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Audun Botterud, Christopher R. Knittel, John E. Parsons,
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Evaluating the Impact of the BIG WIRES Act

Audun Botterud[1,a], Christopher R. Knittel[2,b,c,d],
John E. Parsons[3,b], Juan Ramon L. Senga[4,b], S. Drew Story[5,e]

[a] *Laboratory for Information and Decision Systems, Massachusetts Institute of Technology, Cambridge, MA, USA*

[b] *Center for Energy and Environmental Policy Research, Massachusetts Institute of Technology, Cambridge, MA, USA*

[c] *Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA, USA*

[d] *MIT Climate Policy Center, Massachusetts Institute of Technology, Cambridge, MA, USA*

[e] *Policy Lab, Massachusetts Institute of Technology, Cambridge, MA, USA*
[1]*audunb@mit.edu*, [2]*knittel@mit.edu*, [3]*jparsons@mit.edu*, [4]*jsenga@mit.edu*, [5]*dstory@mit.edu*
Authors are listed in alphabetical order

Introduction

Building interregional transmission is critical to a decarbonized and more resilient U.S. grid. However, according to the most recent DOE Transmission needs study, planned transmission builds up to 2035 are lagging behind the country's anticipated need (DOE, 2023). Several barriers exist to building transmission. These include insufficient coordination between different transmission planning regions brought by the prioritization of local clean energy goals, cost allocation concerns, NIMBYism, and the perception that benefits may not be realized for their own region (Joskow, 2020; Kasina and Hobbs, 2020; Pfeifenberger et al., 2021).[1] To address these challenges, the BIG WIRES Act (S.2827 - 118th Congress) was proposed in the U.S. Congress and would require transmission planning regions to achieve minimum interregional transfer requirements. The bill requires that each FERC Order No. 1000 region should have the capability to transfer at least 30% of its coincident peak load to neighboring regions by 2035 (Hickenlooper and Peters, 2023). The intent is to incentivize coordination among the regions and get part of the benefits of a fully connected grid. In this research commentary, we summarize the key results of a soon-to-be-released working paper that is focused on determining the impact of the BIG WIRES Act.[2] We aim to use insights derived from this work to further the conversation on current and future legislation pushing for minimum interregional transfer requirements.

To undertake the analysis, we use the capacity expansion model, GenX.[3] We evaluated the

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[1] Difficulty in the permitting process is also a reason for the gap between anticipated need and current plans (Pfeifenberger et al., 2021), but we do not look at this in our research.

[2] Results presented here are preliminary and will be updated accordingly in the working paper. We expect insights to be the same.

[3] GenX is a capacity and transmission expansion optimization tool developed at the MIT Energy Initiative (Jenkins and Sepulveda, 2017). We source input data from Shi (2023) and PowerGenome (Schivley, 2023) which is a data processing software that aggregates data from publicly available sources such as NREL's ATB and EFS, and EIA Form-860.

BIG WIRES Act in four areas: (1) interregional transmission builds, (2) electricity system cost savings, (3) climate benefits, and (4) grid resiliency to extreme weather events.

Our evaluation compares two systems: one where we impose a Minimum Interregional Transfer Capacity (MITC) constraint and another where there is no MITC. These two systems represent the cases where the BIG WIRES Act is and is not implemented, respectively. We also examine two future decarbonization scenarios, namely, one without any CO_2 emissions reduction target and another with a 95% CO_2 emissions reduction target vs 2005 levels.[4] These two scenarios illustrate how the BIG WIRES Act interacts with other policies that may be implemented. The systems are all examined for the year 2035.

The first step to modeling the BIG WIRES Act within GenX is representing the 11 FERC Order No. 1000 transmission planning regions. To do so, we adapt Shi (2023). Shi (2023) creates 64 zones within the continental U.S. within GenX, shown in Figure 1a.[5] We group these zones (Figure 1b) to best mimic the FERC transmission planning regions and Texas (Figure 1c). We define any transmission that is built between zones within the same region as *intraregional* and transmission built between zones from different regions as *interregional*.[6] We assume that not implementing the BIG WIRES Act leads to no new interregional transmission being built. We also assume that only enough interregional transmission to satisfy the MITC requirements will be built if the BIG WIRES Act is implemented. In both cases, zones can build new intraregional transmission. This mimics the inclination of Balancing Authorities (BAs) to build within their own transmission planning region while having barriers to building interregional transmission.

