How Interconnection Reform Can Accelerate Clean Energy Deployment

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Contents

Executive Summary

The process of integrating new electricity sources to the power grid—known as "generator interconnection"—must be reformed to realize the full potential of wind, solar, and energy storage. Projects requesting to connect to the grid are organized in "interconnection queues" and analyzed to determine necessary additions and upgrades to transmission infrastructure to accommodate new generation sources. The process to identify and implement interconnection upgrades is growing longer. A generation source coming online in 2023 spent five years on average from requesting connection to commercial operation, up from two years for projects built from 2000 to 2007.[1] Over 95% of project capacity languishing in interconnection queues is solar, wind, and energy storage.[2]

Accelerating the interconnection process would facilitate the achievement of clean energy goals and boost economic growth. This report illustrates the impact of interconnection reform, finding that expedited queue processing could **boost deployment of grid-scale clean energy 60% by 2030 and 90% by 2040**. This incremental clean energy could **supply almost 50 million homes with 100% clean energy in 2030, growing to 71 million homes by 2040**. Across the country, construction of wind, solar, and energy storage projects would **produce almost $100 billion in economic growth and over a million jobs**.

Important steps are being taken to advance interconnection process reforms and expedite clean energy deployment. The Federal Energy Regulatory Commission (FERC) has issued rules to speed up queue processing and promote better transmission planning. The U.S. Department of Energy (DOE) is providing funding to support analysis and construction of transmission projects that will help integrate new resources and enhance connections between regions with different clean energy profiles.

States can support and build on these efforts by engaging in processes to implement FERC rules and pushing for supplemental reforms. States can pursue DOE funding, either independently or in support of project developers, and states can address local obstacles to clean energy deployment by facilitating project siting, streamlining permitting, and supporting workforce and supply chain development.

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[1] Lawrence Berkeley National Laboratory, 2024, *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection,* available at: https://emp.lbl.gov/queues.

[2] Id.

Introduction

Wind, solar, and energy storage projects are being proposed at unprecedented pace and scale across the United States. Yet clean energy projects are taking longer than ever to secure needed approvals, connect to the grid, and start to deliver power to homes and businesses. In response to these growing delays, new rules from the Federal Energy Regulatory Commission (FERC) seek to expedite the process of moving proposed projects through grid interconnection processes. Successfully implementing these rules and pursuing complementary initiatives is key to accelerating the pace at which new clean energy projects can enable states to achieve their clean energy targets and to realize the economic development benefits of new renewable energy and energy storage projects.

The economics of wind and solar power, energy storage, and other clean energy sources are competitive with conventional generation, and clean energy projects currently comprise the vast majority of projects seeking to connect to the transmission grid. In the United States, almost 2,500 gigawatts[3] (GW) of non-emitting power generation and energy storage capacity are seeking to interconnect, equivalent to double the capacity of all generation sources currently online in the United States.[4] Legacy interconnection processes were established decades ago to individually evaluate a small number of large, predominantly coal and natural gas power plant proposals, and these processes are ill-suited to evaluate thousands of more geographically distributed wind, solar and energy storage projects.

Analyzing the flood of proposed projects through outdated processes is causing increased interconnection delays. Whereas in 2008, the processing time to move projects through interconnection queues averaged less than two years, a typical project coming online in 2022 spent five years waiting for interconnection approval.[5] A 2024 survey of wind and solar developers found interconnection to be the leading source of project delays, and the second leading source of project cancelations.[6] PJM, the nation's largest regional transmission organization stretching from the Mid-Atlantic to the Midwest, has stopped accepting new interconnection requests until at least 2025 as it struggles to clear a backlog of 300 GW of pending project proposals.[7] Slow or frozen interconnection processes increase development risk and imperil achievement of clean energy deployment.

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[3] 1 gigawatt is approximately the capacity of a large nuclear power plant.
[4] Lawrence Berkeley National Laboratory, 2024, *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection,* available at: https://emp.lbl.gov/queues.
[5] Id.
[6] Lawrence Berkeley National Laboratory, 2024, *Survey of Large-scale Wind and Solar Developers Report,* available at: Wind and Solar Developer Survey (escholarship.org).
[7] Id.

In response to these challenges, FERC has recently issued two significant orders related to interconnection and grid planning. Order 2023[8] seeks to accelerate interconnection by prioritizing mature projects under a "first-ready, first-served" framework. Under these reforms, interconnection customers (i.e., project developers) are required to prove commercial readiness by demonstrating control of property necessary to build their projects, and by posting significant monetary deposits that are lost if customers withdraw late in the process. Interconnection requests are studied in "clusters" to distribute grid upgrade costs equitably across projects and ensure that sufficient transmission is built to bring multiple projects online. Order 2023 also establishes study completion deadlines that transmission providers must achieve or risk facing financial penalties. Order 1920[9] requires longer-term transmission planning that anticipates needs 20 years in the future, taking account of public policy objectives and transmission projects identified in interconnection studies for multiple new resources.

The U.S. Department of Energy (DOE) is separately working to modernize the nation's grid with funding support and through permitting reforms. Under the Inflation Reduction Act and Infrastructure Investment and Jobs Act, the DOE is providing billions of dollars for grid upgrades and supporting numerous analyses to facilitate new resource integration.[10] The Coordinated Interagency Authorizations and Permits (CITAP) Program[11] will centralize and streamline federal permitting, and DOE is exercising recently granted authority to designate National Interest Electric Transmission Corridors[12] to facilitate transmission development in strategic locations. The longer-term, holistic approach to interconnection and transmission development supported by these federal initiatives promises to expedite completion of new clean energy resources that states, companies, and customers are demanding.

This report describes the benefits of interconnection reform for large-scale clean energy projects that connect to high-voltage transmission systems subject to recent federal, regional, and utility-led interconnection reforms. Distributed clean energy projects also play an important role in achieving renewable energy goals and driving economic growth, but undergo a separate interconnection process that is beyond the scope of this analysis. States can play an important role in accelerating clean energy deployment by supporting the implementation of federal reforms and DOE programs at the state and regional levels, by pushing for additional

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[8] Docket No. RM22-14-000; Order No. 2023 *Improvements to Generator Interconnection Procedures and Agreements*, available at: E-1 | Order 2023 | RM22-14-000 | Federal Energy Regulatory Commission (ferc.gov).
[9] Docket No. RM21-17-000; Order No. 1920 *Building for the Future Through Electric Regional Transmission Planning and Cost Allocation*, available at: E1 | RM21-17-000 | Federal Energy Regulatory Commission (ferc.gov).
[10] Under the Infrastructure Investment and Jobs Act DOE is deploying $20 billion in federal financing tools through the Building a Better Grid Initiative; see: Building a Better Grid Initiative | Department of Energy. A full summary of DOE funding programs can be found at: Funding Opportunities and Requests for Information | Department of Energy.
[11] See: Coordinated Interagency Transmission Authorizations and Permits Program | Department of Energy.
[12] See: National Interest Electric Transmission Corridor Designation Process | Department of Energy.

interconnection process reforms, and by addressing interrelated local barriers to clean energy deployment.

