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Impact of Investment Tax Credit on Interconnection Costs

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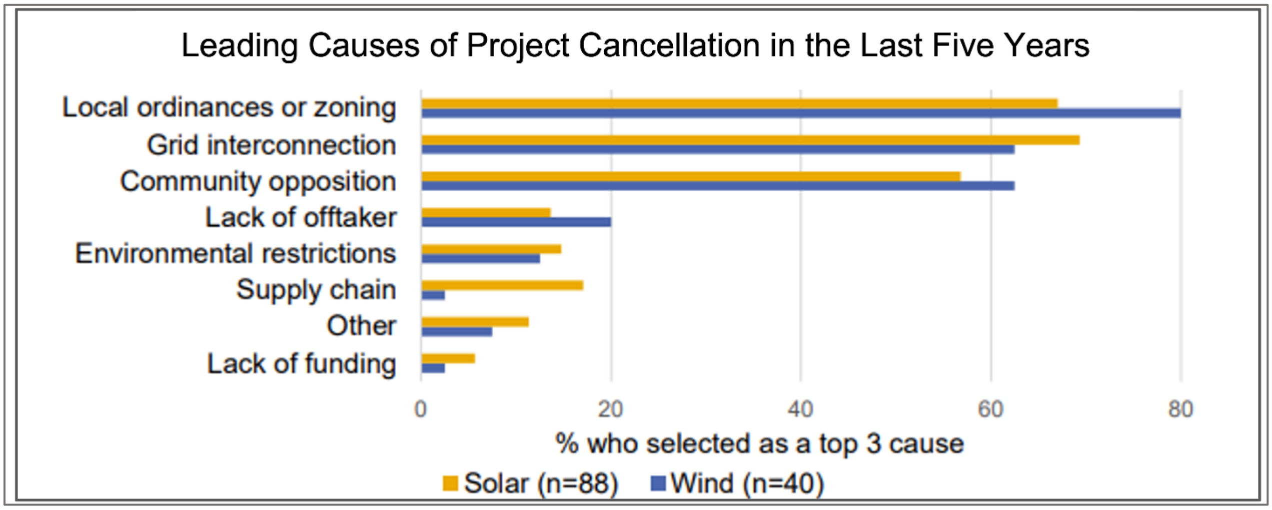
Rising interconnection costs are a major hurdle for renewable energy projects as the aging grid strains under the pressure of new generation and increased demand. In a recent survey of wind and solar developers, more than 60 percent of developers said grid interconnection was a primary cause of project cancellation.[1]

But if the U.S. Treasury Department finalizes new guidance making the Investment Tax Credit (ITC) applicable to interconnection costs, it could provide significant relief to this problem by reducing overall project costs. It would also relieve pressure on projects facing moderately high interconnection costs, according to our retrospective analysis of these costs for onshore wind and solar projects between 2019 and 2022.

Figure 1. Developer reported leading causes of project cancellation in the last five years.



Source: Lawrence Berkeley National Lab.[2]

Across five regions that represent 30 states, we find that an interconnection investment tax credit could have made up the cost differential between cancellation and success for 22 gigawatts (GW) of cancelled onshore wind

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[1] Robi Nilson, Ben Hoen, and Joe Rand, "Survey of Utility-Scale Wind and Solar Developers" (Lawrence Berkeley National Laboratory, January 2024), https://eta-publications.lbl.gov/sites/default/files/w3s_developer_survey_summary_-_011724.pdf.

[2] Nilson, Hoen, and Rand.

and solar projects. An interconnection ITC could have also made up the cost differential for 15 GW of projects that were still active as of 2022.

