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CONGRESSIONAL BRIEFING

Modernizing America's Transmission Network

Briefing Series: Modernizing the U.S. Energy System: Opportunities, Challenges, and the Path Forward

Friday, June 11, 2021

About EESI...

EESI
Environmental and Energy Study Institute

NON-PROFIT

Founded in 1984 by a bipartisan Congressional caucus as an independent (i.e., not federally-funded) non-profit organization

NON-PARTISAN

Source of non-partisan information on environmental, energy, and climate policies

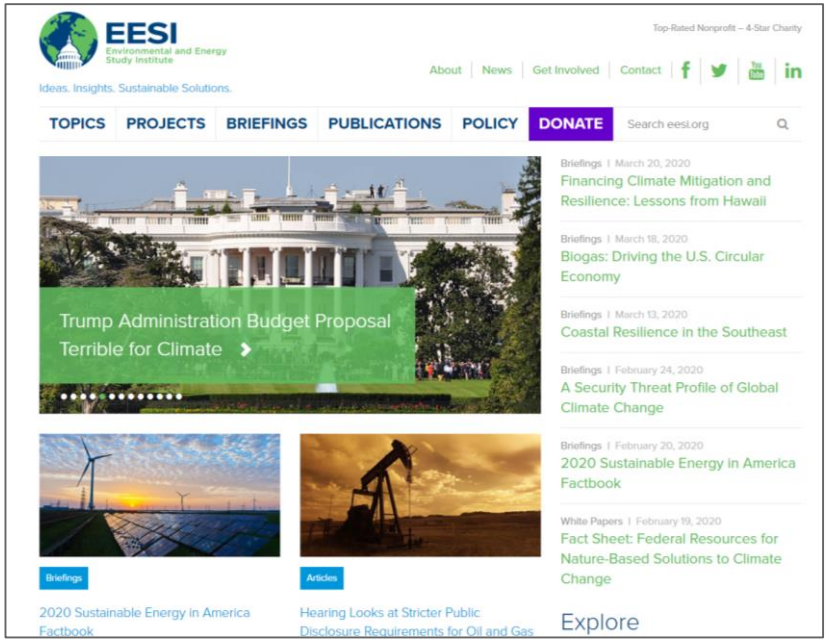
DIRECT ASSISTANCE

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop “on-bill financing” programs

SUSTAINABLE SOCIETIES

Focused on win-win solutions to make our energy, buildings, and transportation sectors sustainable, resilient, and more equitable

...About EESI



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Modernizing the U.S. Energy System: Opportunities, Challenges, and the Path Forward

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- **June 11--Modernizing America's Transmission Network**
- **June 18--Leveraging Grid Edge Integration for Resilience & Decarbonization**

Webcasts and written summaries available at www.eesi.org

Audio-only excerpts released via The Climate Conversation *podcast*

Fact sheets, fact sheets, web articles, and web articles

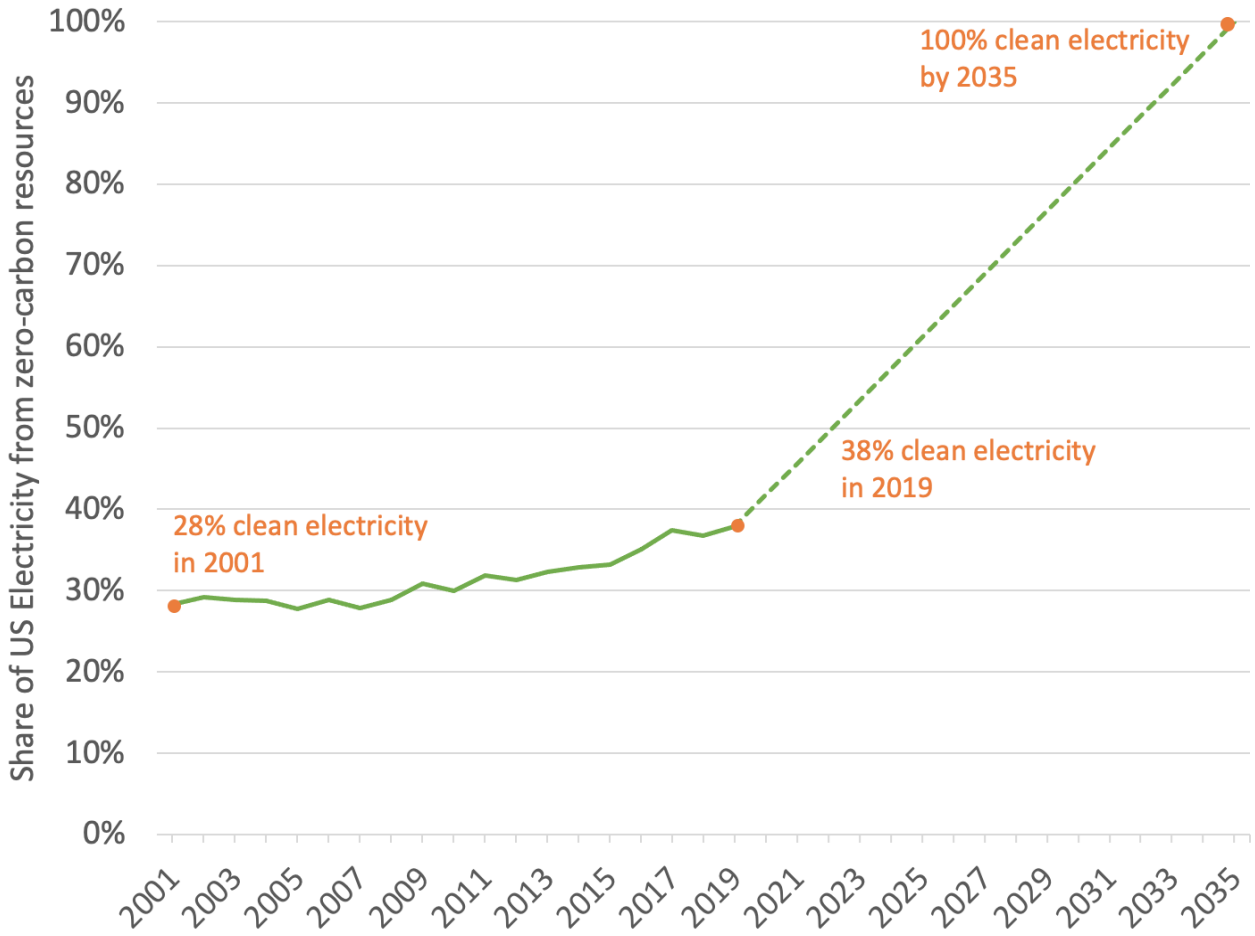
Transmission Planning for 100% Clean Electricity

Dr. Debra Lew, Associate Director, ESIG
EESI Congressional Briefing
June 11, 2021

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

How can we enable cleaner electricity while maintaining affordability and reliability?