While the precise impacts of interconnection reforms on project deployment will take years to play out, the illustrative analysis in this report demonstrates the effects of accelerating the pace at which new clean energy projects connect to the grid. Section 2 of the report summarizes the methodology utilized to assess the impact of expediting interconnections, with a detailed methodological description provided as an appendix. Section 3 presents results of interconnection reform on clean energy deployment and economic activity. Section 4 describes actions that states can take to support and expand upon FERC and DOE initiatives, and additional state-level actions to expedite interconnection.

Analytical Approach

The analysis presented in this report estimates the increased rate at which solar, wind, and energy storage could connect to the grid if interconnection reforms and complementary efforts are implemented successfully and quantifies impacts on renewable energy deployment and economic development. The analysis focuses on the lower 48 states, where impacts are assessed across state and regional grids serving the vast majority of U.S. electricity consumers.[13]

The effect of interconnection reform is illustrated by comparing a business-as-usual scenario (the "BAU" scenario) of backlogged queues with a scenario where reforms prompted by Order 2023, DOE support, and supplemental efforts by FERC, transmission providers, and states (the "IX Reform" scenario) enable new clean energy projects to progress faster through interconnection processes, resulting in fewer project cancellations and accelerated project development. Until interconnection process reforms take effect, the actual impact on queue processing timelines is unknowable. In Order 2023, FERC set a 150-day deadline for transmission providers to complete cluster studies, which are followed by a project-specific facilities study and interconnection agreement. A cluster study could exceed the 150-day study deadline (though the transmission provider would incur penalties), or additional analysis could be required if projects in the initial cluster withdraw. While a precise, uniform queue processing timeline cannot be determined, it is reasonable to assume that reforms designed to address interconnection delays will materially reduce the duration of such processes. To illustrate the impact of interconnection reforms, the report assumes that queue processing

[13] The ISOs, RTOs and large utilities included in the study are: ISO-New England (ISO-NE), New York ISO (NYISO), PJM Interconnection (PJM), Midcontinent Independent System Operator (MISO), Southwest Power Pool (SPP), Electric Reliability Council of Texas (ERCOT, California Independent System Operator (CAISO), Duke Energy (Duke), Southern Company, Tennessee Valley Authority (TVA), Public Service Company of Colorado (PSC of CO), Arizona Public Service (APS), Public Service Company of New Mexico (PSC of NM), NV Energy, Western Area Power Administration (WAPA), Bonneville Power Administration (BPA), and PacifiCorp.

timelines decrease from an average of 2.5 years in the BAU scenario to 1 year in the IX Reform scenario.

Shorter interconnection timelines reduce cost and uncertainty for project developers and thus are anticipated to reduce project attrition. As with queue processing timelines, the impacts of interconnection reforms and complementary DOE and state efforts are illustrated with reasonable assumptions about reduced attrition rates. Under the IX Reform scenario, attrition rates initially increase by 25% in 2024 (to reflect a "purging" of the queue resulting from requirements in Order 2023 that project developers post significant financial security or withdraw). From 2025 onward attrition rates in the IX Reform scenario are assumed to fall by 50% from historic rates, reflecting the impact of interconnection process reforms and supplemental state and DOE initiatives. In the BAU scenario, increasingly clogged queues are projected to lead to a 10% increase in historic attrition rates. The analysis then projects state-level volumes of clean energy projects seeking grid connections based on average interconnection requests in recent years for wind, solar, and energy storage, controlling for significant outlier years to ensure reasonable projections. Applying the two scenarios to future interconnection requests yields a volume of incremental clean energy produced by interconnection reform and complementary efforts.

The analysis utilizes two metrics to illustrate the benefit of incremental clean energy: 1) incremental wind, solar, and energy storage brought online and 2) increased economic activity. Increased clean energy deployment is contextualized by comparing incremental wind and solar generation to select states' clean energy targets. Contributions to achieving state-level clean energy targets are determined by comparing demand driven by a renewable portfolio standard (RPS) and/or clean energy standard (CES) with incremental in-state clean energy enabled by interconnection reform.

Clean energy demand is based on the share of overall electricity demand that must be supplied by clean energy sources. The types of resources eligible for RPS or CES programs vary across states. To avoid inconsistencies, this analysis focuses only on incremental additions of land-based wind and solar, which qualify as clean energy in all RPS and CES programs and dominate interconnection queue requests. Hydroelectric and geothermal resources proposed as of the date of analysis are assumed to come online at the same rate as proposed wind and solar projects, but no additional hydroelectric or geothermal projects are assumed. Given the impact of offshore wind on some state's RPS or CES goals, offshore wind is included in both the business-as-usual and interconnection reform scenarios. Energy storage deployment is evaluated separately, as described below.

Electricity demand is based on projections from utilities, states, and grid operators, utilizing high-load growth scenarios to reflect recent increases in demand projections due to onshoring of manufacturing, increases in data center load, and electrification. The analysis controls for set-asides that require specific resources such as offshore wind and behind-the-meter solar by subtracting anticipated output from these resources from future clean energy demand. The remaining clean energy demand is compared to incremental clean energy supply to quantify the contribution that interconnection reform will make toward achieving state clean energy targets.[14]

The analysis also quantifies economic impacts of incremental clean energy deployment, utilizing the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model for solar and onshore wind.

A more detailed description of the methodology is provided in the Appendix.

Results

Successful interconnection reform is projected to yield significant benefits across the continental 48 states. Results vary between states, which is to be expected, as interconnection requests reflect renewable energy resource potential, state policy support, and local project development considerations such as land availability, perceived permitting complexity, local construction costs, and more. Nonetheless, each state sees incremental renewable energy deployment with interconnection reform. In aggregate, impacts at the national level are significant, as summarized below.