We now proceed with the summary of our evaluation of the BIG WIRES Act, answering the main questions associated with each of the four areas.

1. Where and how much interregional transmission will be built?

Figure 2 shows the existing and additional transmission capacity under the status quo and the BIG WIRES Act, respectively.[7],[8] The decision on where to build transmission starts with a proportional increase in the maximum allowed transfer capacity between zones based on existing transmission infrastructure. The maximum allowed transfer capacity is then increased until the MITC can be met in all regions.[9] Then, GenX determines where to build interregional transmission based on which alternatives lead to the least total system cost while ensuring MITC requirements are satisfied. Table 1 shows the interregional transmission builds and transfer capacities per corridor. We estimate that an additional 13.52 TW-mi of interregional transmission

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[4] We do not account for future state or local regulations in the reduction targets and only impose a system-wide CO_2 constraint

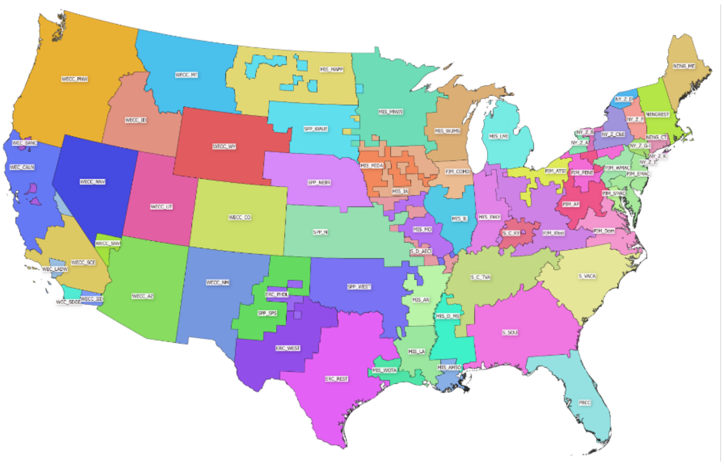
[5] The 64 zones are based on the EPA's IPM Regions and the grouping is done to mimic the FERC Order No. 1000 transmission planning regions as close as possible (EPA, 2022; FERC, 2011)

[6] Another type of transmission that can be built are transmission lines within each zone. We call these *intrazonal* transmission lines but do not model them explicitly. The cost of lines that connect new generators to the grid is also not included explicitly, but the cost is embedded in the investment in new generators

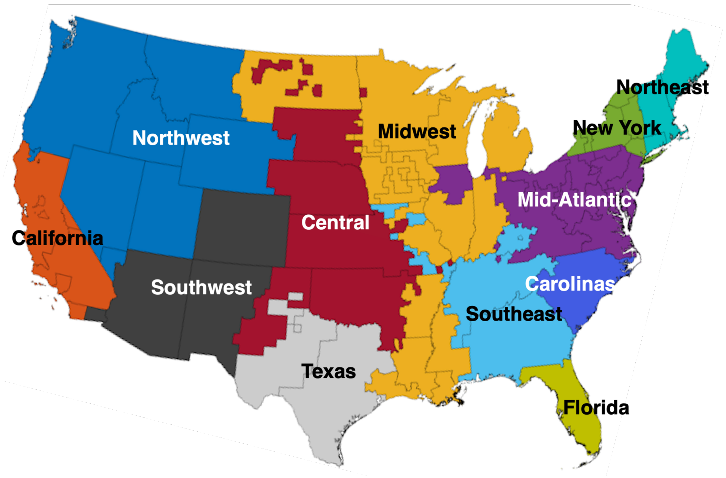
[7] Existing transfer capacity is taken from the EPA's Power Sector Modeling Platform (EPA, 2022; Shi, 2023)

[8] Where a greedy algorithm determines the maximum allowed interregional transmission line reinforcement until the MITC can be met

