



Bridging the Gaps: The Impact of Interregional Transmission on Emissions and Reliability

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The decline in the cost of wind and solar generation over recent decades has significantly altered the energy landscape. With these technologies becoming economically viable, even without stringent decarbonization policies, the role of interregional transmission has become increasingly important. This study examines the value of interregional transmission to the U.S. grid under current policies and deep decarbonization scenarios as it is implemented through transmission legislation. By utilizing the GenX capacity expansion model, we evaluate the proposed BIG WIRES Act, which mandates a minimum interregional transfer capability requirement. Our results show that building more interregional transmission leads to system cost savings, grid reliability during extreme weather events, and climate benefits.

One of the dramatic changes to the energy landscape over the last decade has been the substantial decline in the cost of wind and solar generation. Globally, the levelized cost of electricity (LCOE) for wind and solar decreased by 69% and 89%, respectively, from 2010 to 2022 (IRENA, 2022). The US also saw similar trends with construction costs for wind and solar decreasing by 25% and 58% within the same period (EIA, 2023). New investments in these technologies therefore often make economic sense on their own, even without stringent decarbonization policies. Interregional transmission can be a valuable complementary investment.

The proposed BIG WIRES Act is a piece of legislation that requires each FERC Order No. 1000 region to meet minimum interregional transfer capability (MITC) requirements (Hickenlooper and Peters, 2023). A distinctive feature of the act is that it does not prescribe where each

region should build transmission. Rather, it provides a way to calculate the transfer capability requirement—the minimum between 30% of a region’s peak load and 15% of its peak load plus its current transfer capability—and lets the regions decide how to meet it.¹ This provides a more realistic, policy-driven grid expansion methodology to analyze the value of interregional transmission to the U.S. grid under current policies and deep decarbonization scenarios. We use the GenX capacity expansion model coupled with stylized heuristics that determine transmission builds to analyze four key areas: interregional transmission builds and grid characteristics, electricity system cost savings, grid reliability during extreme weather events, and climate benefits. We consider two main scenarios for a future 2035 grid—the current policies setting and the 95% CO₂ reduction setting—and determine the impact of the BIG WIRES Act and interregional transmission on these two scenarios.

¹ 30% is what we call the “MITC % of peak load” and is varied in sensitivity analyses.

I. Interregional Transmission Builds and Cost:

Table 1 shows the calculated MITC requirement and the existing and additional interregional transfer capability for each of the regions while Figure 1 shows the interregional transfer capability between regions. Both results show that most of the transmission builds are concentrated in the Eastern Interconnect owing to the way the minimum requirements are calculated and these regions' higher peak loads. We also observe that some regions build more than the prescribed minimum because its neighboring regions have higher requirements. An example would be the New York region which builds beyond its MITC to satisfy the Northeast's requirements. The blanket minimum requirements of the

BIG WIRES Act can therefore induce transmission builds beyond what the requirement is. This is especially true in regions that are adjacent to only one other region.

With these transmission builds, the BIG WIRES Act leads to lower system cost in the order of \$487 million and \$3.21 billion annually in the Current Policies and 95% CO₂ reduction scenarios, respectively. The savings come from being able to substitute interregional transmission with capital investments in thermal generators needed to balance the intermittency of renewables in unconnected regions. The larger savings in the 95% CO₂ reduction setting emphasizes the complementary benefit of interregional transmission and VRE resources.

	Peak Load (\bar{D}_r)	Current Transfer Capability ($\hat{T}C_r$)	MITC _r	$\frac{MITC_r}{\bar{D}_r}$	Additional	Total ¹¹	% Increase	$\frac{Total}{\bar{D}_r}$
California	70.93	19.08	21.28	30%	1.98	21.07	10%	30%
Florida	55.80	3.60	11.97	21%	8.25	11.85	229%	21%
Northeast	30.47	2.16	6.73	22%	4.50	6.66	208%	22%
Midwest	157.51	35.92	47.25	30%	13.39	49.31	37%	31%
Northwest	65.75	22.17	19.72	30%	1.73	23.90	8%	36%
New York	33.64	4.08	9.12	27%	8.84	12.92	217%	38%
Mid-Atlantic	195.35	24.01	53.32	27%	28.77	52.78	120%	27%
Southeast	160.27	23.32	47.36	30%	27.64	50.96	119%	32%
Central	59.67	10.42	17.90	30%	7.23	17.65	69%	30%
Southwest	47.17	12.40	14.15	30%	4.73	17.13	38%	36%

Table 1. Current and additional interregional transfer capability per region in the Current Policies setting (GW)