Nationwide, successful interconnection reform and complementary efforts lead to:

- Grid scale clean energy deployment increase of 60% by 2030 and 90% by 2040
- Renewable energy generation sufficient to supply almost 50 million homes with 100% clean energy in 2030; growing to 71 million homes by 2040
- A doubling of energy storage achieving commercial operation by 2030
- $100 billion in economic activity and over a million jobs.

[14] It is important to note that resources beyond the scope of this study such as nuclear, hydroelectricity, geothermal, and other resources can contribute to compliance with state RPS and CES requirements, and as such this report is not an analysis of whether a state is achieving clean energy requirements, but rather an assessment of how incremental wind and solar projects enabled by interconnection reform can contribute to compliance with clean energy requirements.

Energy Storage

In addition to wind and solar, energy storage will play an essential role in the clean energy transition. In recognition of its importance, states are increasingly establishing deployment targets and incentive mechanisms for energy storage. Table 1 lists ten states with capacity-based (MW) energy storage targets. Massachusetts (1,000 MWh by 2025) and Oregon (5 MWh by 2020) have energy-based targets for energy storage.

Table 1: Energy Storage Targets by State

State	Target (MW)	Target Year
CA	1,825	2020
CT	1,000	2030
IL[15]	7,500	2030
ME	400	2030
MD	3,000	2033
MI	2,500	2030
NV	1,000	2030
NJ	2,000	2030
NY	6,000	2030
VA	3,100	2035
Total	**28,325**	

These state-level energy storage targets are important for jump-starting deployment, which has reached 22 GW as of 2023[16] However, much larger volumes of energy storage will be needed to decarbonize the energy system. According to NREL's *Storage Futures Study*, 932 GW of storage will be needed in the United States by 2050 to meet electricity demand under a

[15] Illinois' 7,500 MW target is not an official target set by the state, rather a target proposed in SB 1587, which is still under review.
[16] Based on the LBNL's Queued Up: 2024 Edition data and interconnection queues included in the study. Total presented includes both hybrid and stand-alone storage capacity.

zero-carbon scenario.[17] Encouragingly, there are currently over 600 GW of storage interconnection requests in queues nationwide. [18]

Interconnection reform will help a large share of currently proposed and future energy storage projects come online. This study finds that interconnection reform and complementary initiatives could double the volume of energy storage capacity achieving commercial operations between 2024 and 2030, leading to deployment of approximately 400 GW. Between 2031 and 2040, an additional 450 GW of battery capacity could be brough online through interconnection reform, putting the US on track to reach the NREL-projected volume of storage needed to enable a zero-carbon grid by 2050.[19]

Renewable Energy Deployment

Successful interconnection reform is projected to significantly enhance the rate of renewable energy deployment across the continental United States. Expediting the pace at which new wind and solar projects connect to the grid helps states with clean energy goals hit their targets and provides significant economic benefit in states without clean energy requirements.

By expediting renewable energy development, interconnection queue reform will help states achieve, and in some cases exceed, their renewable and clean energy goals. Renewable energy produced in excess of state requirements can be sold to neighboring states or corporate and institutional buyers. The ability for one state to import energy from other states to achieve RPS/CES requirements varies, but the vast majority of states allow for purchase of clean energy within the same ISO or RTO. Other resources not modeled in this study will play a significant role in enabling states to achieve their clean energy goals. These resources include nuclear, long-duration energy storage, carbon capture and storage, green hydrogen and other clean fuels, large hydropower, geothermal, and others. As a result, the states with large demands and ambitious renewable and clean energy goals will not necessarily achieve RPS and CES compliance in 2030 or 2040 utilizing only the onshore wind and solar projects that are the focus of this analysis.

Table 2 summarizes the impact of interconnection reform on renewable energy deployment in 2030 for states with RPS/CES targets.

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[17] National Renewable Energy Laboratory, 2022, *Storage Futures Study: Grid Operational Impacts of Widespread Storage Deployment*, available at: https://www.nrel.gov/docs/fy22osti/80688.pdf.
[18] Lawrence Berkeley National Laboratory, 2024, *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection,* available at: https://emp.lbl.gov/queues.
[19] The NREL study encompasses the entire contiguous United States (the Eastern Interconnection, the Western Interconnection, and the Texas Interconnection) and does not break down energy storage demand regionally.

Table 2: 2030 Total Renewable Generation Under Business as Usual (BAU) and Interconnection (IX) Reform Scenarios & State RPS/CES Goals

State	BAU Renewable Generation (TWh)	IX Reform Renewable Generation (TWh)	2030 State Level RPS/CES Goal*	
			(TWh)	(% of Retail Sales)
AZ[X]	26	40	15	11%
CA[T]	112	147	158	60%
CO	19	29	52	81%
CT[T]	13	14	13	44%
DE[T]	1	1	3	27%
IL	37	41	45	77%
LA[T]	31	35	81	72%
MA[T]	21	22	40	66%
MD[T]	26	28	31	53%
ME[T]	8	10	11	84%
MI	18	32	62	50%
MN	24	31	51	69%
NC[T]	22	26	94	63%
NH	3	4	3	25%
NJ[T]	29	34	46	53%
NM	43	74	17	57%
NV	17	23	33	51%
NY[T]	41	60	124	70%
OH	22	24	14	9%
OR[T]	12	25	138	86%
PA[X]	11	22	38	26%
RI[T]	3	3	6	72%
UT	1	3	7	20%

VA[T]	35	43	131	56%
VT	5	5	5	83%
WA	25	36	93	100%
WI	20	26	36	44%

[T] States with offshore wind included in renewable generation.
* RPS/CES goal does not include distributed generation. The greater of the RPS and CES goals is assumed.
[X] Arizona's 2030 goal is based on current legislation and does not consider the effect of the RPS repeal. Pennsylvania's 2030 goal is based on proposed legislation.

For the majority of states, successful interconnection reform produces an appreciable to significant increase in clean energy generation. In states where offshore wind is anticipated to comprise a large share of future electricity generation (i.e., Connecticut, Delaware, Maryland, Massachusetts, New Jersey & Rhode Island), incremental renewable energy generation under IX Reform appears modest, as offshore wind is included in BAU projections to reflect that offshore wind deployment is predominantly determined by factors other than interconnection.[20]

In a few states, successful interconnection reform leads to a significant increase in renewable generation such that generation in 2030 exceeds state RPS/CES requirements. New Mexico and Arizona show renewable energy generation increases that outstrip state requirements, showing that each state is well positioned for export first-rate solar and wind-generated electricity.