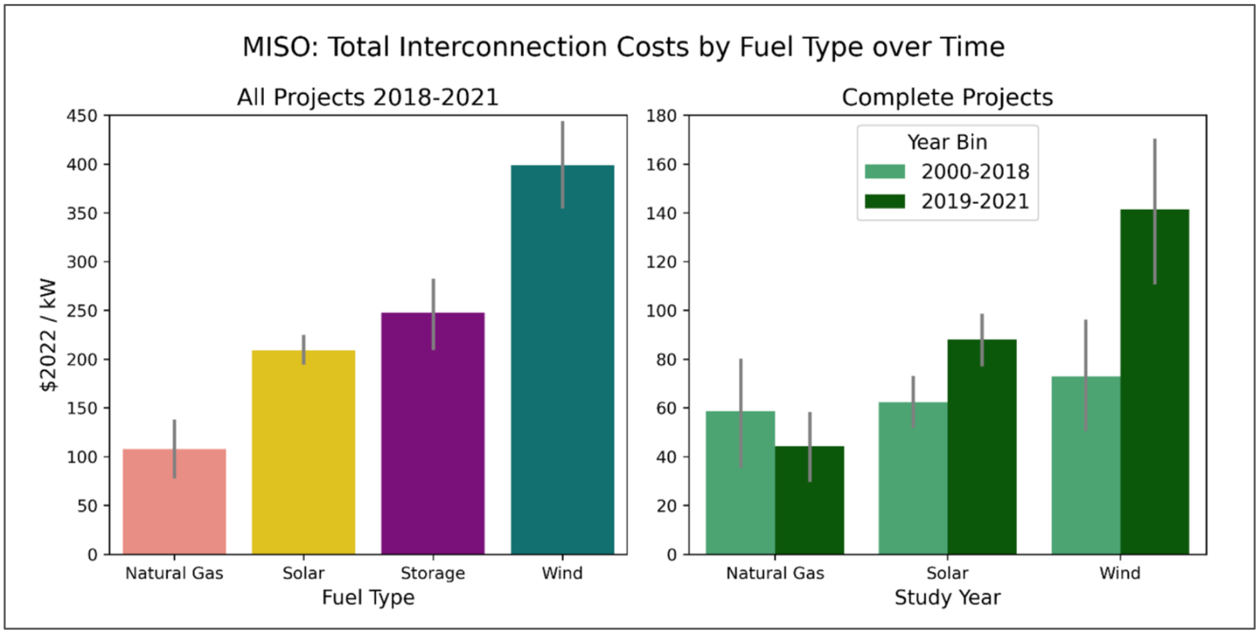
While this is an imperfect measure, it shows a 30 percent reduction in interconnection costs achieved by the Inflation Reduction Act and Treasury regulations will have material positive impacts of interconnection economics. These projects could more than equal the annual record 31 GW of deployed utility-scale wind and solar in the U.S. in 2023. We also find that the tax credit could reduce overall average costs of completed projects by 3 percent and 1.7 percent for wind and solar respectively.

HOW THE INFLATION REDUCTION ACT TAKES ON RISING INTERCONNECTION COSTS

Grid operators have struggled to meet demand for interconnection studies because renewable energy projects are in high demand and often represent a more distributed network of generation with smaller projects trying to connect in more places. This leads to a proliferation of never-ending interconnection study requests and longer wait times. Lack of forward-looking transmission planning has also pushed the costs of expanding the grid onto the interconnection process.[3]

Experts have compared the interconnection backlog and increased costs to trying to merge onto a highway clogged with bumper-to-bumper traffic – projects trying to get onto the highway are asked to pay for grid upgrades that are comparable to building entirely new highway lanes just to access the road. As a result, many projects are finding the costs to interconnect to be prohibitive and failing to materialize at all.[4] For example, the data from Figure 2 shows how average wind and solar interconnection costs began rising dramatically after 2018.

Figure 2. MISO: Total Interconnection Costs by Fuel Type over Time



Source: Lawrence Berkeley National Lab.[5]

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[3] Joachim Seel et al., "Generator Interconnection Costs to the Transmission System - Summary Briefing" (Lawrence Berkeley National Laboratory, June 2023), https://emp.lbl.gov/publications/generator-interconnection-costs.

[4] Shannon Osaka, "This Little-Known Bottleneck Is Blocking Clean Energy for Millions," Washington Post, December 20, 2022, https://www.washingtonpost.com/climate-environment/2022/12/20/clean-energy-bottleneck-transmission-lines/.