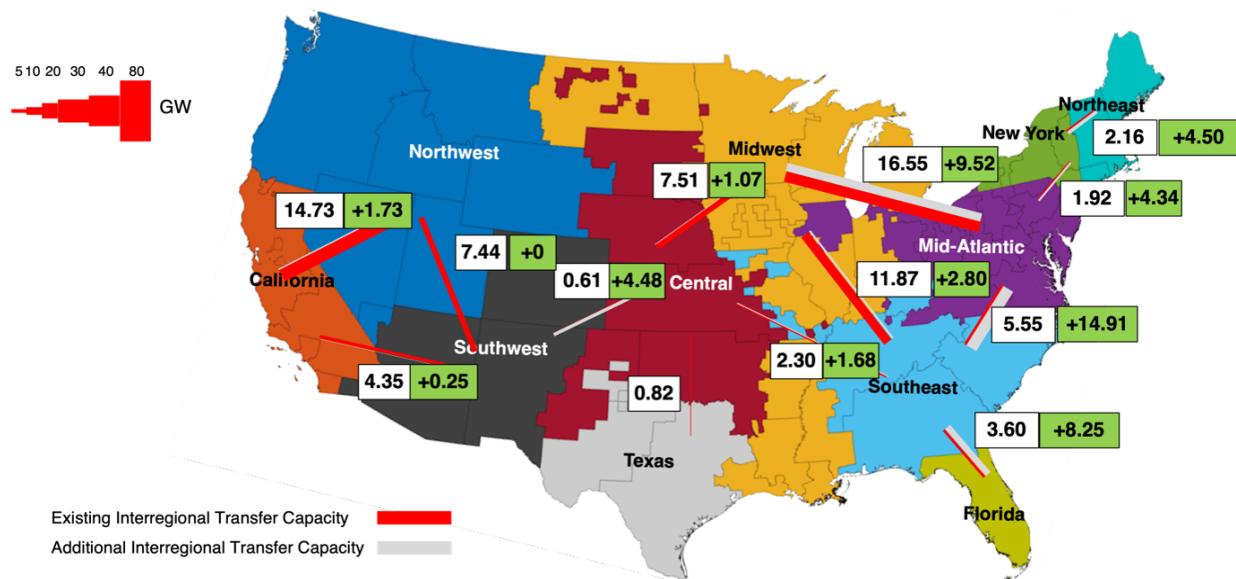


Figure 1. Current and additional interregional transfer capability per region in the Current Policies setting (GW)

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II. Reliability during Extreme Weather Events

Transmission infrastructure is believed to increase a power system's reliability and mitigate the impact of extreme weather events. To test this hypothesis, we assume that an extreme weather event manifests in the form of simultaneous random natural generation capacity outages over a specified period.² We then develop a Monte-Carlo simulation that randomly assigns the same amount of natural gas outages in each of a thousand simulations. A dispatch model is run to calculate the average non-served energy across all the simulations.

Table 2 shows the results of these simulations across different MITC % of peak load requirements. Our results indicate that increased transmission through MITC requirements lead to a substantial reduction in average generation outages during extreme weather events. This is because regions gain the ability to import power from its neighbors when there are outages. Most of these reliability benefits are seen in the Mid-Atlantic/Southeast and the Florida regions, which coincide with the regions where most of the transmission builds under the BIG WIRES Act are done. These results provide evidence supporting the need for more transmission to ensure grid reliability during extreme weather events.

	MITC %						
	0	10	20	30	40	50	60
Mid-Atlantic/Southeast	26,842 (0%)	25,682 (4%)	19,974 (26%)	16,350 (39%)	12,734 (53%)	10,854 (60%)	10,140 (62%)
Midwest	1,040 (0%)	1,095 (-5%)	1,007 (3%)	962 (8%)	538 (48%)	531 (49%)	507 (51%)
Florida	7,544 (0%)	5,661 (25%)	2,960 (61%)	1,678 (78%)	1,168 (85%)	506 (93%)	145 (98%)
New York	2,022 (0%)	1,539 (24%)	561 (72%)	618 (69%)	636 (69%)	589 (71%)	598 (70%)
Northeast	2,295 (0%)	1,865 (19%)	848 (63%)	814 (65%)	639 (72%)	435 (81%)	369 (84%)
California	186 (0%)	182 (2%)	181 (3%)	99 (47%)	29 (84%)	24 (87%)	14 (92%)
Texas	2,208 (0%)	2,197 (0%)	2,195 (1%)	2,196 (1%)	2,177 (1%)	2,194 (1%)	2,238 (-1%)
Southwest	77 (0%)	76 (1%)	74 (4%)	81 (-5%)	166 (-115%)	175 (-127%)	182 (-135%)
Northwest	56 (0%)	55 (1%)	55 (1%)	12 (78%)	0 (100%)	0 (100%)	0 (100%)
Central	3 (0%)	2 (26%)	0 (97%)	0 (100%)	0 (100%)	0 (100%)	0 (100%)

Table 2. Average hourly outages in MWh (% Reduction relative to MITC % = 0)

III. Climate Benefits

Finally, we look at the climate benefits of interregional transmission and the BIG WIRES Act. We find that increased transmission consistently leads to lower CO₂ emissions as seen in Figure 2. This is again because of more renewables in a more interconnected grid and the consequent reduction in generation from fossil fuels. In particular, the BIG WIRES Act leads to 43 million metric tons (Mmt) less CO₂ emissions compared to when there is no BIG WIRES Act. This translates to roughly \$8.2 billion of annual savings based on the EPA's proposed estimate for the social cost of carbon of \$190 per metric ton (EPA, 2023).