Decarbonization requires action on a transformative scale



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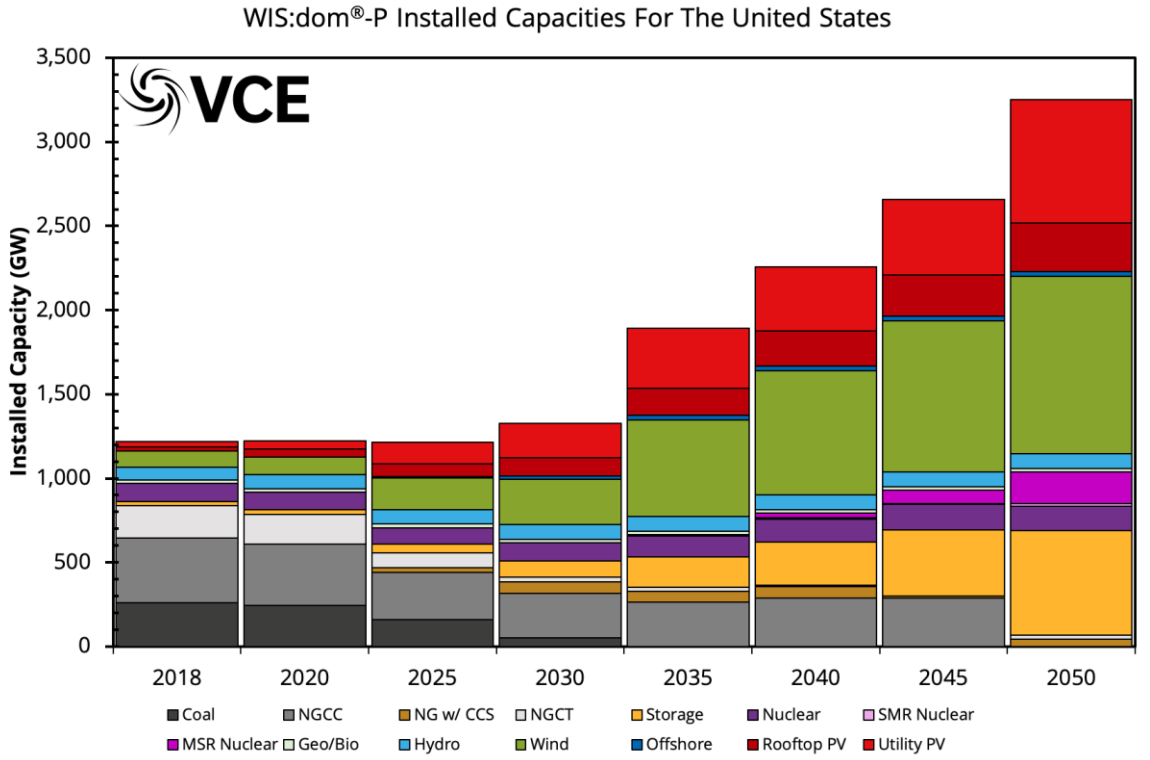
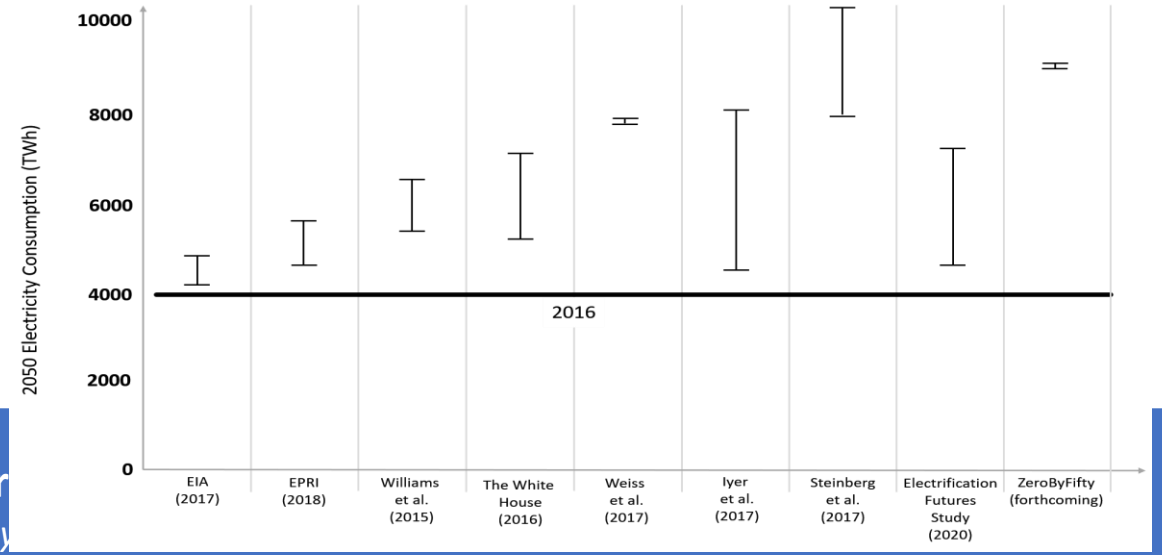
We need transmission to deliver significant resources

- We may need 1000 GW+ of new wind and solar for 100% clean electricity goals.
- Electrification will lead to significantly increased demand.
- Distributed energy resources (DERs) will contribute but are not sufficient on their own





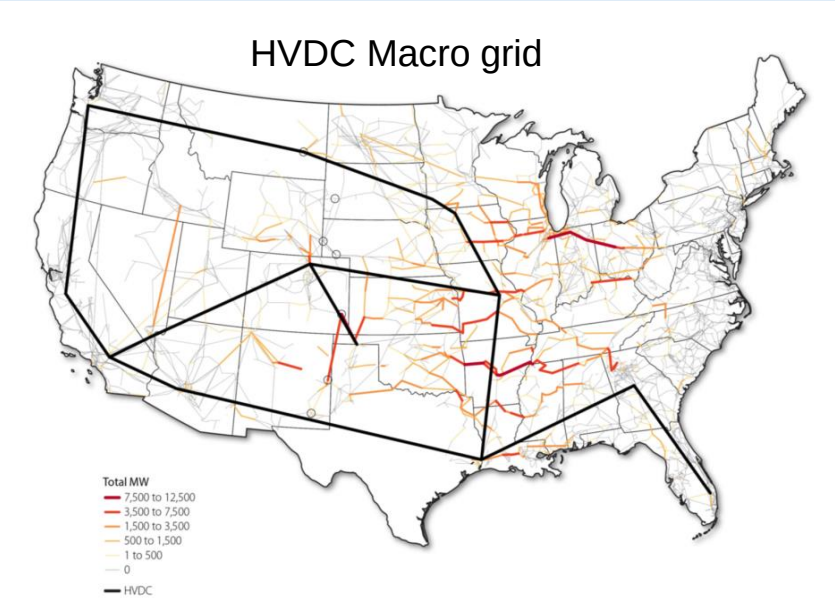
MISO RIIA 100% buildout [MW]			
	DPV	UPV	wind
MISO	32,190	67,975	129,647
SPP	8,139	14,700	41,750
TVA	40,174	85,275	7,300
SERC	85,119	180,825	15,250
PJM	41,174	93,100	185,600
NYISO	8,483	19,675	31,600
Total	**215,279**	**461,550**	**411,147**

Energy Systems Integr
Charting the Future of Energy

Source: MISO RIIA Study, Preliminary results from VCE's ZeroByFifty Study, NREL Electrification Futures Study