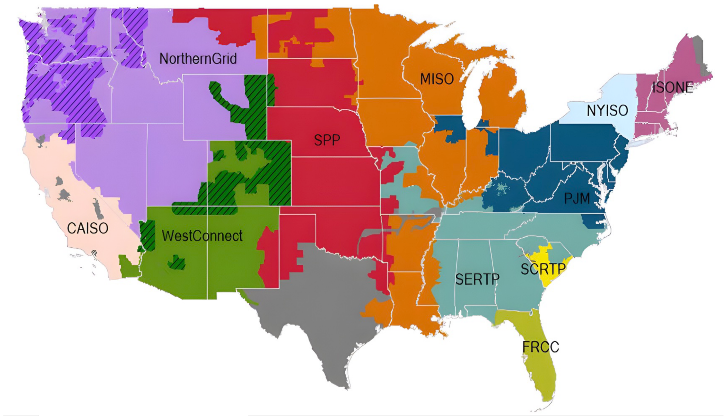
[9] The authors are actively working on alternative methods for assigning maximum allowed transfer capacities between zones, but we expect the insights to remain the same.



(a) 64 Zone Map



(b) 12 Model Region Map created by aggregating the 64 zones



(c) FERC Order No 1000 Transmission Planning Regions

Figure 1: Zonal and Regional Maps

will be built, equivalent to 56.11 GW of additional transfer capacity. Most of the expansion is concentrated in the Eastern Interconnect between the Midwest and the Mid-Atlantic (3.67 TW-mi deployment; 18.01 GW additional transfer capacity), Southeast and Florida (2.90 TW-mi; 8.65 GW), Mid-Atlantic and Carolinas (1.92 TW-mi; 7.03 GW), Midwest and Central (1.35 TW-mi; 4.64 GW), and Mid-Atlantic and Southeast (1.04 TW-mi; 4.30 GW). New interregional transmission deployment in these corridors represents 80% of the total additional interregional transmission builds (in TW-mi) and 75% of additional transfer capacity (in GW) under the BIG WIRES Act.

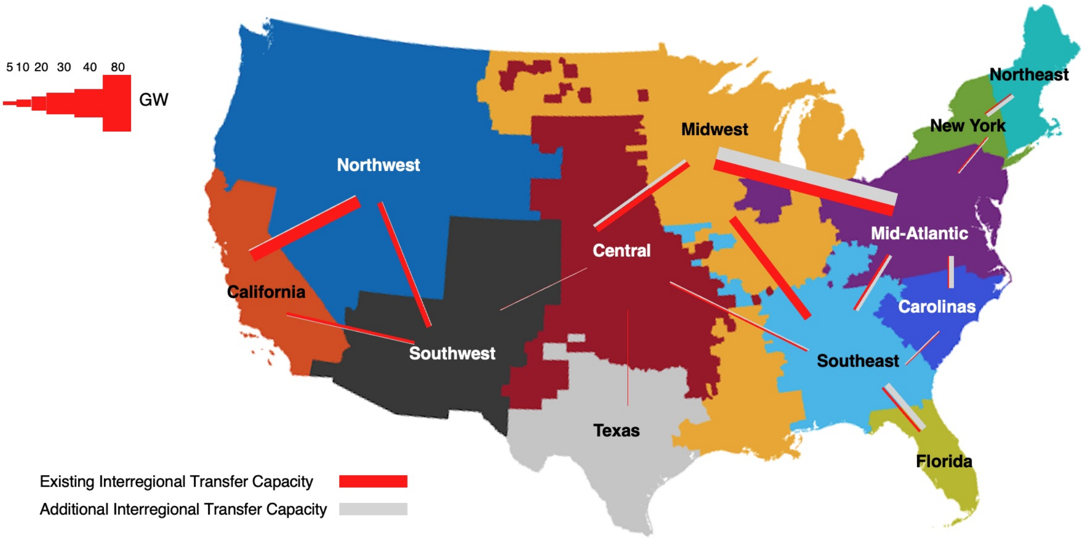


Figure 2: Map of existing and additional interregional transfer capacity between regions

