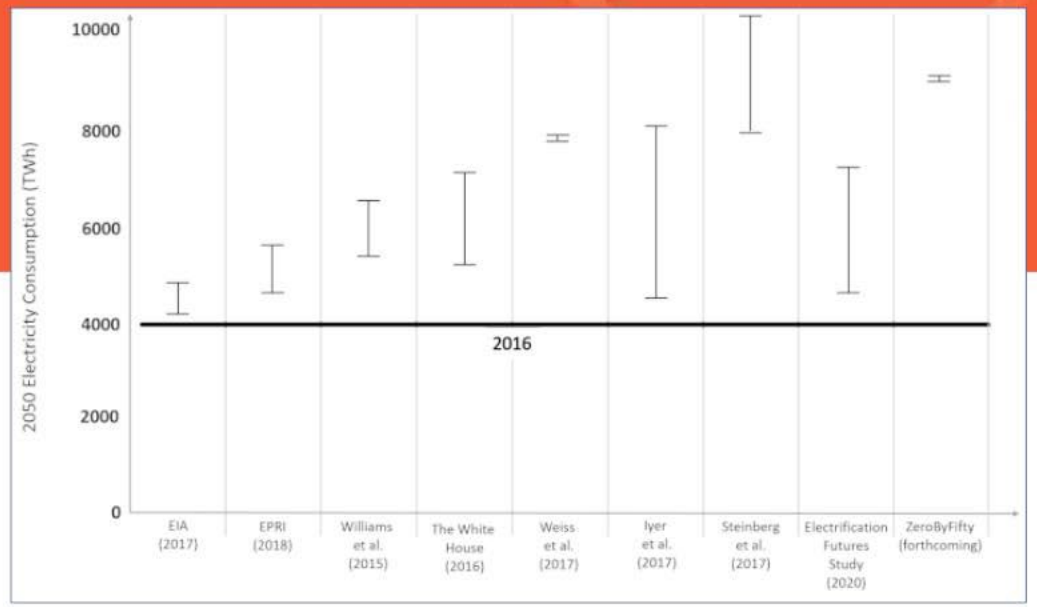
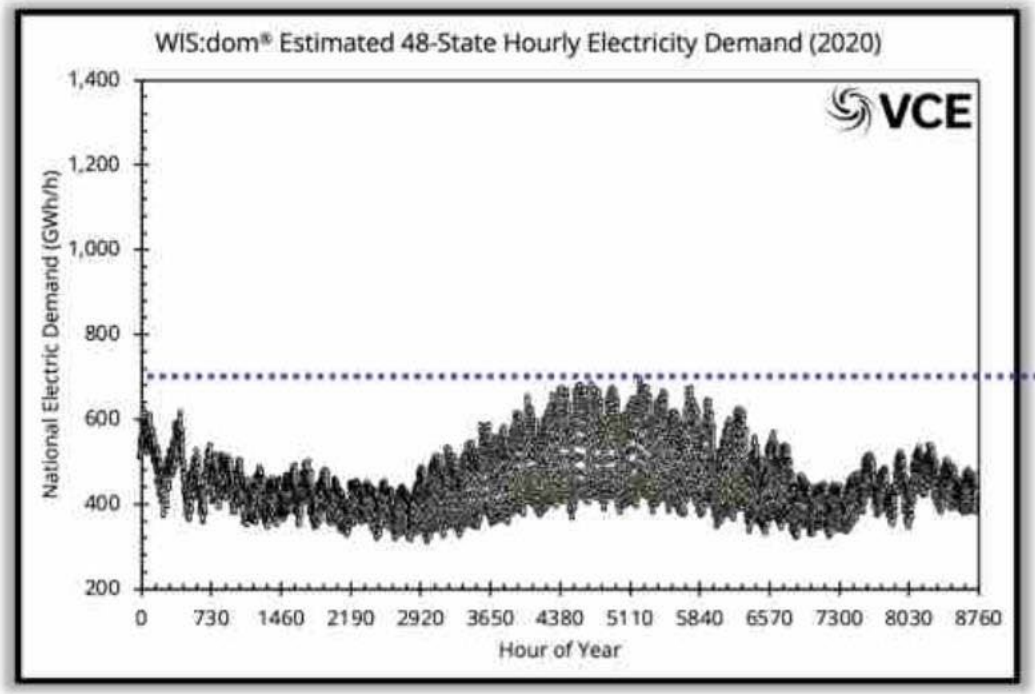
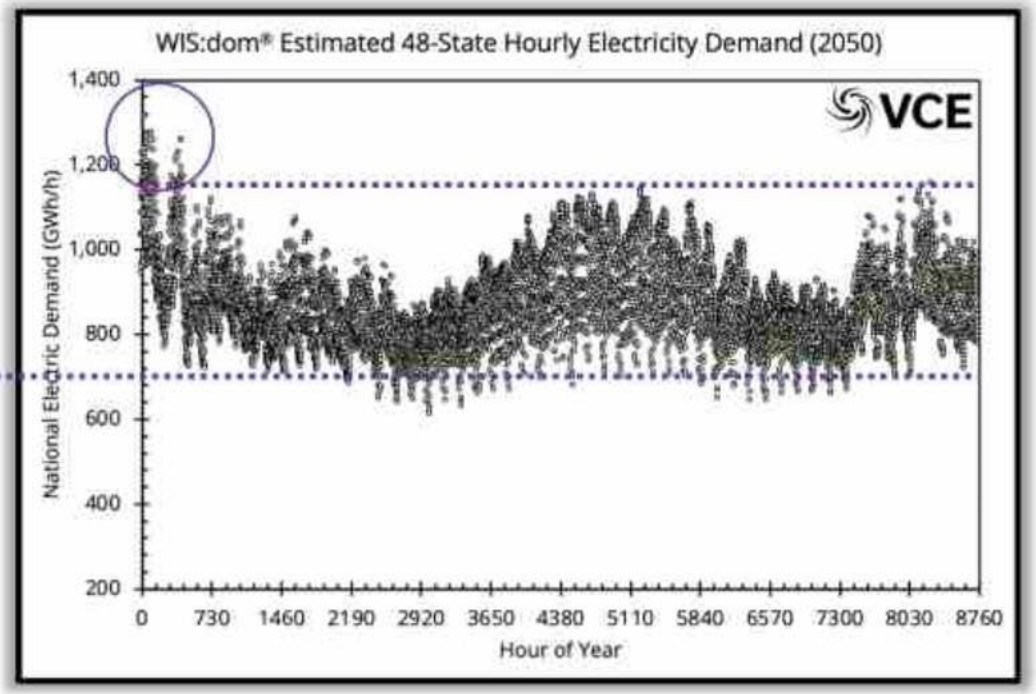
Electricity demand will change and increase