A macro grid saves money – especially if you are decarbonizing

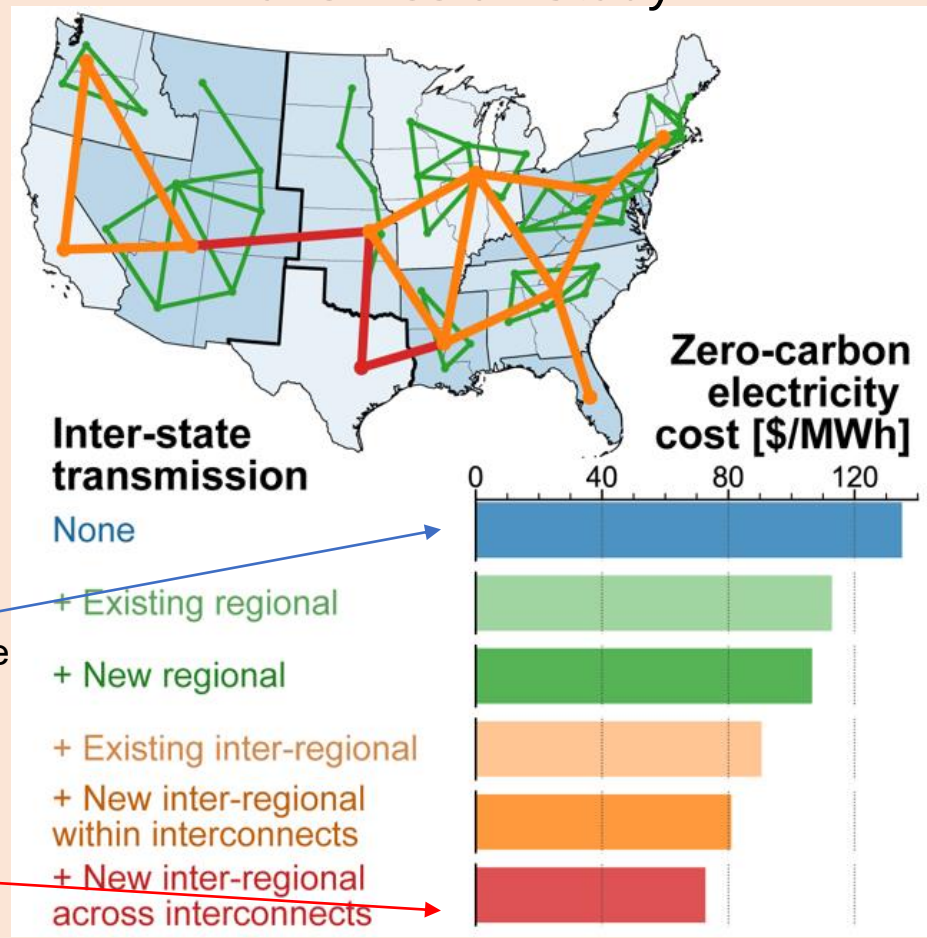
NREL Interconnection Seams Study



- 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

https://www.nrel.gov/analysis/seams.html

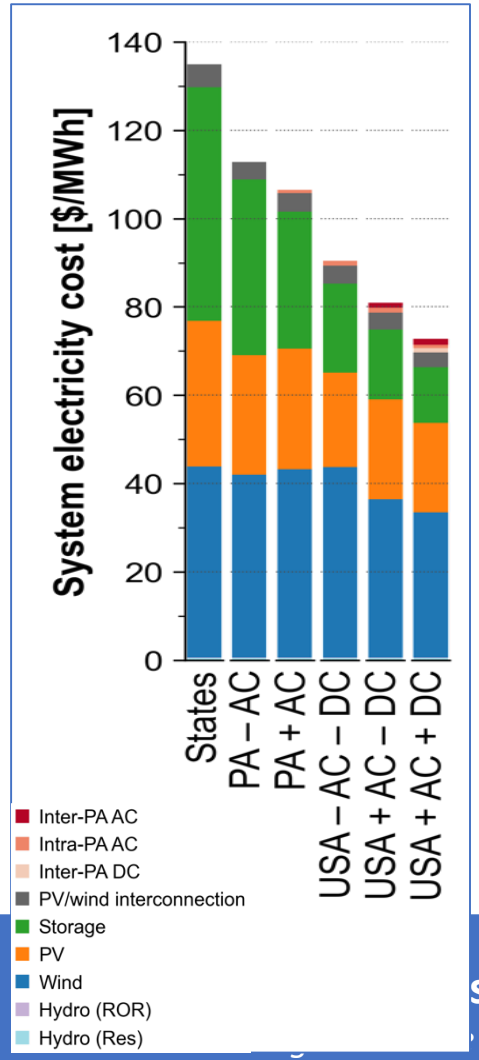
MIT Transmission Study

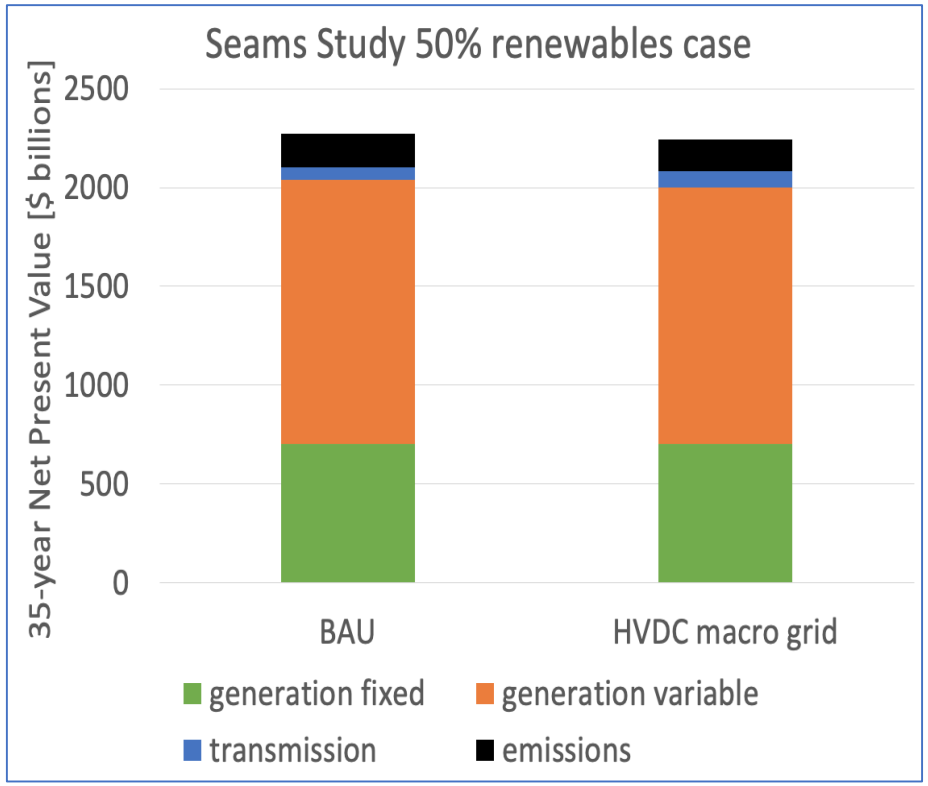


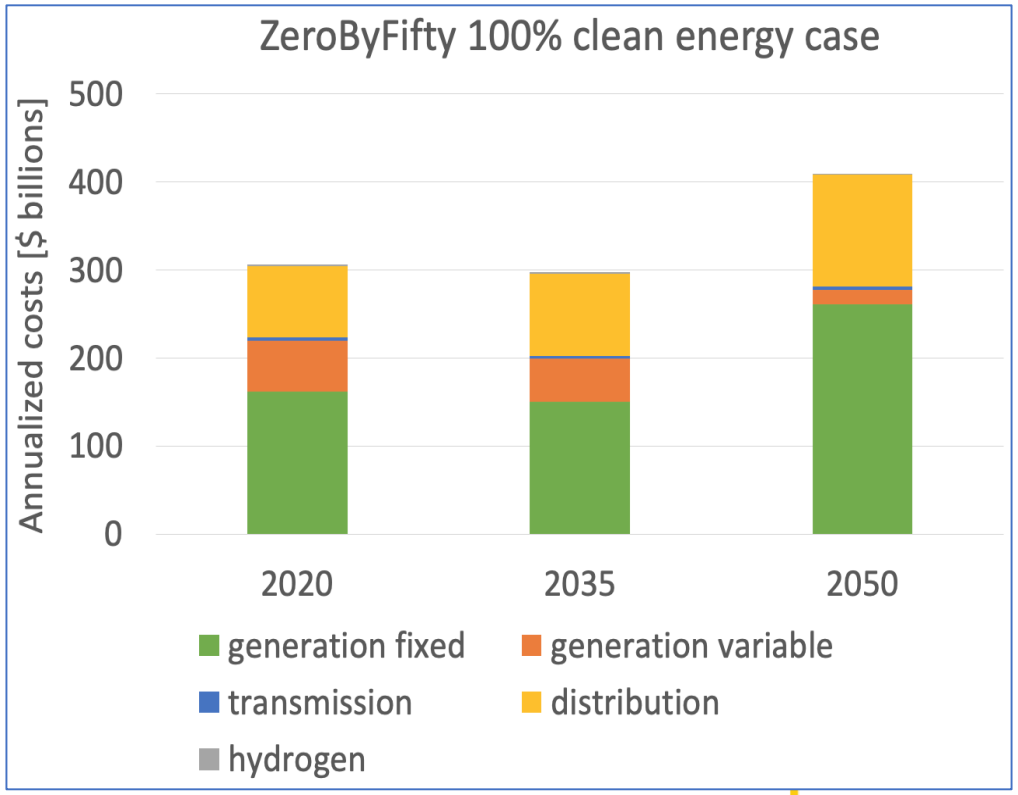
”Every state for itself” costs twice as much as the nationally optimized and coordinated approach

https://doi.org/10.1016/j.joule.2020.11.013

Transmission costs are tiny compared to other clean resources/infrastructure







s Integration Group

of Energy Systems Integration and Operations

Brown and Botterud, 2020; NREL Interconnection Seams study; Preliminary results from VCE's ZeroByFifty Study

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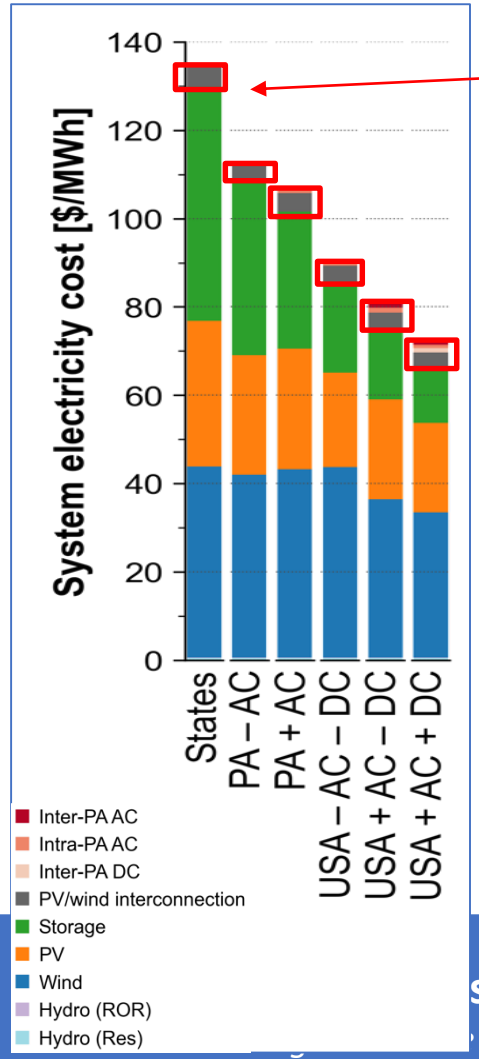
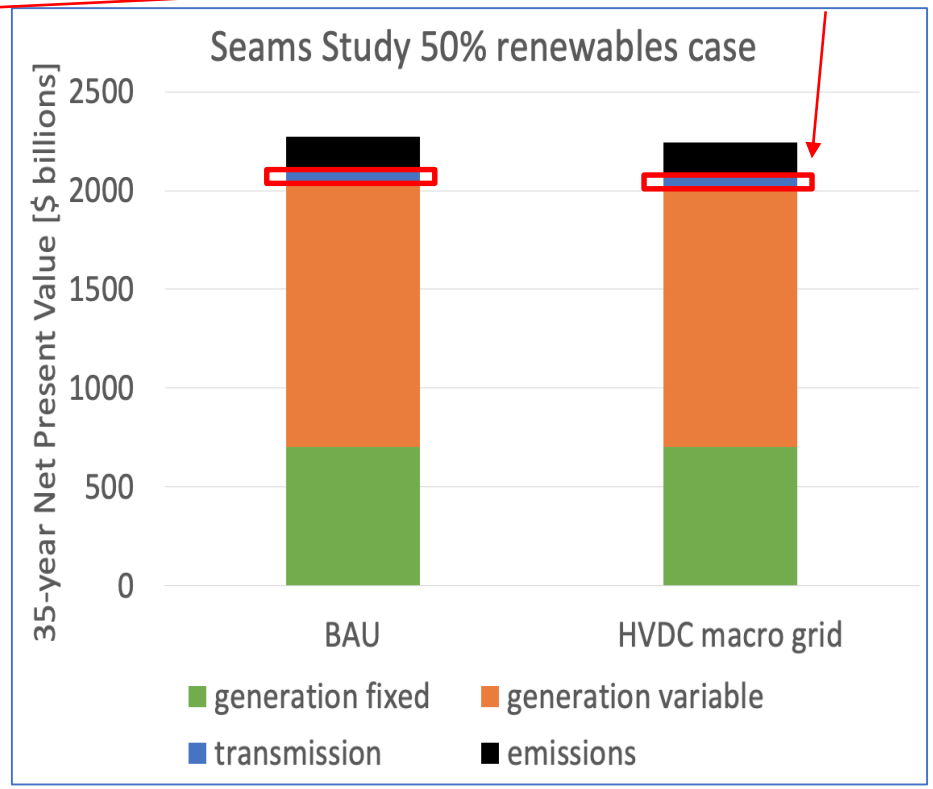
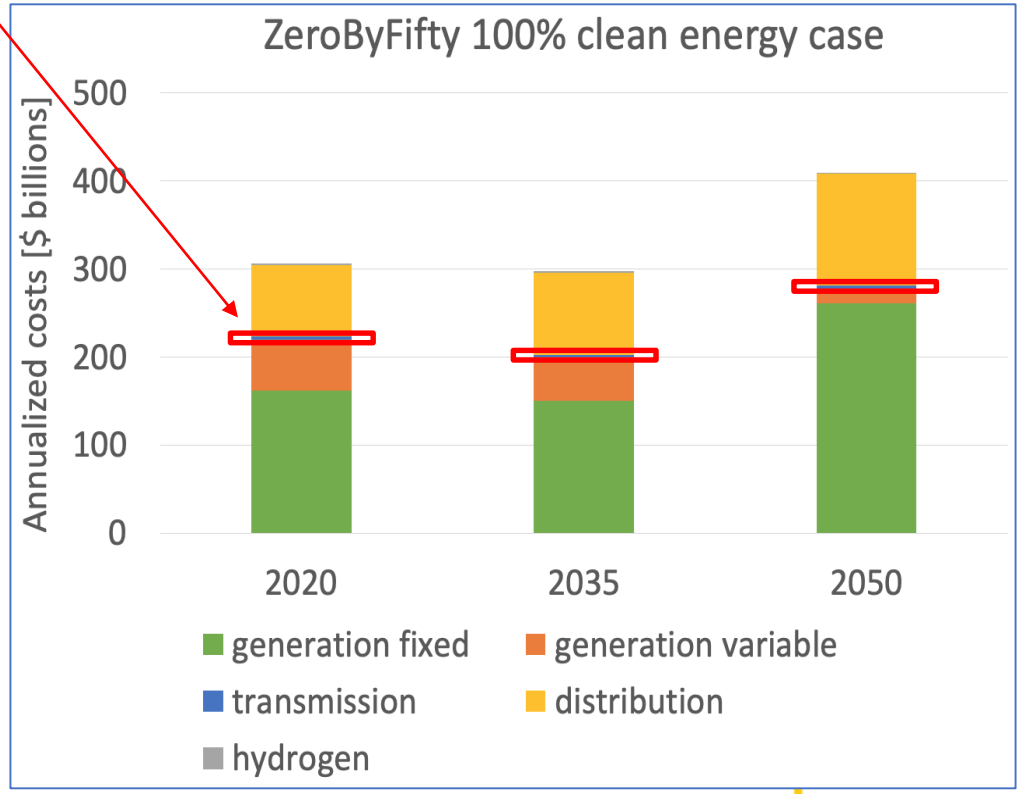
Transmission costs are tiny compared to other clean resources/infrastructure