Table 1: Existing and additional interregional transfer capacity and transmission builds per corridor

	Transfer Capacity (GW)			Transmission Builds (TW-mi)		
Corridors	**Existing**	**Additional**	**Total**	**Existing**	**Additional**	**Total**
California – Northwest	14.73	1.77	16.50	5.40	0.52	5.92
California – Southwest	4.35	1.17	5.52	1.30	0.35	1.65
Northwest – Southwest	7.44	0.73	8.17	1.97	0.19	2.17
Southwest – Central	0.61	0.48	1.09	0.14	0.11	0.24
Southeast – Central	2.30	1.45	3.75	0.67	0.42	1.10
Florida – Southeast	3.60	8.65	12.25	1.21	2.90	4.10
Carolinas – Southeast	1.62	1.33	2.94	0.55	0.45	0.99
Carolinas – Mid-Atlantic	2.22	7.03	9.25	0.61	1.92	2.53
Mid-Atlantic – Midwest	16.55	18.01	34.56	3.56	3.67	7.23
Mid-Atlantic – New York	1.92	1.62	3.54	0.28	0.21	0.49
Mid-Atlantic – Southeast	3.33	4.30	7.63	0.80	1.04	1.84
Midwest – Central	7.51	4.64	12.15	2.20	1.35	3.55
Midwest – Southeast	11.87	-	11.87	2.63	-	2.63
Northeast – New York	2.16	4.92	7.08	0.17	0.38	0.55
	80.20	56.11	136.31	21.48	13.52	35.00

2. How much will the BIG WIRES Act save?

We calculate that the BIG WIRES Act leads to annual system cost savings of $330 million for the no CO_2 reduction target scenario and $2.46 billion for the 95% CO_2 reduction target scenario, relative to the status quo.[10,11] This result shows that the BIG WIRES Act facilitates larger savings in low-carbon systems. We examined this further in Figure 3, illustrating the

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[10] Annual system cost is the sum of investment in generation and storage, fixed and variable operating and maintenance costs, new transmission investment costs, fuel and startup costs, and tax credits/incentives, if any.

[11] The transmission investment cost is the cost of expanding existing interregional and intraregional transmission, which is based on NREL REEDS and the Phase II Eastern Interconnection Planning Collaborative (EIPC) report estimates (Shi, 2023; Ho et al., 2021; EIPC, 2015)

cost differences between the BIG WIRES Act and the status quo for each cost component. In the no CO_2 target reduction scenario, the savings are driven by lower fuel costs from increased solar and wind generation capacity investments. This re-emphasizes how interregional transmission increases the viability of renewables by giving regions access to more quality wind and solar resources (Brown and Botterud, 2021; Joskow, 2020). In the 95% CO_2 reduction target scenario, there are savings on investments in new generation and storage capacity. The high-decarbonization target means a greater reliance on renewables, leading to a larger solar, wind, and battery storage fleet than when there is no CO_2 target. Having additional interregional transmission facilitates the use of more efficient renewable resources in regions such as the Mid-Atlantic, Central, and Northeast, leading to more generation from renewables even with less capacity investments. Notably, investment in new intraregional transmission also increases in both scenarios because more renewables under the BIG WIRES Act also rely on being able to transfer electricity within each region effectively.