[5] Seel et al., "Generator Interconnection Costs to the Transmission System - Summary Briefing."

Policymakers are tackling this issue from several angles, with the Federal Energy Regulatory Commission (FERC) finalizing a rule to streamline the interconnection process to reduce costs and timelines in August 2023.[6] FERC also has a regional transmission planning rule in progress, which would take a much-needed proactive approach to adding transmission capacity, a necessary step to long-term success.[7]

However, an under-the-radar provision from the Inflation Reduction Act could now relieve some project cost burdens by providing a credit for costs related to grid interconnection.

The IRA provision modified Section 48 of the U.S. tax code, making clean energy property smaller than 5 megawatts (MW) eligible to include interconnection costs into its claim for the 30 percent ITC. The tax code defines a unit of energy property as a set of components that can operate together, independent of any other components, including equipment used to generate, store, and prepare the electricity for transmission on the power grid. It also includes transformers, inverters, and converters, but not transmission and distribution equipment itself. In the context of the tax code, an energy property is distinct from an "energy project," which can consist of several energy properties that are co-located or share a grid interconnection.[8]

The guidance directly states that an energy project with more than 5 MW total capacity is eligible to claim this 30 percent tax credit if each individual energy property that is a part of the project is less than 5 MW. As even the largest single onshore wind turbines have a nameplate capacity of less than 3.5 GW, almost all onshore wind and solar projects that elect to take the ITC should be able to apply it to their interconnection costs. The guidance importantly indicates the tax credit be applied to the cost of the physical infrastructure of the grid interconnection as well as for required network upgrades to the transmission system, which are increasing apace of transmission system bottlenecks.

With these rising costs, we find that this interconnection property ITC could reduce overall project costs by an average of 3 percent for solar projects and 1.7 percent for wind projects, but more importantly, it could bring more projects to fruition by relieving pressure on projects facing moderately high interconnection costs. Here, we analyze the potential for the interconnection ITC to directly enable more wind and solar projects by analyzing projects that were withdrawn from interconnection processes and those that are still actively undergoing studies.

Across the five regions we studied, we find that the interconnection ITC could have paid for the difference between the costs faced by 22 GW of onshore wind and solar projects withdrawn from interconnection queues and those that completed all studies. We also found that the ITC could have reduced costs for 15 GW of onshore wind and solar projects that were still undergoing interconnection studies as of 2022 to the range seen by completed projects. Together, these would exceed the combined 31 GW of utility-scale solar and wind deployed in the U.S. in 2023. Since the regions studied encompass only 30 states, the potential GW impact of the tax credit could be even higher.

ANALYSIS

Lawrence Berkeley National Laboratory researchers compiled data on interconnection costs across five regional grids operated by different grid operators in the United States: the Midcontinental Independent System Operator (MISO), the Southwest Power Pool (SPP),[9] the PJM Interconnection (PJM),[10] the New York Independent System

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[6] "Explainer on the Interconnection Final Rule | Federal Energy Regulatory Commission," accessed February 1, 2024, https://www.ferc.gov/explainer-interconnection-final-rule.

[7] "Explainer on the Transmission Notice of Proposed Rulemaking | Federal Energy Regulatory Commission," accessed October 7, 2022, https://www.ferc.gov/explainer-transmission-notice-proposed-rulemaking.

[8] "Definition of Energy Property and Rules Applicable to the Energy Credit" (Department of the Treasury, November 17, 2023), https://public-inspection.federalregister.gov/2023-25539.pdf.

[9] Joachim Seel et al., "Generator Interconnection Cost Analysis in the Southwest Power Pool (SPP) Territory" (Lawrence Berkeley National Laboratory, April 2023), https://emp.lbl.gov/publications/generator-interconnection-cost-0.