TRANSMISSION COSTS







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Brown and Botterud, 2020; NREL Interconnection Seams study; Preliminary results from VCE's ZeroByFifty Study

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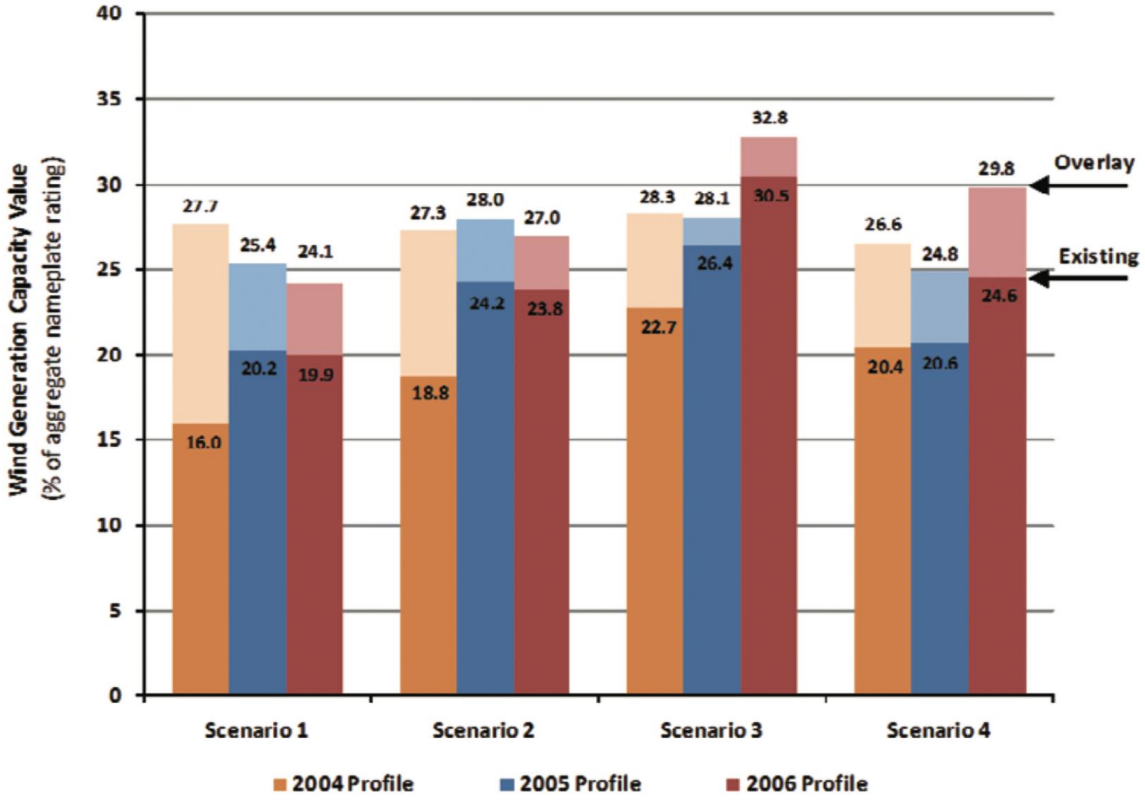
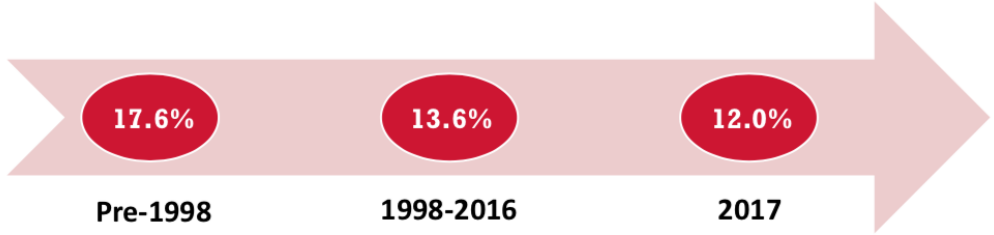
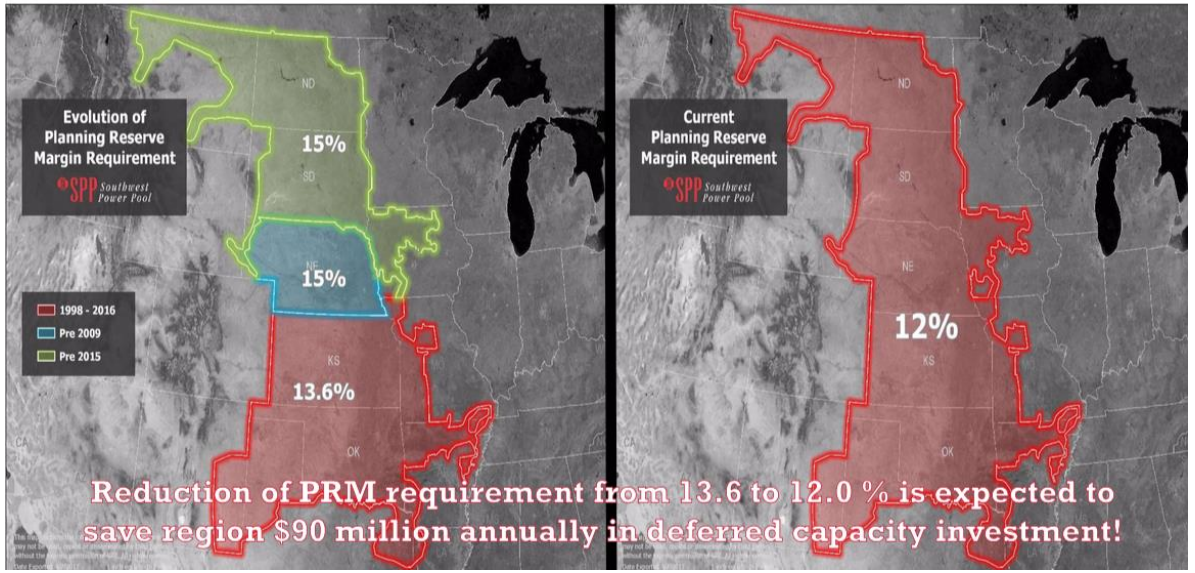
Transmission is not just about delivering resources to load