Demand will increase due to electrification

DERs will contribute but are not sufficient on their own



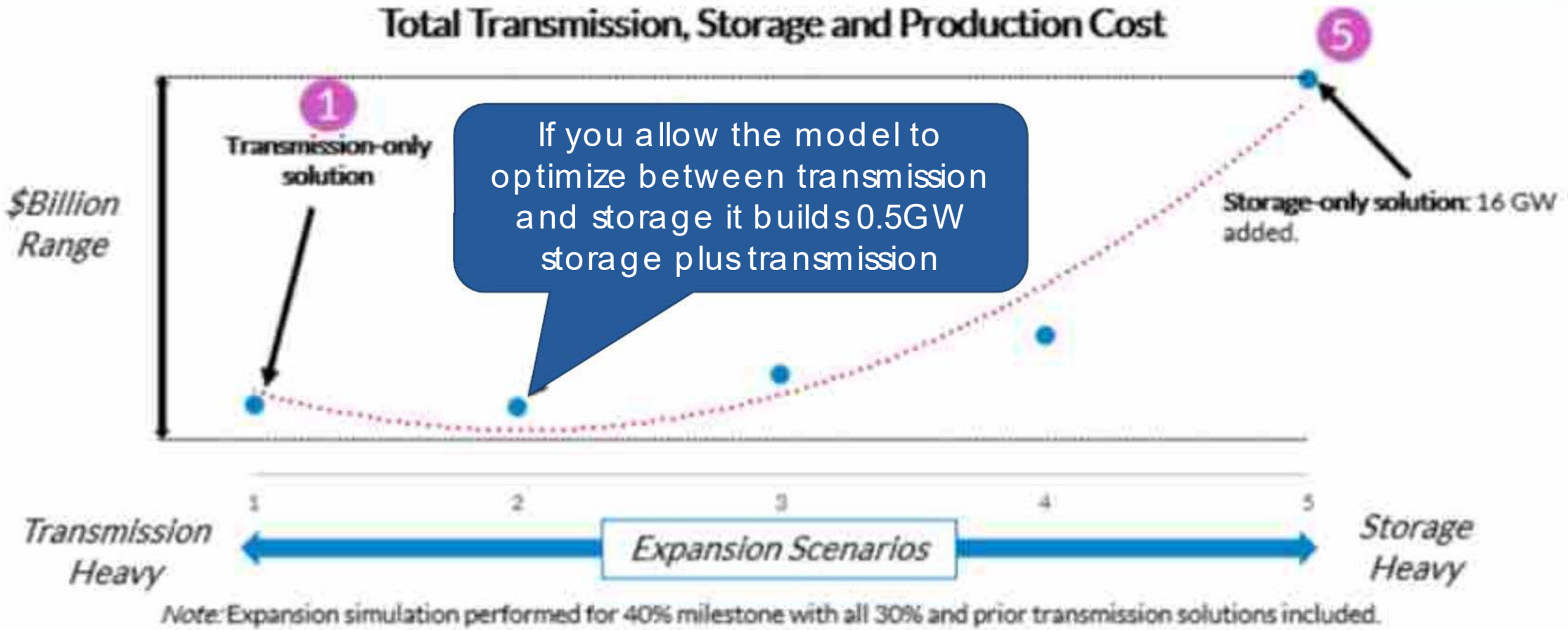




Source: C. Clack, IEEE PESGM 2021, NREL Electrification Futures Study 2020

Storage-only solutions can be more expensive and may not address all the issues