[10] Joachim Seel et al., "Interconnection Cost Analysis in the PJM Territory" (Lawrence Berkeley National Laboratory, January

Operator (NYISO),[11] and the Independent System Operator of New England (ISO NE).[12] The projects in the data sets are categorized by their status in the interconnection study process: complete, active, and withdrawn. Completed projects are those that have completed all interconnection studies and moved on to the interconnection agreement phase including projects that are ultimately put in service, active projects are still working through interconnection studies, and withdrawn projects are those that have withdrawn from the queue.[13] We use that data to analyze the potential impact of the 30 percent interconnection tax credit on financial viability of wind and solar project interconnection.

Across the country, interconnection requests are successful 13-38 percent of the time, with the lowest success rate seen in California and the highest seen in New England.[14] Costs are a primary reason why projects withdraw from interconnection queues, but other factors cause withdrawal, including the fact that developers often submit the same project for study at different locations on the grid to increase their chance of finding a successful connection point. Therefore, some projects withdraw simply because they are duplicates. Increasing timelines for interconnection studies can also lead to projects facing permitting issues, and again having to drop out.[15]

An analysis of the average interconnection cost of completed solar and wind projects across all five regions shows this tax credit could reduce overall project costs of by several percentage points. The average interconnection cost for solar projects that completed the interconnection study process across all five regions was $107.22 per kilowatt (kW), while overall project costs were $1070/kW in 2022.[16] For wind, the average interconnection cost for completed projects was $77.86/kW, while the cost of a wind project was $1367/kW.[17] Therefore, a 30 percent interconnection ITC could save an additional 3 percent on overall project costs for solar projects, and 1.7 percent on wind projects on average, with higher incremental impacts for projects facing high interconnection costs.

Looking at projects that began interconnection studies in 2019 or later, we compare the costs of projects that had all interconnection studies completed with those that either withdrew from the interconnection queue or were still active as of 2022. The comparison with withdrawn projects illustrates the tax credit's potential on projects that ultimately failed to materialize, while the comparison with projects that are still active gives insight into how this tax credit can directly benefit projects working their way through the interconnection study process.

In Figure 3, box and whisker plots compare the distribution of total interconnection costs (including network upgrade costs and costs associated with the physical point of inconnection) for solar projects that completed the interconnection study process with solar projects that withdrew from the queue. While the majority of withdrawn projects faced interconnection prices much higher than those that completed the study process, it is clear many projects have costs just above those that were completed. This is particularly prominent in the MISO region, where withdrawn project costs are spread across a shorter distribution and with a lower median than withdrawn or active projects.

2023), https://emp.lbl.gov/publications/interconnection-cost-analysis-pjm.

[11] Julie Mulvaney Kemp et al., "Interconnection Cost Analysis in the NYISO Territory" (Lawrence Berkeley National Laboratory, March 2023), https://emp.lbl.gov/publications/interconnection-cost-analysis-nyiso.

[12] Julie Mulvaney Kemp et al., "Interconnection Cost Analysis in ISO-New England" (Lawrence Berkeley National Laboratory, 2023), https://emp.lbl.gov/publications/interconnection-cost-analysis-iso-new.

[13] Seel et al., "Generator Interconnection Costs to the Transmission System - Summary Briefing."

[14] Joseph Rand et al., "Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2022" (Lawrence Berkeley National Lab, April 2023), https://emp.lbl.gov/sites/default/files/queued_up_2022_04-06-2023.pdf.