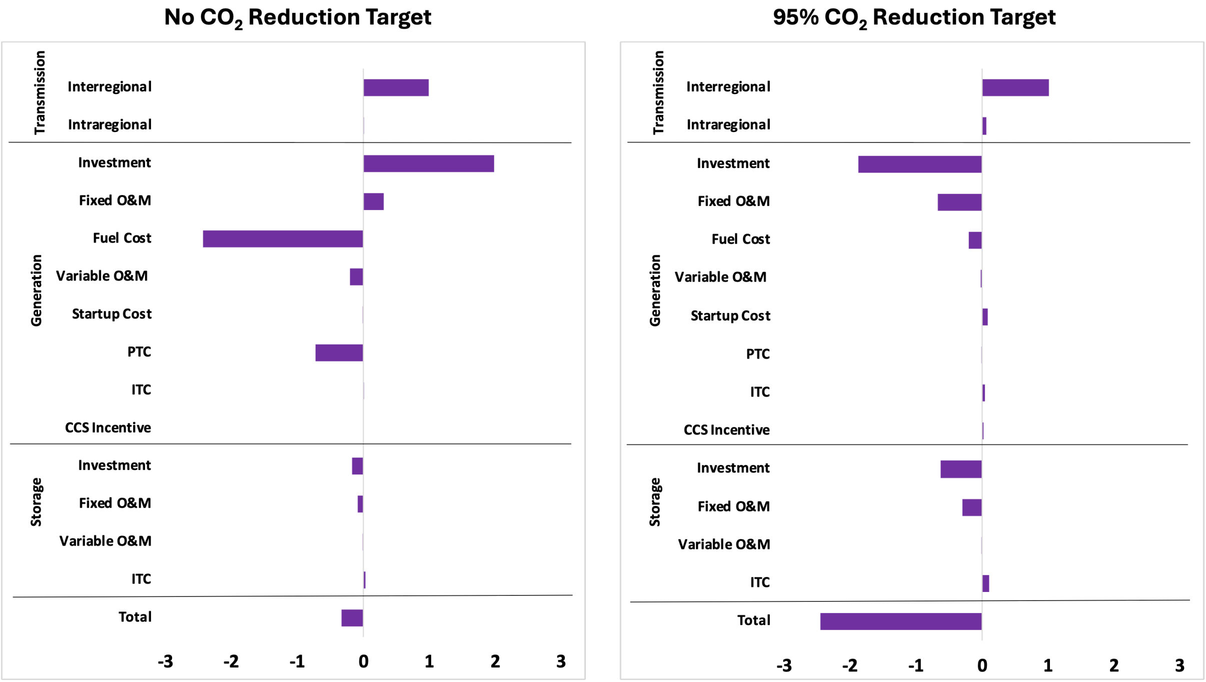

Figure 3: System cost difference of the BIG WIRES Act vs Status Quo (Billion \$)

We also evaluated variation in the MITC in the BIG WIRES Act to find the optimal percentage of peak load (i.e., MITC % Peak Load). Figure 4 shows the annual system cost at different MITC % Peak Load for the no CO_2 and 95% CO_2 reduction target scenarios. The dashed horizontal line represents the system cost of the status quo. Based on 5% increments from 0 to 100% of peak load, an MITC constraint between 5 and 50% of peak load leads to cost savings in the no CO_2 reduction target scenario. Below 5%, regions would already meet the MITC, and beyond 50%, the costs of adding more transmission are higher than the cost savings. Interestingly, the optimal in this scenario is at 30% – exactly what the BIG WIRES Act proposes. In the 95% CO_2 reduction scenario, there is savings beyond 5% of peak load, and the minimum is at 95%.