If you allow the model to optimize size of storage only, it builds 16GW storage



https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf

You may need transmission even with high levels of DERs

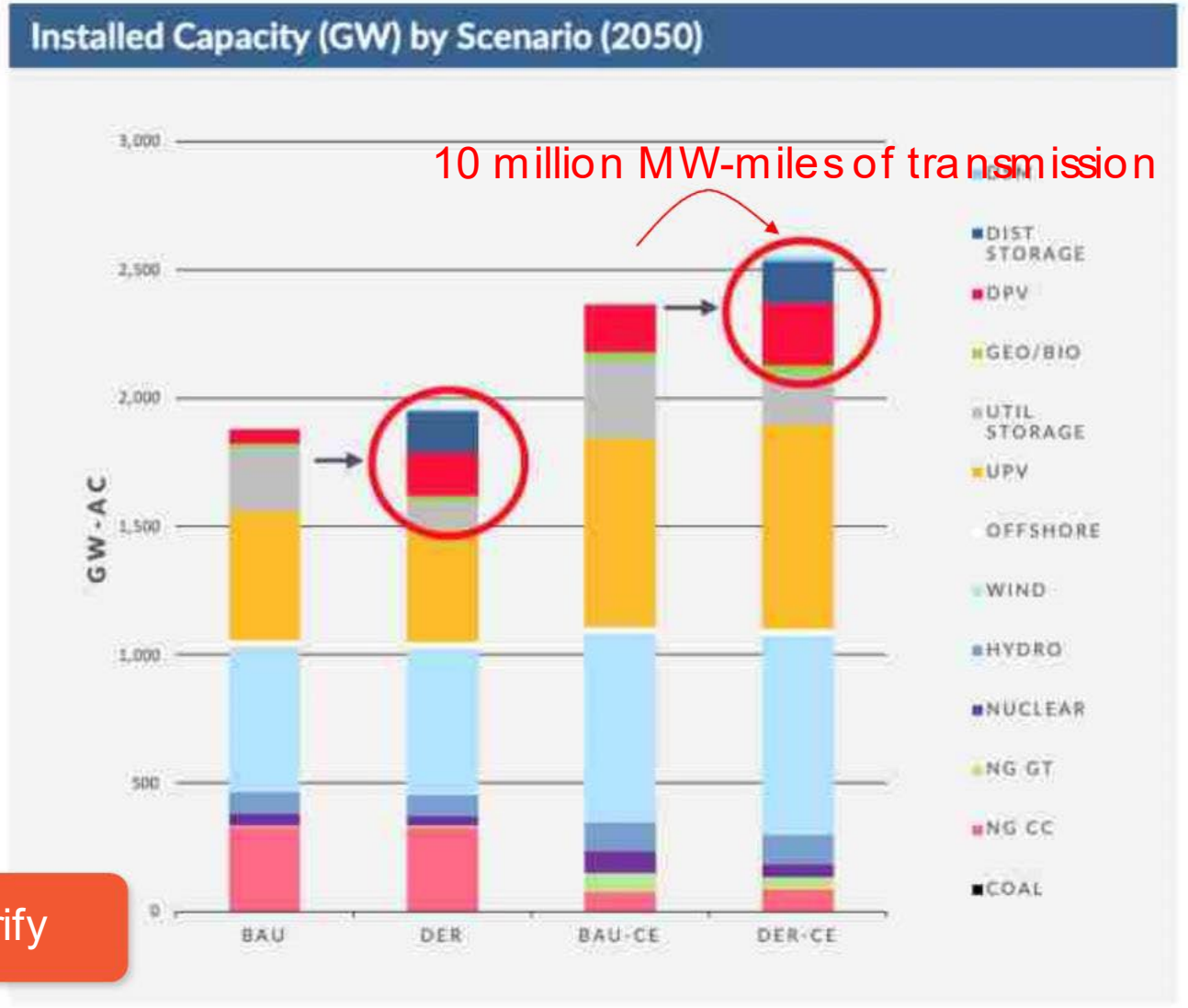
Optimizing G, T&D saves money vs not including distribution in optimization