Large states with diverse clean energy resources evidence the benefit of successful interconnection reform. In Pennsylvania, the volume of renewable generation in 2030 doubles in the IX Reform scenario. California, the fifth largest economy in the world, has a roughly 30% increase in renewable generation due to interconnection queue reform.

Table 3 summarizes the impact of successful interconnection reform in 2040. Similar to the 2030 results, successful interconnection reform leads to significant increases in renewable energy deployment for the majority of states.

[20] While offshore wind projects go through the same interconnection processes as onshore wind and solar, other factors such as contracting, permitting, supply chain constraints, and project construction schedules are more determinative of deployment timing. As further explained in the appendix, offshore wind interconnection requests have thus been included in the BAU and IX Reform scenarios, and are reflected in the state RPS/CES targets.

Table 3: 2040 Total Renewable Generation Under Business as Usual (BAU) and Interconnection (IX) Reform Scenarios & State RPS/CES Goals

State	BAU Renewable Generation (TWh)	IX Reform Renewable Generation (TWh)	2040 State Level RPS/CES Goal*	
			(TWh)	(% of Retail Sales)
AZ[X]	49	63	25	11%
CA[T]	168	259	292	95%
CO	25	43	62	83%
CT[T]	19	22	30	100%
DE[T]	5	5	5	40%
IL	66	74	52	89%
LA[T]	58	61	104	84%
MA[T]	39	42	62	84%
MD[T]	52	57	35	53%
ME[T]	19	21	15	84%
MI	37	67	81	100%
MN	33	43	78	100%
NC[T]	46	55	116	67%
NH	3	4	4	25%
NJ[T]	65	75	58	53%
NM	106	159	25	79%
NV	40	52	36	75%
NY[T]	96	122	261	100%
OH	41	44	15	9%
OR[T]	42	49	174	100%
PA[X]	30	38	47	26%
RI[T]	6	6	10	100%
UT	3	7	7	20%

VA[T]	77	110	310	82%
VT	5	5	5	80%
WA	44	47	98	100%
WI	30	35	66	72%

[T] States with offshore wind included in renewable generation.
* RPS/CES goal does not include distributed generation. The greater of the RPS and CES goals is assumed.
[X] Arizona's 2030 goal is based on current legislation and does not consider the effect of the RPS repeal. Pennsylvania's 2030 goal is based on proposed legislation.

Economic Benefits and Jobs

In order to further contextualize benefits of interconnection reform, economic benefits and job creation resulting from increased deployment of onshore wind and solar were calculated. In total, interconnection reform is projected to produce 667,000 job-years of employment and $57 billion in economic benefit from solar energy deployment, and 376,000 job-years and $42 billion in economic benefit from onshore wind deployment.

These illustrative results describe total economic benefit, including direct impacts (e.g. wages from project construction) and induced impacts (e.g. economic impacts resulting from spending of wages in the local economy). These impacts consider the construction period and operations and maintenance (O&M) impacts for the first year of operation. In the results described in Table 4 and Table 5, jobs refer to full-time equivalent (FTE) employment for one year (2,080 hours). Results for the construction period are short-term, with each construction job equating to one full-time job for one year. The Compensation category includes wages and salaries paid to workers. The Economic Output category indicates the economic activity or value of production added to the state. Lastly, the Net Economic Value-Added category represents the difference between the gross economic output and the cost of intermediate inputs, including business and sales taxes. These figures are limited to effects within the respective states. States are omitted from the respective tables if no incremental wind or solar capacity is projected to come online during the study period.

Table 4: Incremental Economic and Jobs Benefits from Increased Solar Deployment Due to Interconnection Queue Reforms

State	Jobs (1,000 FTE)	Compensation (2024$ Millions)	Economic Output (2024$ Millions)	Net Economic Value Added (2024$ Millions)
AL	11	652	1,412	922
AR	20	1,059	2,363	1,484
AZ	12	753	1,360	981
CA	5	363	682	506
CO	6	412	773	547
CT	3	201	383	281
DE	2	121	222	160
FL	9	508	1,096	722
GA	21	1,291	2,742	1,869
IA	10	553	1,248	780
ID	24	1,272	2,930	1,814
IL	23	1,603	3,053	2,153
IN	32	1,851	4,232	2,730
KS	27	1,593	3,768	2,374
KY	26	1,527	3,613	2,276
LA	7	424	926	596
MA	3	215	394	297
MD	7	431	795	593
ME	3	155	296	206
MI	26	1,636	3,082	2,129
MN	7	471	927	629
MO	28	1,687	3,790	2,400
MS	24	1,194	2,918	1,736

MT	3	149	365	217
NC	8	472	936	650
ND	7	329	805	479
NE	10	583	1,336	832
NH	3	217	432	300
NJ	5	344	639	469
NM	24	1,366	2,785	1,916
NV	1	92	170	125
NY	33	2,392	4,229	3,215
OH	13	802	1,542	1,063
OK	7	367	872	532
OR	17	1,057	2,041	1,415
PA	38	2,508	4,900	3,416
RI	20	1,138	2,394	1,605
SC	3	168	398	246
SD	13	812	1,762	1,186
TN	43	2,712	6,115	3,959
TX	5	285	565	375
UT	20	1,394	2,579	1,879
VA	20	1,394	2,579	1,879
WA	22	1,501	2,728	2,081
WI	10	576	1,074	760
WV	15	812	1,663	1,115
WY	14	754	1,600	1,076
Total	**667**	**40,806**	**84,940**	**57,099**

Table 5: Incremental Economic and Jobs Benefits from Increase Land-based Wind Deployment Due to Interconnection Queue Reforms

State	Jobs (1,000 FTE)	Earnings (2024$ Millions)	Output (2024$ Millions)	Value Added (2024$ Millions)
AL	0	0	0	0
AR	5	328	1,382	574
AZ	15	995	3,640	1,656
CA	55	4,606	16,407	8,116
CO	9	644	2,203	981
IA	20	1,172	5,370	2,145
ID	24	1,437	5,747	2,259
IL	1	53	188	97
IN	11	798	3,257	1,438
KS	24	1,591	6,874	2,961
KY	1	62	247	102
LA	1	60	239	106
ME	3	157	587	250
MI	6	278	998	541
MN	7	510	1,715	794
MO	4	255	1,046	438
MS	1	82	396	148
MT	1	76	339	124
NC	1	45	171	81
ND	18	1,329	5,739	2,901
NE	11	757	2,969	1,309
NJ	6	563	1,616	804