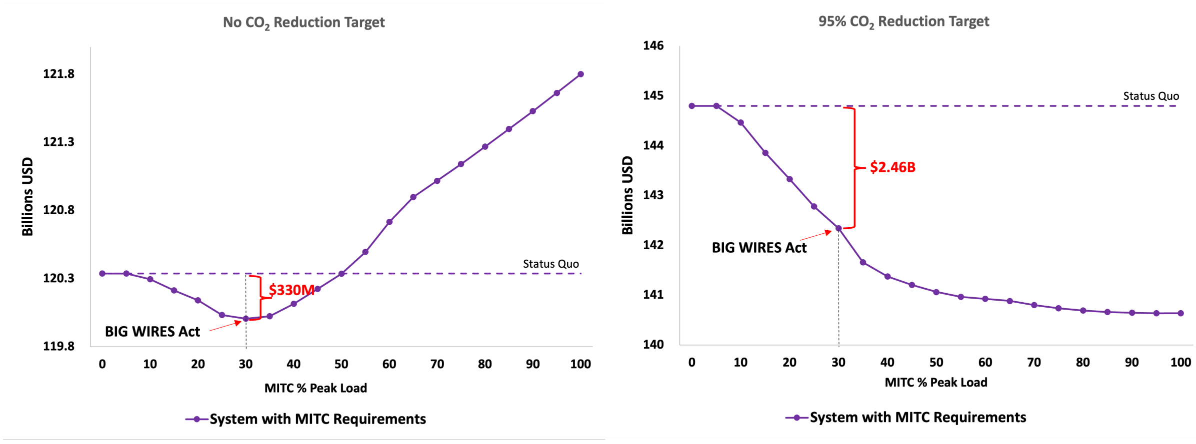

Figure 4: Annual system cost curve per MITC % Peak Load Calculation

2.1. Which regions will see savings and cost increases?

We assume that costs associated with a generation facility are assigned to a region where the facility is located. Given this assumption, the results in Table 2 show that the California, Carolinas, Midwest, New York, and Texas regions will all have savings under the BIG WIRES Act in both decarbonization scenarios while the Central, Mid-Atlantic, Northeast, and Southwest regions will have increased costs. The increase in both decarbonization scenarios is primarily due to combinations of increases in wind generation investments, higher fixed operating and maintenance costs, and interregional transmission builds. It is important to note that an increase in costs is not necessarily a negative impact on the region. Table 3 reports the change in exports and imports from and to each region. In those regions, we see an increase in costs, and we also see an increase in electricity exports to other regions, thereby increasing regional revenues.

Table 2: Cost per region under each scenario in billion \$. (Note: Costs are assigned based on where generation facilities are located. The cost of transmission investment between two regions is allocated proportionally to load)

	No CO_2 Reduction Target			**95% CO_2 Reduction Target**		
	No BIG WIRES	**With BIG WIRES**	**Difference**	**No BIG WIRES**	**With BIG WIRES**	**Difference**
California	4.81	4.73	(0.08)	5.33	5.28	(0.05)
Carolinas	8.46	7.69	(0.77)	10.79	9.54	(1.25)
Central	5.44	5.64	0.19	6.11	6.56	0.45
Florida	9.11	9.51	0.41	11.54	10.08	(1.46)
Mid-Atlantic	27.64	28.91	1.27	31.05	31.52	0.48
Midwest	20.59	20.13	(0.46)	26.04	24.78	(1.26)
New York	4.04	3.86	(0.18)	4.82	4.65	(0.17)
Northeast	3.67	3.79	0.12	4.32	4.67	0.35
Northwest	5.42	5.44	0.03	6.78	6.66	(0.12)
Southeast	15.68	14.84	(0.84)	19.68	20.21	0.53
Southwest	5.24	5.29	0.05	6.76	6.87	0.11
Texas	10.24	10.17	(0.07)	11.56	11.49	(0.07)
Total	120.33	120.00	(0.33)	144.76	142.31	(2.45)

3. What are the climate benefits of the BIG WIRES Act?

The BIG WIRES Act leads to a 73 million metric tons (Mmt) (5.5%) reduction of CO_2 emissions relative to the status quo. This is equivalent to a \$14 billion reduction in climate damages based on the new proposed EPA social cost of carbon of \$190 per mt (EPA, 2023).

Table 3: Net regional electricity exports (imports) in TWh.

	No CO_2 Reduction Target			**95% CO_2 Reduction Target**		
	No BIG WIRES	**With BIG WIRES**	**Difference**	**No BIG WIRES**	**With BIG WIRES**	**Difference**
California	(38.3)	(40.2)	(2.0)	(47.4)	(49.4)	(2.0)
Carolinas	(10.3)	(22.1)	(11.8)	0.4	(11.7)	(12.2)
Central	28.9	44.7	15.7	14.3	36.2	21.8
Florida	2.8	7.9	5.0	(0.3)	(24.6)	(24.3)
Mid-Atlantic	(8.4)	25.6	34.0	(35.0)	(23.0)	12.0
Midwest	28.9	19.2	(9.7)	50.0	47.2	(2.7)
New York	(4.7)	(11.0)	(6.3)	(1.0)	(7.8)	(6.8)
Northeast	(3.1)	(0.1)	3.0	1.1	10.7	9.6
Northwest	19.1	19.3	0.2	21.8	19.9	(1.9)
Southeast	(32.3)	(60.5)	(28.2)	(28.3)	(24.2)	4.1
Southwest	17.6	18.4	0.8	23.8	26.3	2.5
Texas	(0.4)	(1.1)	(0.6)	0.6	0.5	(0.1)

The emissions reduction is again because of the increased penetration of renewables and the consequent reduction of coal. In the 95% CO_2 reduction setting, the climate benefit is the \$2.46 billion less spending to achieve the CO_2 target.