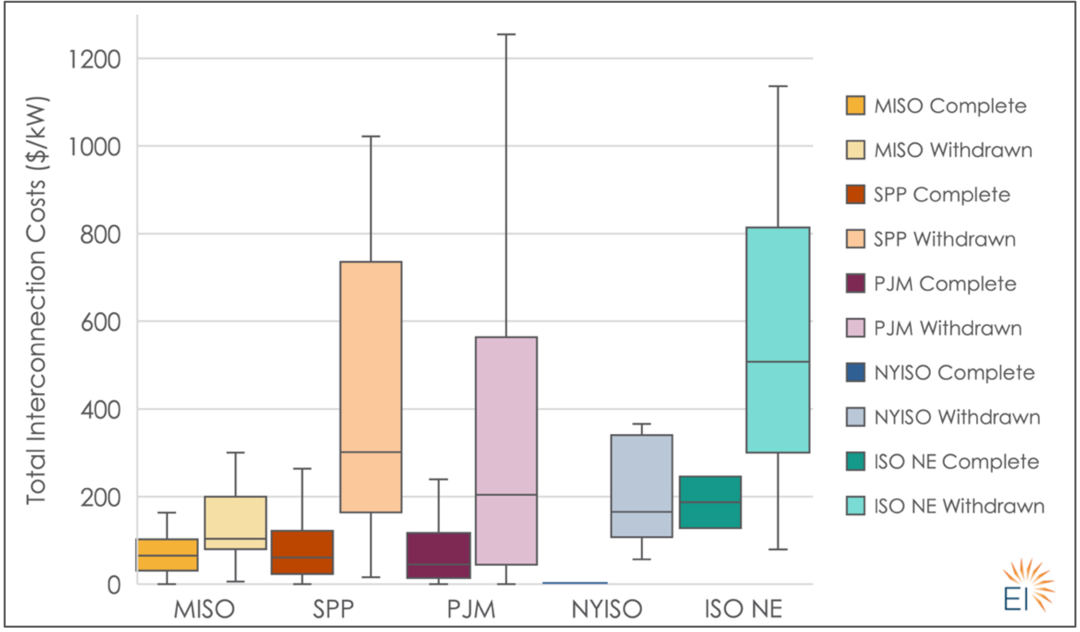
[15] "Interconnection 101" (American Clean Power, June 2023), https://cleanpower.org/wp-content/uploads/2023/06/ACP_Interconnection_FactSheet_0623.pdf.

[16] Mark Bolinger et al., "Utility-Scale Solar, 2023 Edition" (Lawrence Berkeley National Laboratory, October 2023), https://emp.lbl.gov/sites/default/files/emp-files/utility_scale_solar_2023_edition_slides.pdf.

[17] Ryan Wiser et al., "Land-Based Wind Market Report: 2023 Edition" (U.S Department of Energy, 2023), https://emp.lbl.gov/sites/default/files/emp-files/2023_lbwmr_final.pdf.

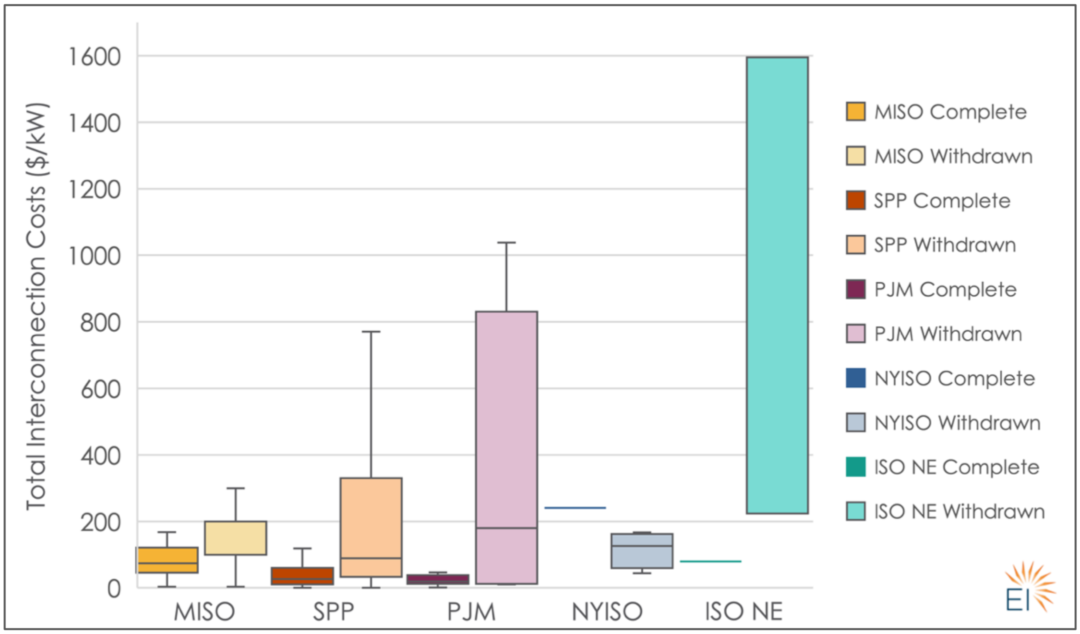
The same analysis for onshore wind is shown in Figure 4, where again high potential to impact withdrawn projects is seen in MISO, but SPP also sees a much tighter and cheaper distribution for withdrawn projects.