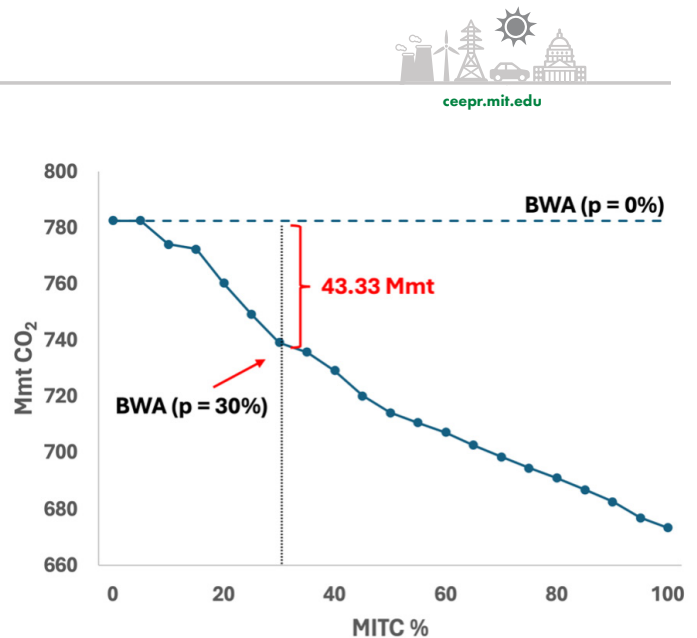


Figure 2. Total Emissions per MITC % under Current Policies

² This is similar to the events of Winter Storm Elliot in December 2022 which affected the Mid-Atlantic/Southeast region.

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In summary, our results show that there are many benefits that arise from building interregional transmission and the BIG WIRES Act. The act leads to an increase in interregional transmission builds across the entire US, concentrated in the Eastern Interconnect. It also reduces system cost by reducing reliance on fossil fuel generators in favor of VRE resources.

Interregional transmission and the BIG WIRES Act reduce the impact of extreme weather events by allowing regions to import power from its neighbors during outages. Lastly, there is a reduction in CO₂ emissions because of an increase in VRE resources with more interregional transmission.

References

EIA (2023). U.S. construction costs dropped for solar, wind, and natural gas-fired generators in 2021. <https://www.eia.gov/todayinenergy/detail.php?id=60562>.

EPA (2023). EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances. Technical report, Environmental Protection Agency.

Hickenlooper, J. and Peters, S. (2023). S.2827 - 118th Congress. The BIG WIRES Act. <https://www.congress.gov/bill/118th-congress/senate-bill/2827>.

IRENA (2022). Renewable Power Generation costs in 2022. Technical report, International Renewable Energy Agency.

Link to the full working paper discussed in this brief:

Botterud, A., Knittel, C.R., Parsons, J.E., Senga, J.R.L. & Story, S.D. (2024), "Bridging the Gaps: The Impact of Interregional Transmission on Emissions and Reliability," [MIT CEEPR Working Paper 2024-13](#), August 2024.

About the Authors



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John Parsons is the Deputy Director for Research of the MIT Center for Energy and Environmental Policy Research (CEEPR). His research focuses on the valuation and financing of investments in energy markets. Recent publications have touched on interregional transmission investments, including the interaction with hydro assets and expanded penetration of renewables, the value of investments in life extensions of nuclear power plants, and the economics of new microreactors, and the impact of decarbonization on generation assets in the U.S. midcontinent. Dr. Parsons has served as an Associate Member of the U.S. Commodity Futures Trading Commission's Energy and Environmental Markets Advisory Committee and has been a Visiting Scholar at the Federal Energy Regulatory Commission. He holds a Ph.D. in Economics from Northwestern University and an A.B. from Princeton University.



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Drew Story, PhD, is the Policy Director of the MIT Climate Policy Center and the Managing Director of MIT's Policy Lab. In these roles he guides MIT faculty through strategic policy engagement to increase the impact of their work. As a result, MIT researchers establish themselves as resources and advisors to policymakers, and they develop insight into improved research design for producing scholarship with greater potential for societal impact. Prior to joining MIT, Drew served as a policy advisor in the US Senate on energy, environment, and scientific research policy issues, including a year as an AAAS/ACS Congressional Science and Engineering Fellow. Over a dozen legislative provisions Drew advised on were signed into law as part of the Energy Act of 2020, the Infrastructure Investment and Jobs Act, the Inflation Reduction Act, the CHIPS and Science Act, and other legislative vehicles.



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