NM	19	1,029	5,361	1,843
NV	11	765	2,832	1,316
NY	14	1,213	3,978	1,998
OH	2	174	633	291
OK	17	1,322	4,382	1,952
OR	12	840	3,073	1,424
PA	2	126	426	198
SD	9	591	2,375	980
TN	1	65	242	107
TX	27	2,016	8,001	3,756
UT	2	153	626	262
VA	0	12	38	19
WA	10	1	3	1
WI	2	0	1	0
WV	2	0	1	0
WY	24	1	8	3
Total	**379**	**24,107**	**93,109**	**41,973**

The Role of States in Expediting Interconnection

States have an important role to play in realizing the benefits of expedited interconnection. States can support implementation of interconnection process reforms initiated by FERC and the RTOs, and can push for additional interconnection process reforms. States can take advantage of DOE programs offering funding and technical support, and can address obstacles at the state and local levels that impede the interconnection process. These efforts undertaken by states will help achieve the benefits illustrated in this report and could achieve additional benefits by further expediting clean energy deployment.

Supporting Interconnection and Planning Reforms

States can shape implementation of reforms to interconnection processes and transmission planning at the regional and state levels, either by engaging individually, or collectively through associations at the national or regional levels.[21] FERC orders are directives that must be implemented by transmission providers,[22] and implementation processes include significant opportunities for stakeholder engagement.

Compliance filings for Order 2023 were submitted in May of 2024, and FERC will now determine whether interconnection process reforms proposed by transmission providers fully comply with required changes. During FERC's review, states can object to elements of compliance filings and pursue interconnection reforms not proposed by transmission providers.[23]

Order 1920 explicitly requires transmission providers to consult with states on compliance plans. Specifically, transmission providers must hold a six-month engagement with relevant state agencies to establish default cost allocation provisions to pay for transmission identified through the longer-term, planning processes that account for multiple transmission benefits. States can also engage in stakeholder processes to develop compliance plans for other elements of Order 1920, including the processes to identify and advance transmission projects that will expedite interconnection of new resources.

Advocating for Additional Reforms

States can also advocate for additional reforms that go beyond Orders 2023 and 1920, both at FERC and by engaging their relevant RTO/ISO. Priority reforms summarized below are excerpted from *Unlocking America's Energy: How to Efficiently Connect New Generation to the Grid*.[24] Reforms include:

1. **Increasing interconnection certainty** – Transmission providers would proactively build interconnection capacity based on long-term, multi-driver, and scenario-based

[21] Examples of regional associations include the New England States Committee on Electricity (NESCOE), the Organization of PJM States, Inc., and the Organization of MISO States.
[22] "Transmission provider" in the context of both Order No. 2023 and Order 1920, includes any entity that owns, controls, or operates transmission or distribution facilities used for the transmission of electricity in interstate commerce and provides transmission service under an Open Access Transmission Tariff. This encompasses not only RTO/ISOs but also other public utility transmission providers that manage the interconnection process and must implement the required reforms to reduce backlogs and improve the efficiency of interconnections.
[23] For example, the New Jersey Board of Public Utilities filed an objection to PJM's proposed treatment of energy storage resources, see: https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20240620-5235&optimized=false.
[24] Grid Strategies and The Brattle Group, *Unlocking America's Energy: How to Efficiently Connect New Generation to the Grid* (August 2024), available at https://blog.advancedenergyunited.org/reports/unlocking-americas-energy.

planning processes and generators would subscribe to available capacity based on commercial readiness and willingness to pay an "entry fee."

2. **Fast-track utilization of available interconnection capacity** – Interconnection requests would be processed on an expedited basis in locations where available interconnection capacity exists. This would be particularly useful for utilizing "headroom" created by retiring generation sources.

3. **Improve efficiency of interconnection studies** – Study processes could be improved by tailoring analysis to the desired interconnection service level (i.e., capacity vs. energy-only), standardizing study assumptions, evaluating alternatives to traditional transmission upgrades, utilizing automation, and establishing independent monitors to evaluate transmission providers' processes and enhance transparency.

4. **Expedite construction of necessary upgrades** – Timelines required to implement necessary upgrades could be shortened by adopting industry best practices and proactively addressing supply chain constraints.

FERC has an open docket (AD24-9) to consider additional interconnection innovations and efficiencies beyond Order 2023.

Accessing DOE Funding

DOE has been provided significant funding and given new authorities through the Inflation Reduction Act and Infrastructure Investment and Jobs Act. States can access these programs directly or can support applications for projects that would expedite interconnection or provide other benefits. Key DOE programs focused on enhancing grid capacity and expediting interconnection are highlighted below, and additional information on these and other DOE programs is available through the Grid and Transmission Program Conductor[25] from DOE's Grid Deployment Office.

Grid Resilience and Innovation Partnerships Program (GRIP)[26]

The $10.5 billion GRIP program is intended to enhance grid flexibility, resilience, and reliability through competitive grants for deployment of new technologies and grid management approaches. GRIP consists of three sub-programs:

[25] DOE, *Grid and Transmission Program Conductor,* available at: Grid and Transmission Program Conductor | Department of Energy
[26] See: Grid Resilience and Innovation Partnerships (GRIP) Program | Department of Energy

1. Grid Resilience Utility and Industry Grants ($2.5 billion) are open to utilities and transmission developers for projects that strengthen the grid against severe weather and natural disasters.

2. Smart Grid Grants ($3 billion) are open to all applicants for projects that increase transmission capacity, prevent faults, and integrate renewables or other grid-edge technologies such as electric vehicles.

3. The Grid Innovation Program ($5 billion) is open to states for projects that utilize innovative transmission technologies (up to $250 million per project) and for interregional transmission (up to $1 billion per project).

Transmission Facilitation Program (TFP)[27]

The TFP is a revolving loan fund of $2.5 billion dollars that enables DOE to subscribe up to 50% of the capacity of a new transmission system of over 1,000 MW or a transmission rebuild of 500 MW or more. The program authorizes DOE to serve as an "anchor customer" to enable financing and construction of a transmission project. Once the project is completed DOE remarkets its capacity to third parties. Under the TFP program, DOE can also provide loans or enter public-private partnerships with transmission developers. States can support transmission developers in applying for TFP support.