4. Does the BIG WIRES Act reduce the impact of extreme weather events?

To answer this question, we simulated 1000 random outages at the same scale as Winter Storm Elliot which led to 80.5 GW of generation capacity going offline in the Mid-Atlantic, Southeast, and Carolinas in December 2022 (Howland, 2023).[12] We found that the average number of homes affected in these regions is reduced from 4.7 million in the status quo to 2.1 million under the BIG WIRES Act.[13] This represents a 58% reduction in power outages and is mostly due to increased transfers from New York and the Midwest into the Mid-Atlantic. Figure 5 shows the distribution of outages from the simulation of the status quo and the BIG WIRES Act across the 1000 simulated storms.

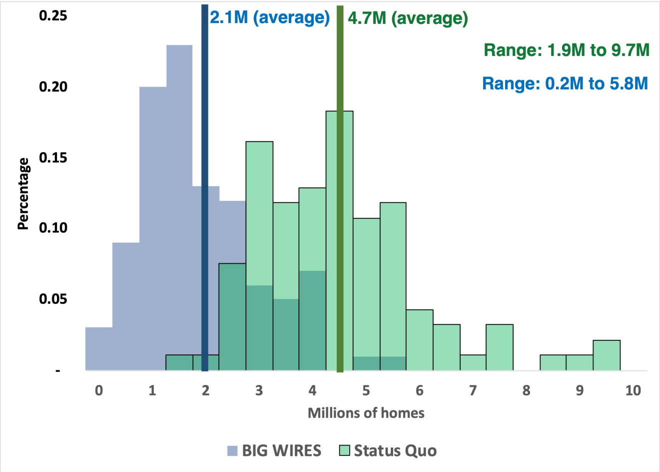

Figure 5: Distribution of number of homes experiencing an outage

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[12] In our simulation, we scale the plant outages according to the increase in load from 2022 to 2035. This leads to outages of 110 GWs. Most of the outages during Winter Storm Elliot were natural gas plants (FERC, 2023). Therefore, for each of the 1000 simulated storms, we randomly choose which natural gas plants in the Mid-Atlantic, Carolinas, and Southeast regions experience an outage.

[13] We assume that 1MW is enough to power 750 homes (CAISO, nd)

Conclusion

In this research commentary, we present the results of an evaluation of the BIG WIRES Act, a proposed legislation that would mandate minimum interregional transfer capacity among the FERC Order No. 1000 transmission planning regions. Using the capacity expansion model GenX, we compared two systems: one with and one without the MITC constraint, under two decarbonization scenarios: one with no CO_2 reduction target and one with a 95% CO_2 reduction target vs 2005 levels. Our main findings are:

- The BIG WIRES Act would significantly increase the interregional transmission capacity across the U.S., especially between the regions with high renewable potential and high demand.
- The BIG WIRES Act would reduce the electricity system cost by $330 million annually in the no CO_2 reduction scenario and by $2.46 billion annually in the 95% CO_2 reduction scenario, compared to the status quo.
- The BIG WIRES Act would enable higher penetration of renewable energy sources, resulting in lower CO_2 emissions. The CO_2 emissions would decrease by 73 Mmt annually in the no CO_2 reduction scenario and reduce the costs of meeting a 95% reduction in CO_2 by $2.46 billion annually, relative to the status quo.
- The BIG WIRES Act would enhance the grid resiliency to extreme weather events, such as heat waves, cold snaps, and hurricanes, by providing more flexibility and diversity in the generation mix and reducing the reliance on natural gas. For the case of a storm of similar magnitude to the Winter Storm Elliot of 2022, the BIG WIRES Act leads to a 58% reduction in power outages, on average.

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