Transmission contributes to resource adequacy



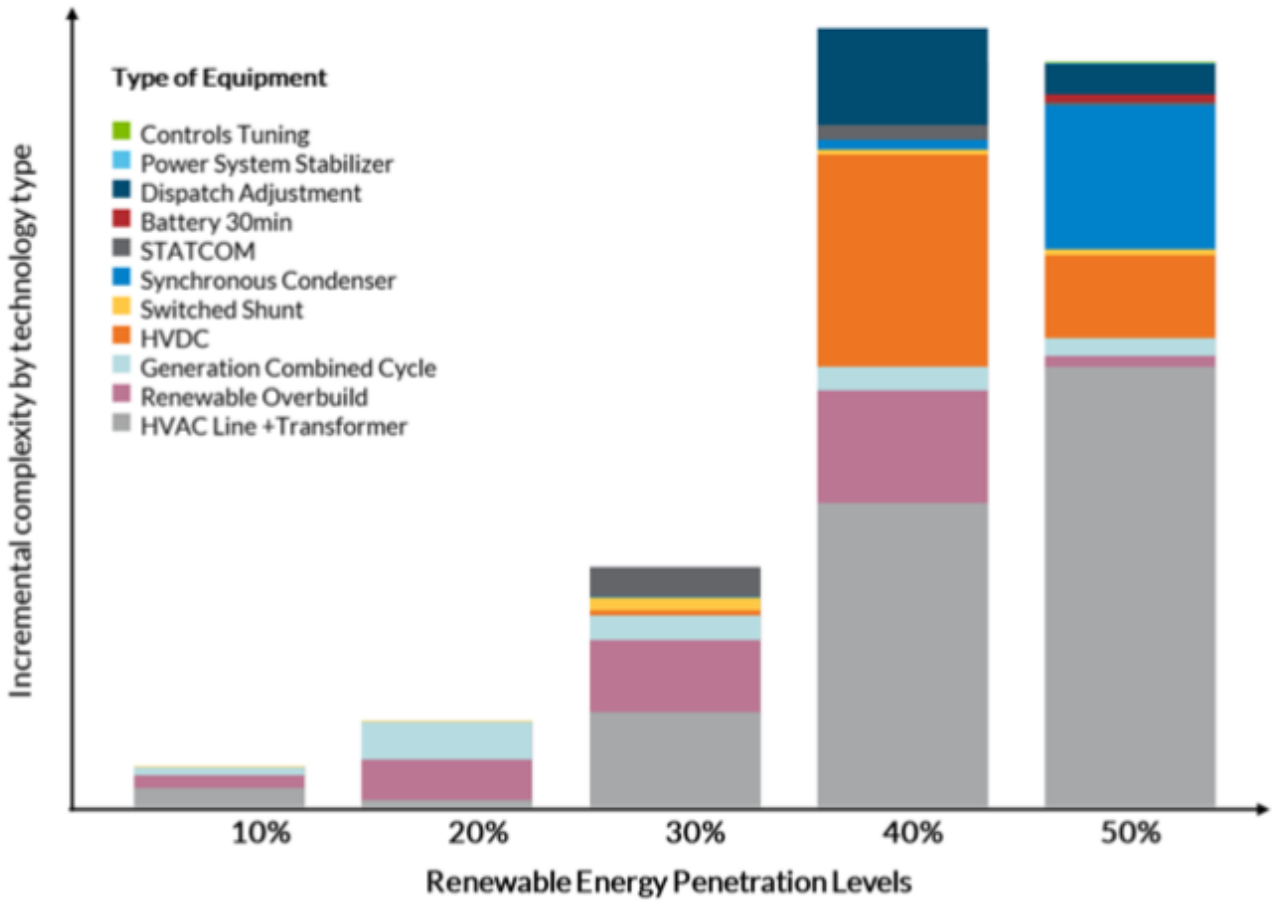


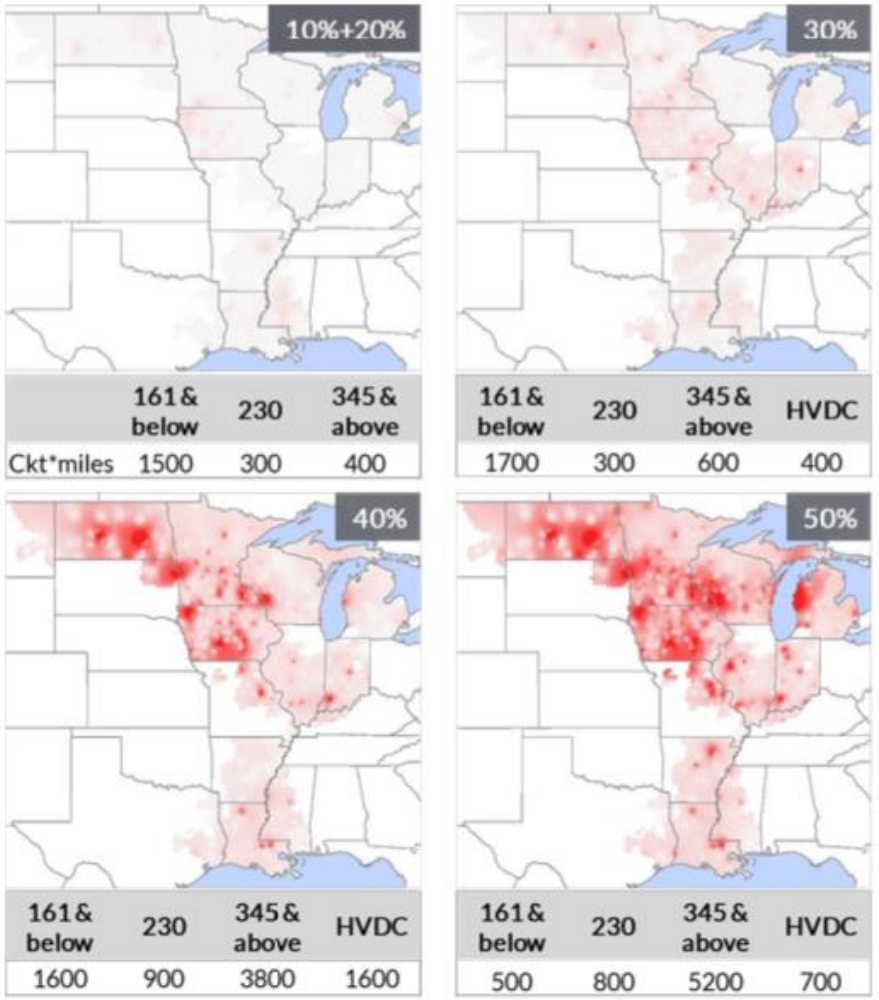


Transmission smooths all time scales of weather variability

Source: Enernex, EWITS, NREL/SR-550-47078, 2010; L. Nickell, SPP, CREPC Spring meeting, 2017

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





	161 & below	230	345 & above
Ckt*miles	1500	300	400

	161 & below	230	345 & above	HVDC
	1700	300	600	400

	161 & below	230	345 & above	HVDC
	1600	900	3800	1600

	161 & below	230	345 & above	HVDC
	500	800	5200	700

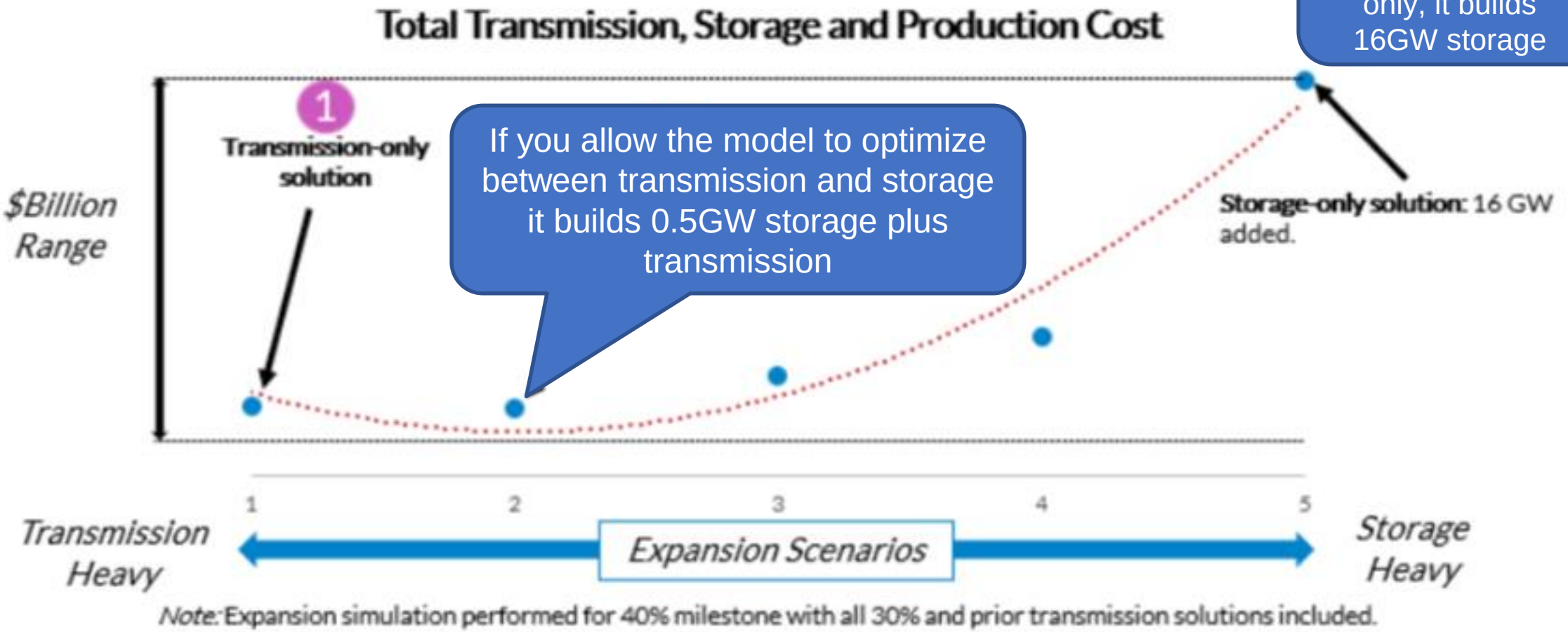
https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf

ESIG

Can’t we do this with storage? Or DERs?