Benefits are even bigger if you have clean energy goals - save $473B by optimizing G, T&D

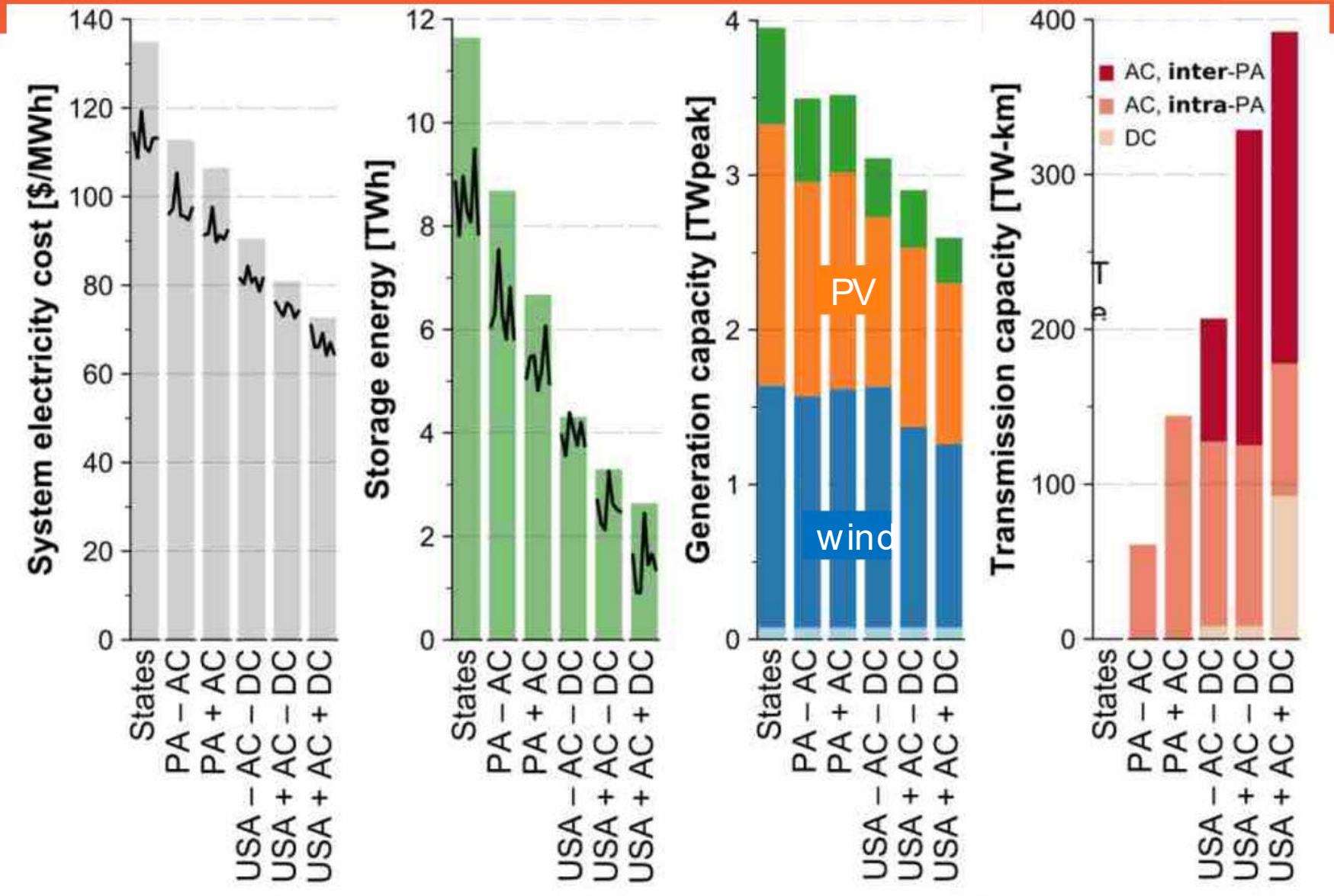
Optimizing G, T&D builds more DERs and also builds more transmission

https://www.vibrantcleanenergy.com/wp-content/uploads/2020/12/WhyDERs_TR_Final.pdf

Managing distribution will be critical as we electrify



Increased transmission reduces storage capacity needs



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