Figure 3. Interconnection costs of completed vs withdrawn solar projects.



Data source: Lawrence Berkeley National Lab[18]

Figure 4. Interconnection costs of completed vs withdrawn wind projects.



Data source: Lawrence Berkeley National Lab

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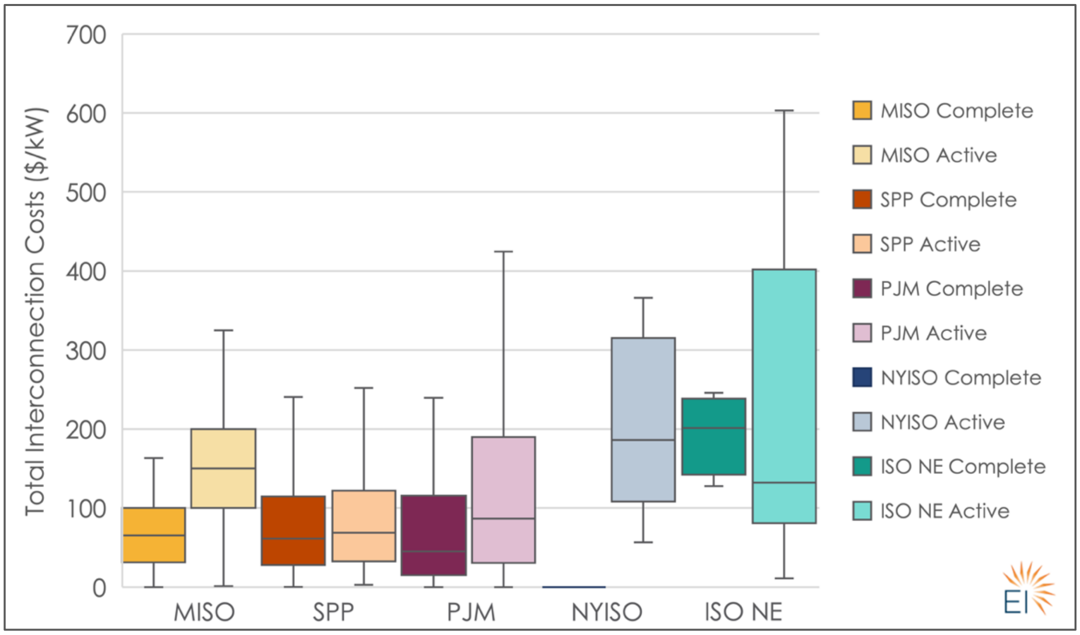
[18] Joachim Seel et al., “Generator Interconnection Cost Analysis in the Midcontinent Independent System Operator (MISO) Territory” (Lawrence Berkeley National Laboratory, October 2022), https://emp.lbl.gov/publications/generator-interconnection-cost-0.