Storage-only solutions are more expensive and don't address all the issues

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

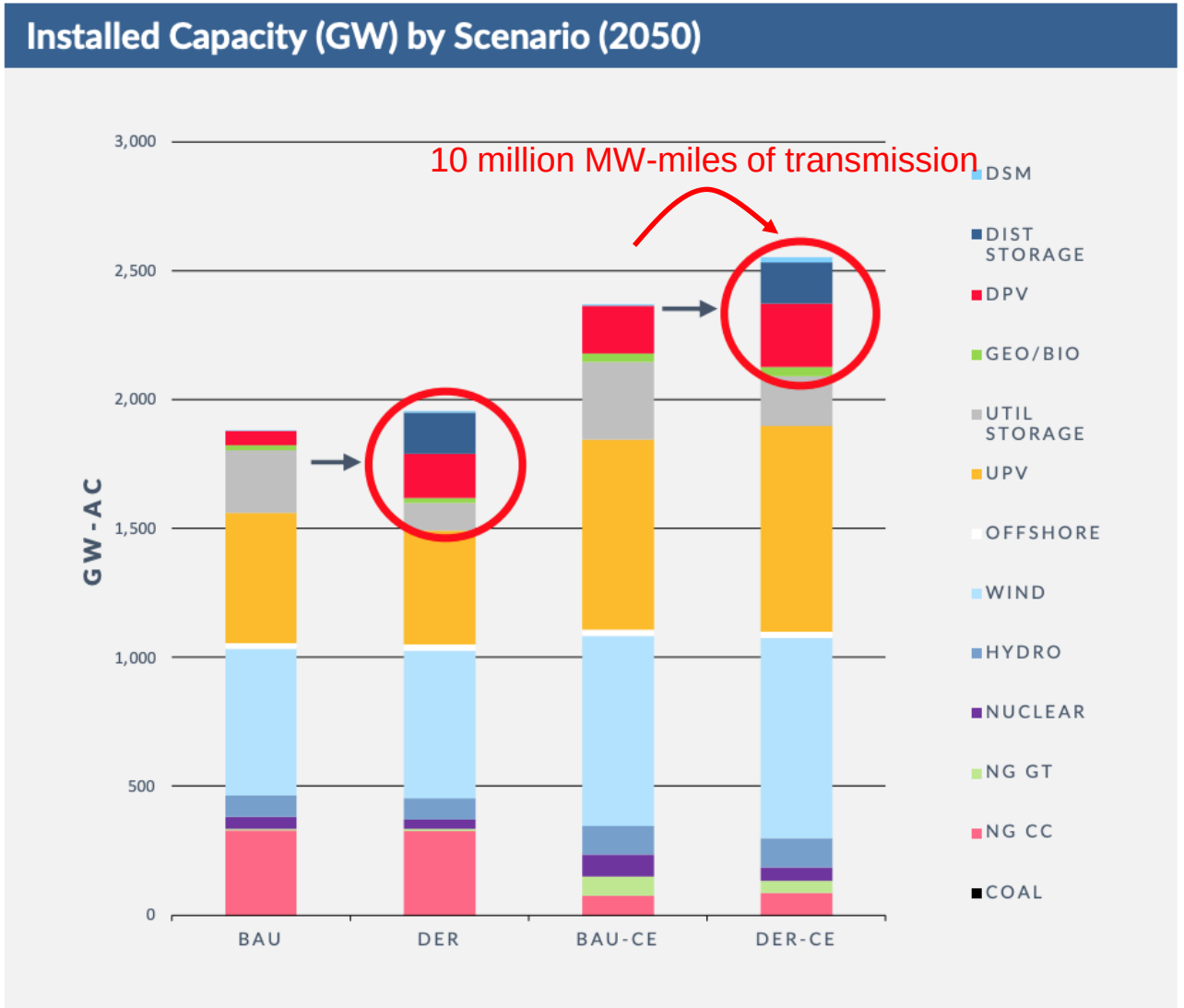


https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf

DERs are part of the solution. We still need utility-scale wind/PV

- 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

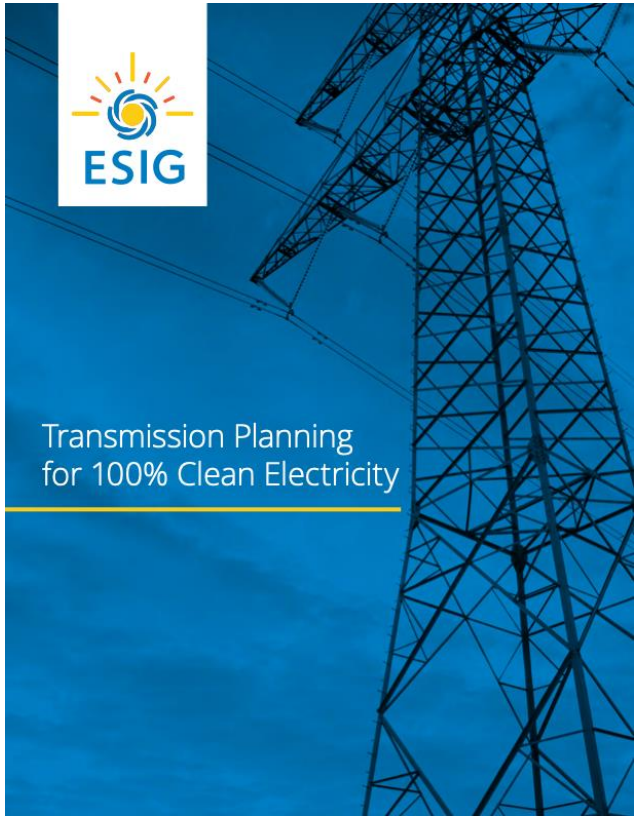
https://www.vibrantcleanenergy.com/wp-content/uploads/2020/12/WhyDERs_TR_Final.pdf



ESIG Recommendations

1. Create a national transmission planning authority that conducts ongoing national transmission planning
2. Identify renewable energy zones
3. Design a national macro grid

https://www.esig.energy/transmission-planning-for-100-clean-electricity/



Dr. Debra Lew
Debbie@esig.energy
(303) 819-3470

Extra slides

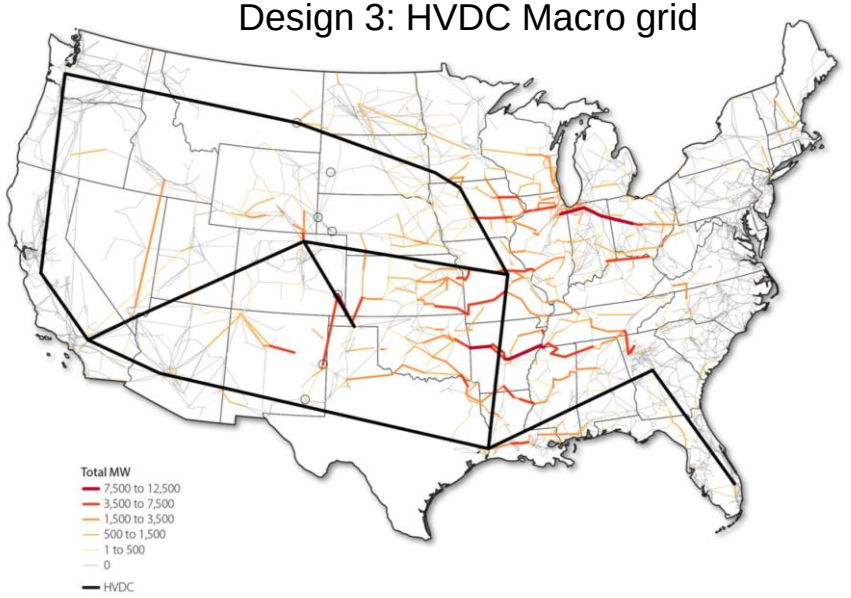
We evaluated a number of studies

Study	Region	Renewable Capacity	Clean Energy Level(s)	Annual Electricity Demand	Target Year
Electrification Futures Study	United States and Canada	600 GW (wind) 1,000 GW (solar)	23% to 75% renewable energy	7,000 TWh	2050
Interconnections Seam Study	United States (except Texas) and Canada	600-900 GW (wind and solar)	63% to 95% carbon free electricity	4,900 TWh	2038
MIT study	United States	1,200 GW (wind) 1,100 GW (solar)	100% clean electricity	5,000 TWh	2040
Renewable Integration Impact Assessment	United States - Eastern Interconnection	411 GW (wind) 677 GW (solar)	Up to 100% clean electricity for the eastern interconnection	2018 demand	N/A
ZeroByFifty	United States	1,100 GW (wind) 1,000 GW (solar)	100% clean energy	9,000 TWh	2050