The Transmission Infrastructure Program (TIP)[28]

TIP is an infrastructure financing program aimed at expanding and modernizing the grid in the 15-state Western Area Power Administration territory. TIP has $3.25 billion in borrowing authority for loans and development assistance.

Transmission Siting and Economic Development Program (TSED)[29]

The TSED program has $760 million to support state, tribal and local authorities in permitting new high-voltage onshore and offshore transmission systems, including routing analysis, participation in regulatory proceedings, and expert analysis.

[27] See: Transmission Facilitation Program | Department of Energy
[28] See: Transmission Infrastructure Program (TIP) – Western Area Power Administration (wapa.gov)
[29] See: Transmission Siting and Economic Development Grants Program | Department of Energy

Interregional and Offshore Wind Electricity Transmission Planning, Modeling and Analysis[30]

DOE has $100 million to support stakeholder convening and analysis to enable development of interregional and offshore wind transmission. States could be provided a share of this funding to support analysis of priority regional and interregional projects.

Addressing Local Obstacles to Clean Energy Deployment

Barriers to deployment of clean energy projects beyond interconnection exist at the state and local levels. Siting and permitting new clean energy projects can be a major impediment to deployment, as can workforce and supply chain constraints. Each of these issues can be alleviated or addressed through state-level initiatives. While these challenges are separate from the interconnection process, they are interrelated: delays to these elements of the project development process can further complicate the interconnection process, and lack of alignment and coordination between generator interconnection processes and state-level processes can hamper efficient commercial operation.

Siting

States can minimize siting conflicts by mapping resource locations and encouraging development in preferred locations. This can be achieved by tailoring incentives or streamlining permitting for projects in certain locations and/or for projects that utilize preferred technologies or project configurations.

Permitting

Overlapping or disparate permitting authorities and processes can slow project development and increase risks and associated costs for new clean energy projects. Reforming permitting and regulatory regimes for large-scale projects with the two key interests in mind—accelerating deployment and safeguarding participation from affected communities and stakeholders—can help address permitting challenges. State efforts to address siting and permitting constraints can draw on information collated by DOE on siting and permitting best practices and existing processes in all 50 states.[31]

Workforce

Bolstering the clean energy workforce can be achieved by funding education at higher educational and vocational institutions, through professional certification programs, and

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[30] See: https://www.energy.gov/gdo/offshore-wind-transmission-federal-planning-support
[31] See: https://www.energy.gov/eere/siting-large-scale-renewable-energy-projects

through public-private partnerships. States can also incent workforce development through clean energy procurements or through other incentive programs. Transmission providers should ensure sufficient staffing for interconnection analyses through hiring and training programs.

Supply Chain

States can help to address supply chain constraints by centralizing information for buyers and sellers of needed goods and services, and by fostering growth of new supply chain sectors. State registries that describe the capabilities of local companies can help project developers secure goods and services efficiently, while facilitating business development for suppliers. State incentives such as tax relief, grants, or provision of state property can attract new supply chain companies to fill gaps, and multi-state or regional coordination can ensure broad distribution of supply chain benefits.

Conclusion

Reforms to interconnection and planning processes can expedite clean energy deployment, help states achieve policy goals, and boost economic growth. If successful, reforms to generator interconnection stemming from FERC Order 2023 and other actions being taken by grid operators and states could result in nearly 60% more renewable capacity being connected to the contiguous United States grid by 2030. Additionally, an incremental 30% more large-scale renewable capacity could come online between 2031 and 2040 through interconnection queue reform. The additional renewable capacity brought online as a result of interconnection reform is enough to meet total projected electricity demand in 2030 and 2040 across the US Northeast (New England, New York, New Jersey, and Pennsylvania). Additional measures to expedite interconnection and improve transmission planning could further accelerate the pace of clean energy deployment. States can and should play important roles in supporting federal initiatives and addressing local challenges. Concerted and coordinated efforts across multiple levels of government will match the challenges and opportunities created by the clean energy transition and will deliver significant benefits across the country.

Appendix: Detailed Methodology

Overview

This analysis estimates the impact of interconnection queue reforms on incremental clean energy deployment. The analysis should be viewed as illustrative, as the precise impacts on interconnection timelines and project attrition are unknowable at present. Reasonable assumptions have been made regarding the expected impacts of faster queue process on project success and resulting onshore wind and solar deployment.

The benefit of interconnection reform is analyzed by evaluating the contribution of incremental clean energy deployment on state clean energy requirements and on economics. Additionally, the analysis estimates the incremental volume of battery energy storage that could be processed through the interconnection queue with reforms.

Interconnection Queue Analysis

To establish the effect of interconnection queue reform on renewable energy deployments, the analysis compared a business-as-usual (BAU) scenario with extended interconnection times, with a scenario under which interconnection process reform ("IX Reform" scenario) leads to expedited queue processing. The BAU scenario reflects the current state of interconnection queue delay and resulting project attrition, projecting that these conditions are likely to worsen over time without reform. The IX Reform scenario reflects reforms that accelerate interconnection queue processing, including reduced interconnection queue processing times and resulting reduction in attrition rates. A secondary effect is lower volumes of projects requesting interconnection (i.e., a reduction in projects seeking an interconnection queue position on a speculative basis) as a result of increased commercial readiness requirements reflected in monetary commitments from project developers. Information on interconnection queues is drawn from Lawrence Berkley National Lab's (LBNL's) *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection.*[32] A subset of projects from the database reflecting those that entered the interconnection queue from 2014 through 2023 was selected for the analysis.

Interconnection Queue Processing Time

The interconnection queue processing time represents the amount of time it takes a project to proceed through the interconnection queue process and achieve an executed interconnection

[32] See: Lawrence Berkeley National Laboratory, 2024, *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection,* available at: https://emp.lbl.gov/queues.

agreement. For the BAU scenario, the interconnection queue processing time reflects the average balancing authority-specific queue processing time between 2014 and 2023. For the IX Reform scenario, this time reflects the compliance filings made by the various balancing authorities in April 2024 to FERC in response to FERC Order No. 2023. No change was made to the ERCOT interconnection queue processing time given ERCOT does not fall under FERC jurisdiction. Under the BAU scenario, interconnection queue processing times average 2.5 years. Under the IX Reform scenario, the time is reduced to an average of a year.