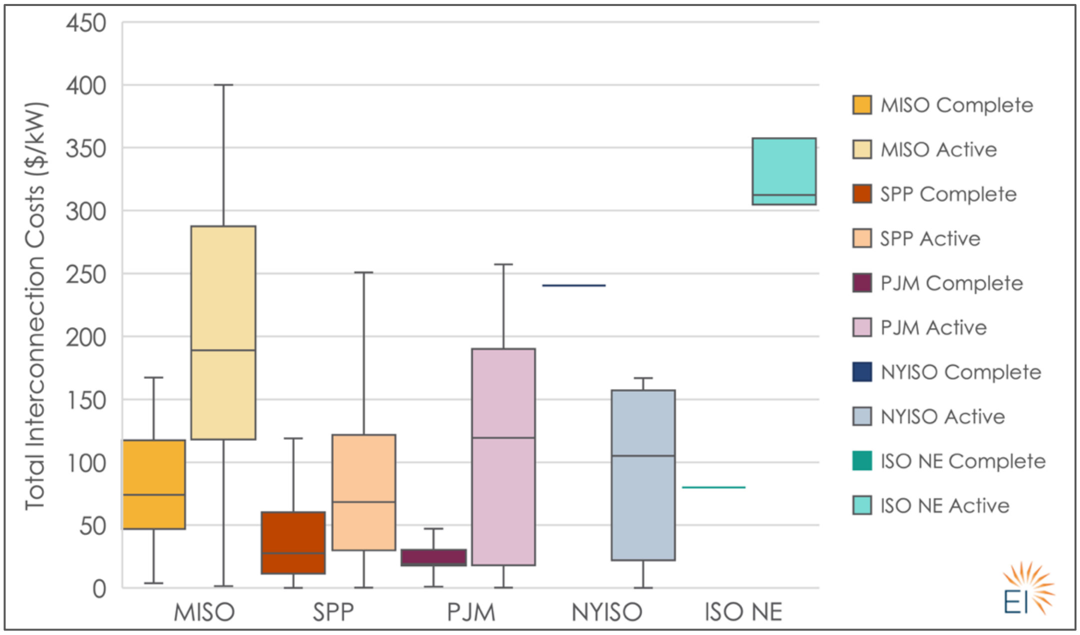
In Figures 5 and 6, box and whisker plots compare solar and wind projects that have completed all interconnection studies with those remain active, respectively. For these projects, across solar and wind, we see strong potential for the tax credit to make an impact in MISO, SPP, and PJM.

Figure 5. Interconnection costs of completed vs active solar projects.



Data source: Lawrence Berkeley National Lab

Figure 6. Interconnection costs of completed vs active wind projects.



Data source: Lawrence Berkeley National Lab

For many projects that withdrew from queues, costs could be up to five times even the highest costs seen for projects that completed the interconnection study process. For the high-end of interconnection costs, while a 30 percent ITC on the value of their interconnection costs would be higher, it would still not bring the project costs close to those that completed interconnection studies. However, many withdrawn projects had costs within 30 percent of the costs of projects that completed the interconnection study process.

To assess potential for the ITC to impact projects facing cost barriers to interconnection, we identified the withdrawn projects that had total interconnection costs higher than the 75th percentile value of the completed projects interconnection costs, but within 30 percent of that 75th percentile value. For these projects, the ITC would bring their interconnection costs within the 75th percentile of completed projects.

These results are shown in Table 1, showing that the MISO queue had by far the largest capacity at 11,872 MW of withdrawn projects with costs that that fell above the 75th percentile of completed projects, but within 30 percent of that 75th percentile threshold. For wind, the results were similar, with 8,364 MW of capacity in the range. For active projects, while MISO had the largest solar capacity that could move into the 75th percentile, SPP had the largest total capacity of active projects at 6,923 MW that could move into the 75th percentile.

In total, across all regions, 22,613 MW of withdrawn projects and 15,799 MW of active projects could have used the interconnection ITC to decrease costs to the 75th percentile.

Table 1. MW within 30% of 75th percentile completed.

	Withdrawn			Active		
Region	**Solar**	**Wind**	**Total Withdrawn**	**Solar**	**Wind**	**Total Active**
MISO	11872	8364	20236	4769	106	4876
SPP	504	1257	1761	4124	2798	6923
PJM	294	0	294	3774	0	3774
NYISO	0	0	0	0	0	0
ISO NE	322	0	322	225	0	225
Total	**12992**	**9621**	**22613**	**12893**	**2905**	**15799**

Because there is no exact threshold at which a project's interconnection costs will switch from too high to surmountable, we performed the same analysis for the cost value at the 50th percentile of completed projects in each region. Here, we saw similar results, again with MISO having the largest capacity of withdrawn projects that could move from outside the 50th percentile range to inside, with 18,728 MW. SPP again had the largest capacity of active projects that could move into the 50th percentile range.