Interconnections Seam Study

- What's the value of interconnecting the east and west?
- Crossing the seam allows you to build the solar in the west and the wind in the east and share
- 50% renewables case: macro grid adds $19B to transmission costs but saves $48B (generation capacity, O&M and emissions), for a benefit/cost ratio of 2.5
- 85% renewables case (95% clean electricity): macro grid builds 40GW transfers across seam with a benefit/cost ratio of 2.9

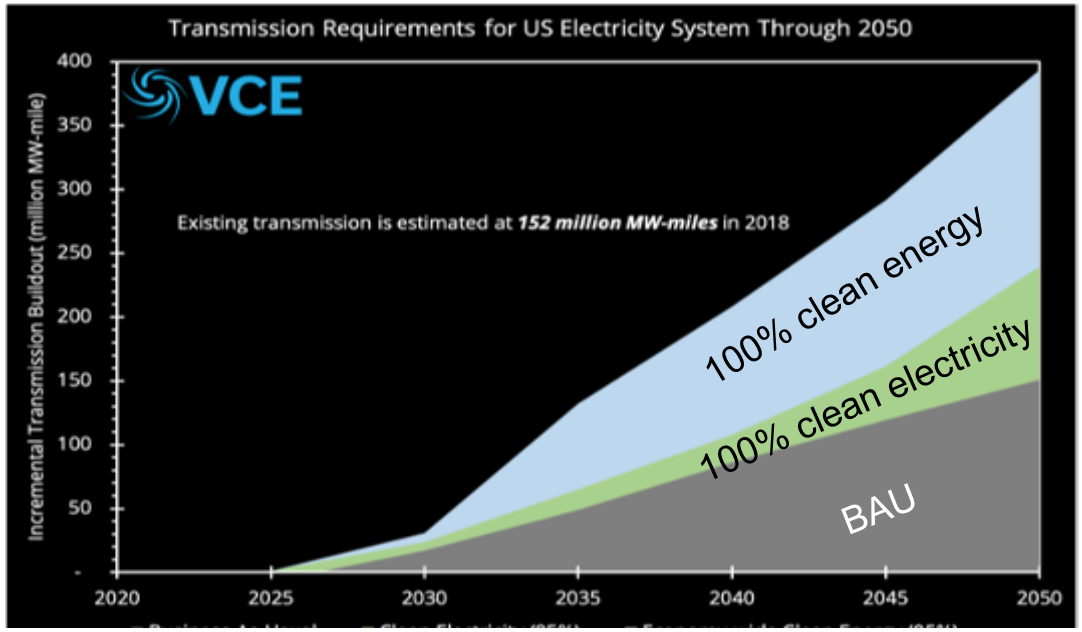
Design 3: HVDC Macro grid

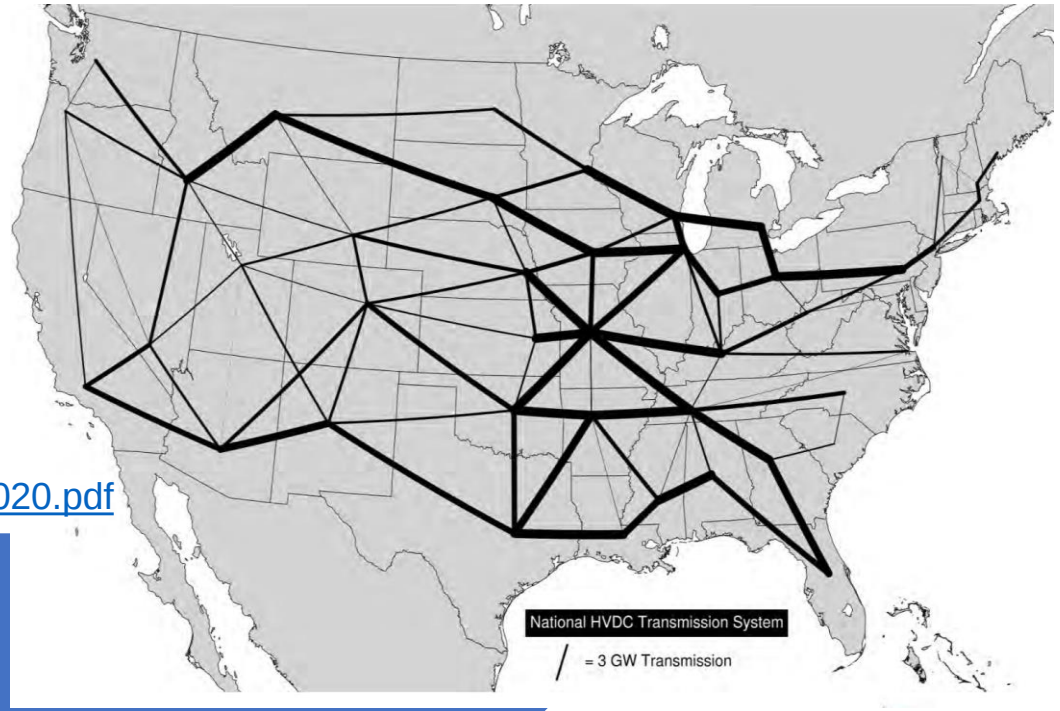


50% Renewables case	BAU across seams	HVDC Macro grid	
Objective function	**Design 1**	**Design 3**	**Delta**
Line investment (B$)	61.21	80.10	18.89
Generation investment (B$)	704.03	700.51	-3.52
Operation and maintenance (B$)	1336.36	1300.70	-35.66
Emission cost (B$)	171.10	162.50	-8.60
35-yr B/C ratio	-	-	2.52

ZeroByFifty

- What is the optimal resource and transmission expansion to decarbonize the whole energy economy including massive electrification?
- Considers widespread DERs, new nuclear, CCS, and hydrogen
- Co-optimize generation (utility-scale and distributed), storage and transmission; combines capacity expansion and production simulation
- Transmission expansion costs are $200B and $350B for 100% clean electricity and energy, respectively
- Transmission depends on scenario: ~38GW between east/west; 30GW between east and ERCOT; 8 GW between west and ERCOT
- Finds that if a macro grid is NOT built, it costs an additional $1 Trillion to get to 100% clean energy by 2050