Non-Interconnection-Related Delay to Commercial Operation

The non-interconnection-related commercial operation delays encompass any delay faced by a project after it has received an executed interconnection agreement but before it achieves commercial operation. For the ISOs and RTOs, this value is based on the average non-interconnection-related delay between 2014 and 2022. For the other interconnection queues, this value is assumed to be 2 years based on a review of solar and wind development times. This value is held constant between the two scenarios in order to highlight the impact of the interconnection queue-related changes.

Technology-Specific Attrition Rate

For projects entering the interconnection queue between 2016 and 2020, technology-specific attrition rates were calculated for each of the 17 balancing authorities using historical data. 2016 through 2020 was chosen as it is the most recent time period that accurately reflects the rate of project attrition. Using data for projects entering the queue between 2021 and 2023 would underestimate the attrition rate given that these projects have entered the queue more recently and had less time to experience project attrition. Under the BAU scenario, the attrition rate is expected to increase (i.e., more projects would experience attrition). To illustrate the impact of increased attrition rates we assume 10% additional attrition in the BAU scenario (i.e., 2016 – 2020 average attrition rate for solar is 45%, and under the BAU scenario the post 2023 attrition rate is 55%). Under the IX Reform scenario, the 2016-2020 attrition rate is expected to increase in 2024, representing a “cleansing” of the interconnection queue as a result of the requirement in FERC Order 2023 that active projects post significant financial deposits to remain in the queue. A 25% increase in attrition is assumed in 2024 (i.e., 2016 – 2020 average attrition rate for solar is 45%, under the IX Reform scenario, the 2024 attrition rate is 45% x (100%+25%)). From 2025 onwards, the attrition rate is forecasted to decline by 50% (i.e., 2016–2020 average attrition rate for solar is 45%, under the IX Reform scenario, the post-2024 attrition rate is 45% x 50%).[33]

[33] In some instances, these assumptions were modified to yield reasonable results.

Attrition Rate for Projects with Executed Interconnection Agreements

After completing the interconnection process projects can fail to be constructed due to other issues. A large number of projects with executed interconnection agreements have yet to achieve commercial operation. Given inflationary pressures, supply chain, and permitting challenges, these projects are expected to experience a relatively high level of attrition despite their finalization of the interconnection process. A 50% attrition rate is thus applied in both the BAU and IX Reform scenarios for projects with interconnection agreements executed that entered the interconnection queue between 2014 – 2023 but have not achieved commercial operation.

Volume of Interconnection Requests Entering the Queue by State

The volume of interconnection requests entering the queue is a critical assumption. Under the BAU scenario, a 3-year rolling average is used for solar and battery storage requests (i.e., 2024 interconnection requests are the average of 2021 through 2023). For wind, the 4-year rolling average is used. Three years was selected for solar and batteries given the shorter development timeline and magnitude of interconnection requests compared to onshore wind. For some states, the volume of solar, wind, or battery storage was modified to ensure reasonableness. An example is interconnection requests in MISO for solar in Arkansas over the 2021 – 2023 period. In 2022, over 25 GW of solar projects submitted interconnection requests, exceeding the 2017 – 2021 average by over 600%. As a result, the 2022 solar interconnection capacity is excluded from the rolling average calculation, and requested solar capacity from 2020 is used in its place. Similar to the BAU scenario, professional judgment was used to amend the volume of solar, wind, or battery storage entering the interconnection queue in the IX Reform scenario to ensure reasonableness.

Summary of Interconnection Queue Analysis Assumptions

Table 6 summarizes the inputs and assumptions for each scenario. These inputs are specific for each of the 17 balancing authorities included in the analysis.

Table 6: Interconnection Queue Analysis Inputs and Assumptions

	BAU	IX Reform
Interconnection Queue Processing Time (Years)	Based on historical rates for 2014 – 2023. If no information is available, average of two closest balancing authorities used.	Based on FERC 2023 compliance filings. No change for ERCOT as not under FERC jurisdiction.
Non-Interconnection Related Delay to Commercial Operation (Years)	Based on historical rates for 2014 – 2023. If no information is available, average of two closest balancing authorities or professional judgement used.	No change from BAU.
Technology Specific Attrition Rate (%)	Average of 2016 – 2020. Assumed to increase over time as a result of increasing interconnection queue backlog.	Average of 2016 – 2020 used as starting point, higher attrition expected in 2024 to cleanse the queue. Lower attrition rate expected from 2025 onwards.
Attrition Rate (%) for Projects with Executed Interconnection Agreements	Attrition rate of 50% assumed given commercial and permitting challenges.	Attrition rate of 50% assumed given commercial and permitting challenges.
Volume of Interconnection Request Entering the Queue by State (MW)	3-year average for solar and battery requests. 4-year average for wind requests. Historical data smoothed to control for outlier years.	75% of 3-year average for solar and battery requests. 75% of 4-year average for wind requests. Projections adjusted as needed for reasonableness.

Interconnection Queue Reform Impact

To contextualize the impact of interconnection queue reform, the volume of wind and solar generation that would be available is compared to RPS and CES targets. The RPS and CES demand was forecasted by multiplying the RPS or CES requirement for a given year by the state demand forecast. For states with both an RPS and CES goal, the greater of the percentages is used. To determine the MWh of renewable energy production, state-specific capacity factors were utilized from EIA.[34]

For all states, the economic benefits of additional solar and wind capacity enabled by interconnection queue reforms are estimated. Incremental solar and wind additions are determined as the difference between the capacity projected to come online under the BAU scenario and the IX Reform scenario. Using the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model for solar and onshore wind, the benefits from the incremental additions were determined.[35] The JEDI model projects jobs and economic benefits for projects in construction to 2030. As a result, the cumulative economic benefits of solar and wind capacity to achieve operation in 2024 through 2030 are evaluated. The model results include the total impacts during construction and annual operations and management (O&M).