In total, 19,913 MW of withdrawn projects and 7,450 MW of active projects could have moved into the 50th percentile with the interconnection ITC.

Table 2. MW within 30% of 50th percentile completed.

	Withdrawn			Active		
Region	**Solar**	**Wind**	**Total Withdrawn**	**Solar**	**Wind**	**Total Active**
MISO	4878	13850	18728	1479	321	1800
SPP	0	853	853	2999	815	3814
PJM	160	0	160	1625	0	1625
NYISO	0	0	0	0	0	0
ISO NE	172	0	172	210	0	210
Total	**5210**	**14703**	**19913**	**6314**	**1136**	**7450**

CONCLUSION

The interconnection ITC adder could bring the interconnection price of 19-22 GW of withdrawn projects and 7-15 GW of active projects within a range comparable to completed projects across 30 states – a total of 26-37 GW. It could also reduce the overall average costs of completed projects by 3 percent for utility-scale solar and 1.7 percent for utility-scale onshore wind. This implies that this unheralded piece of the IRA will have a material positive impact on clean energy project costs, and ultimately consumer pocketbooks.

This analysis is retrospective, it does not take into account the impacts of this ITC alongside other improvements to interconnection policies on the horizon, and only considers the cost barriers to inteconnection.

Projects currently in the queue could see their prospective interconnection costs fall upon implementation of FERC’s Order 2023, which initiates the use of “cluster studies” that spread costs across more projects so that no single project will have to bear the weight of a significant upgrade on its own.[19] This could broaden the potential impact of the interconnection ITC adder on project viability. Broader use of energy-only interconnection could also reduce interconnection costs for many of these projects, a method currently in use in ERCOT which allows new generators to take on curtailment risk in exchange for lower interconnection costs. Also referred to as “connect-and-manage,” this interconnection paradigm then uses curtailment signals to drive the deployment of new transmission lines instead of passing those costs onto generators.[20]

Ultimately, the success of the clean energy transition and U.S. climate and clean energy goals hinge on policy changes beyond the tax code. While wind and solar are the cheapest energy resources on the planet, economics only help when utilities and the industry are properly motivated by competition. Policymakers and utilities must take a proactive approach to invest in a modernize the grid, regulate to overcome incumbent bias slowing down the transition, and reduce barriers to siting and permitting these resources and enabling transmission. In particular, the U.S. needs to improve its long-term transmission and resource planning if it hopes to accelerate clean energy deployment in line with an 80 percent clean electricity system by 2030 and 100 percent clean by

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[19] Erin Bartlett, Thomas Mullooly, and Olya Petukhova, “FERC’s Generator Interconnection Reform Order No. 2023 | Foley & Lardner LLP,” Foley & Lardner, LLP, August 25, 2023, https://www.foley.com/en/insights/publications/2023/08/ferc-generator-interconnection-reform-order-2023.

[20] Tyler H. Norris, “Beyond FERC Order 2023: Considerations on Deep Interconnection Reform,” Text (Nicholas Institute for Energy, Environment & Sustainability, Duke University, August 22, 2023), https://nicholasinstitute.duke.edu/publications/beyond-ferc-order-2023-considerations-deep-interconnection-reform.

2035, and beyond to a net zero economy by 2050.[21] FERC's pending proposed rule on regional transmission planning, strategies to increase the capacity of the existing grid, reuse of interconnection infrastructure of retiring fossil will be needed to add clean energy at a pace consistent with U.S. climate goals, consumer affordability, and grid reliability.

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[21] Jesse D. Jenkins et al., "Climate Progress and the 117th Congress: The Impacts of the Inflation Reduction Act and Infrastructure Investment and Jobs Act" (Princeton, NJ: REPEAT Project, July 14, 2023), https://doi.org/10.5281/ZENODO.8087805.