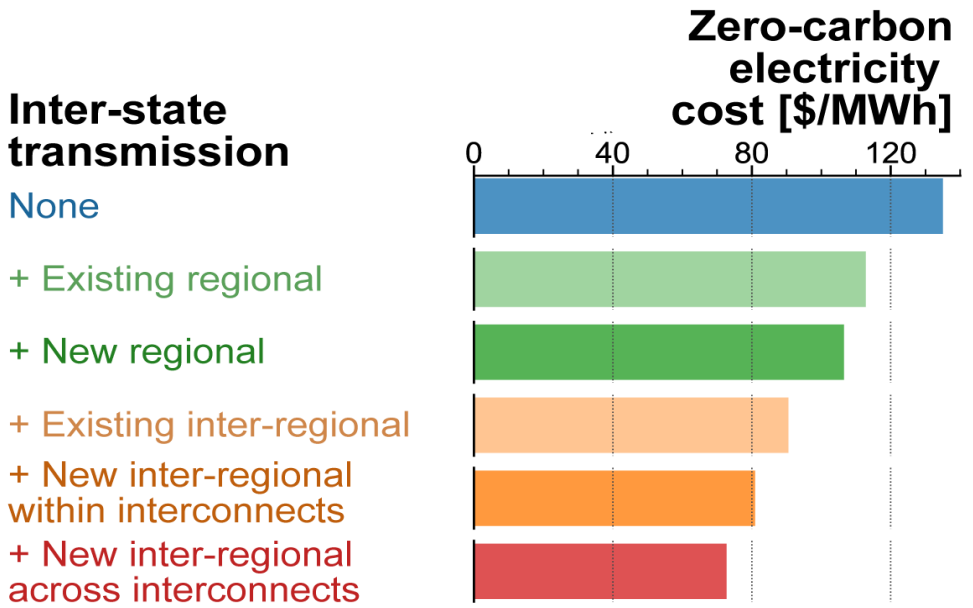


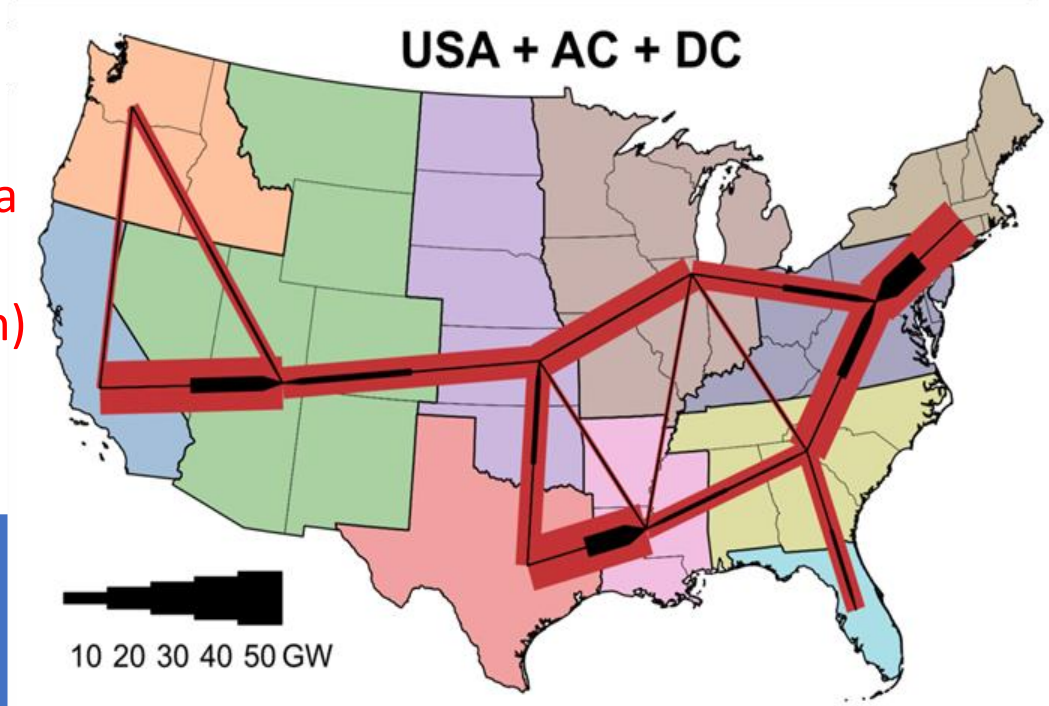


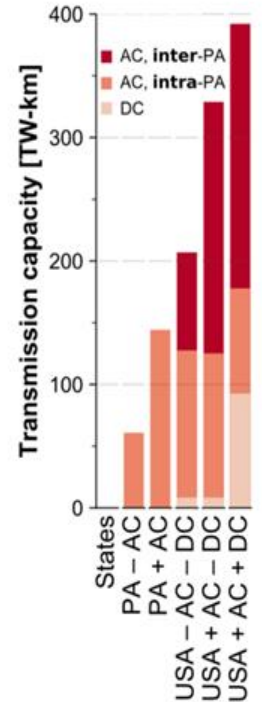
https://www.vibrantcleanenergy.com/wp-content/uploads/2020/11/ESIG_VCE_11112020.pdf

MIT Study - Value of Transmission for Decarbonization

- What is the value of coordination within regions, between regions and nationally?
- Co-optimized capacity expansion and dispatch model with 7 years of hourly weather
- Least-cost plan results in nearly double today's transmission system (in MW-miles) with 29 GW transfers between east and west and 74 GW between ERCOT and east
- Finds that an "every state for itself" approach has a levelized capital and O&M cost of $135/MWh and that this cost can be reduced by 46% (to $73/MWh) with inter-regional coordination and transmission expansion







https://doi.org/10.1016/j.joule.2020.11.013

Energy Systems Integration Group

Charting the Future of Energy Systems Integration and Operations

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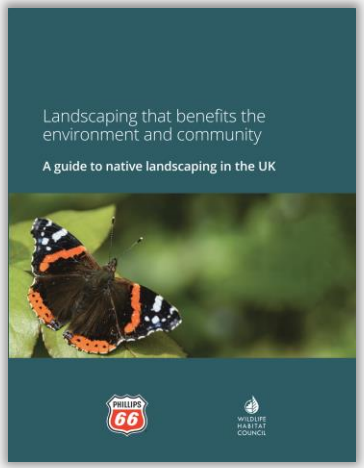
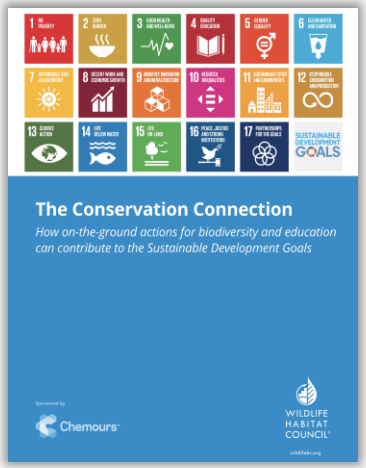
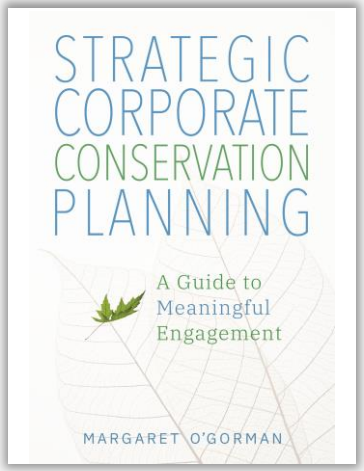
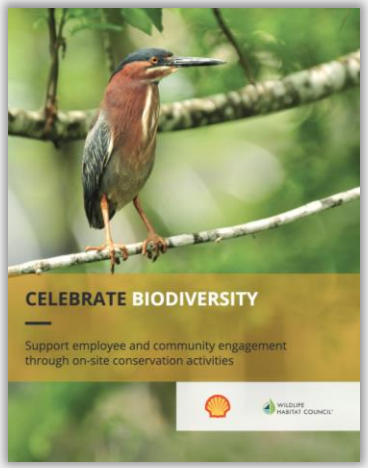
Maximizing Co-benefits of America's Transmission Network

Leaders in community-forward conservation strategies tailored to the context of the private sector









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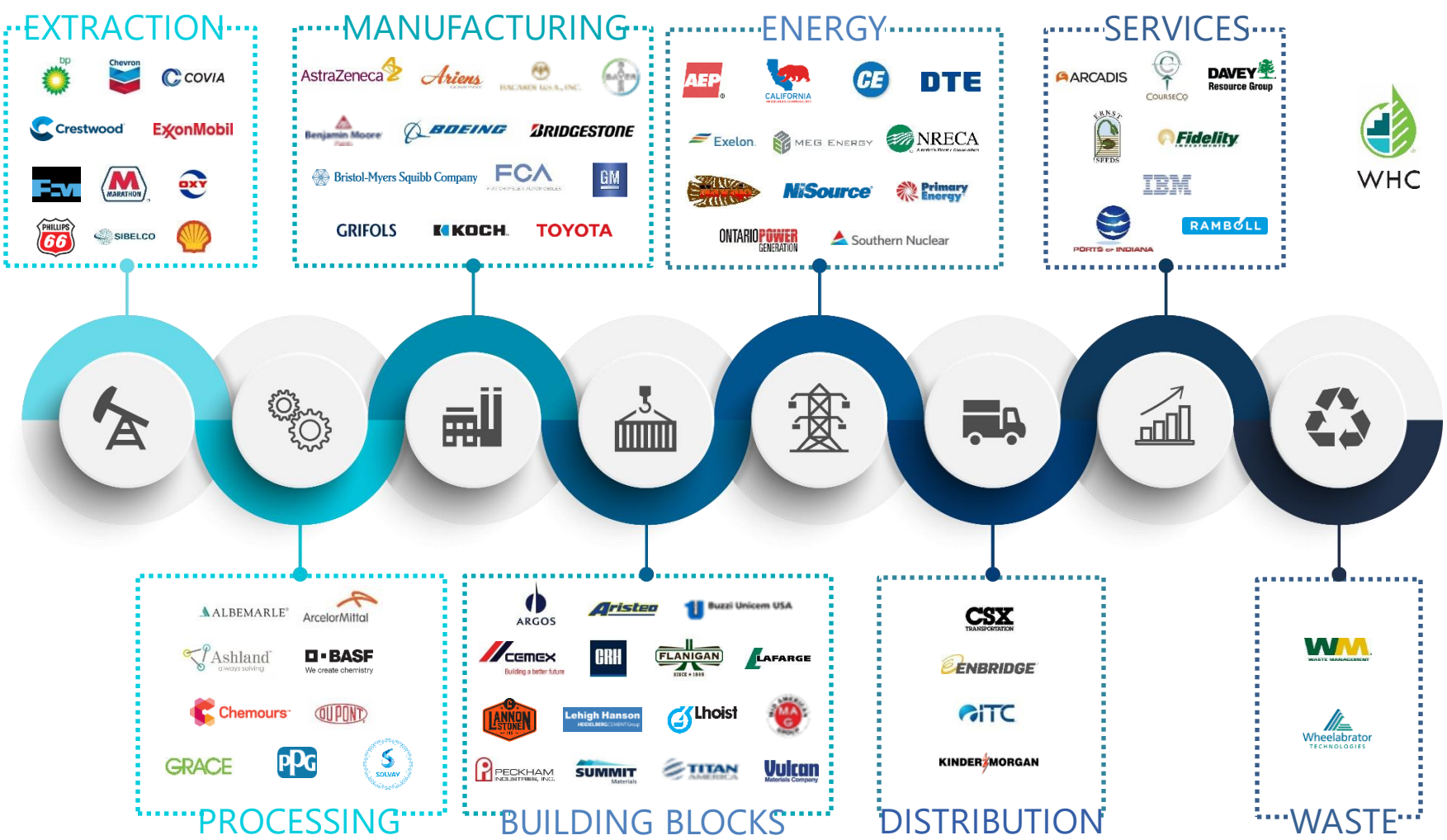
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In brief

- Ecosystem conservation
- Respecting Tribal Lands
- Resilient Communities
- Integrated Strategy

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Thank you

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