JEDI allows customized inputs for local content in determining employment and economic impact within a specific analysis area. This analysis assumes that 50% of project spending occurs in each state across most inputs. Certain costs, such as local property taxes, local sales tax rates, and O&M labor, are assumed to accrue 100% in-state. The assumptions for local share of project costs are informed by NREL's *Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the §1603 Treasury Grant Program*, which uses a range of 30-70% domestic content assumption for both solar and wind projects.[36] To account for industry and supply chain development changes since the publishing of the NREL report, solar and wind project case studies, and recent reports were utilized. A 2019 report on the *Economic Impacts from Wind Energy in Colorado Case Study: Rush Creek Wind Farm*, reported in-state content shares averaging 42% for equipment costs, 64% for balance-of-plant (BOP) costs, and 86% for O&M costs.[37] Given the incentives under the Inflation Reduction Act, including the domestic content bonus credit, domestic and in-state content shares are expected to increase in the future.[38]

Geographic Scope

The geographic scope of balancing authorities for interconnection queue review was determined to ensure that the scope of the study included the balancing authorities with the

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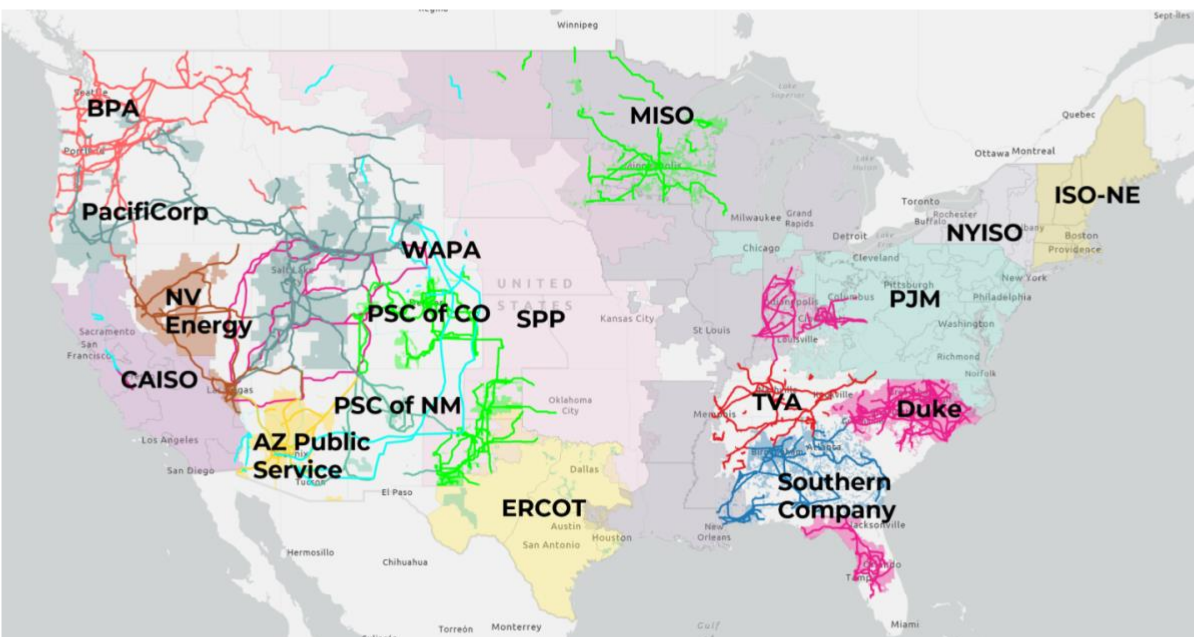
[34] See: State Profiles and Energy Estimates | United States Energy Information Administration
[35] See: Jobs and Economic Development Impact (JEDI) Models | NREL
[36] National Renewable Energy Laboratory, 2013, Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the §1603 Treasury Grant Program, available at: https://www.nrel.gov/docs/fy12osti/52739.pdf
[37] National Renewable Energy Laboratory, 2019, Economic Impacts from Wind Energy in Colorado Case Study: Rush Creek Wind Farm, available at: https://www.nrel.gov/docs/fy19osti/73659.pdf
[38] See: Inflation Reduction Act of 2022 | Internal Revenue Service (irs.gov)

highest amount of renewable energy seeking to interconnect.[39] The seven Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) selected for analysis cover 37 states. These include ISO-New England (ISO-NE), New York ISO (NYISO), PJM Interconnection (PJM), Midcontinent Independent System Operator (MISO), Southwest Power Pool (SPP), Electric Reliability Council of Texas (ERCOT) and California Independent System Operator (CAISO).

To achieve greater geographic coverage, 10 additional balancing authorities were selected. These balancing authorities include Duke Energy (Duke), Southern Company, Tennessee Valley Authority (TVA), Public Service Company of Colorado (PSC of CO), Arizona Public Service (APS), Public Service Company of New Mexico (PSC of NM), NV Energy, Western Area Power Administration (WAPA), Bonneville Power Administration (BPA), and PacifiCorp. Not all balancing authorities within the United States are covered in this study due in part to the number of balancing authorities[40] and the relatively small footprint of many of these. This is likely to result in an underestimation of the volume of renewables that will be added in the coming years and the benefits of reforming interconnection processes. Nonetheless, the 17 balancing authorities assessed provide for a robust evaluation of the impact of interconnection queue reforms on renewable deployment.

Figure 1 highlights the balancing authority and state coverage of this study. Balancing authorities are represented by both shading and lines representing transmission systems.

Figure 1: Geographic Scope of Study



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[39] This study covers all 48 continental US states, omitting Hawaii and Alaska.
[40] There are about 66 balancing authorities within the continental United States.

Approach to State-Level Analysis

The study quantifies the impacts of interconnection queue reform in two ways: additional renewables brought online in states with clean energy targets, and economic benefits from construction of new projects. Clean energy targets are based on state Renewable Portfolio Standards (RPS) and Clean Energy Standards (CES) as of April 2024 and proposed targets for select states (see Table 2 for details). For the states without RPS or CES goals, the incremental economic benefits (i.e., jobs and economic output) are estimated based on the incremental volumes of renewable energy enabled through interconnection reform.

Renewable Portfolio Standard and Clean Energy Standards

State RPS and CES goals underpin the demand for renewable energy and provide a benchmark for the rate of interconnection queue processing to meet these goals. When combined with a load forecast, the RPS and CES goals provide the state demand for renewable energy production (megawatt hours) for a given year. Depending on the state, certain loads or portions of loads (e.g., municipal utilities or coops) may be exempt from an RPS or CES requirement. This study did not account for the reduction in renewable energy demand resulting from RPS or CES-exempt loads. These exemptions represent a small share of overall state load, and as such are not anticipated to materially affect results.

The Lawrence Berkely National Laboratory (LBNL) *U.S. State Renewables Portfolio & Clean Electricity Standards: 2023 Status Update* is the starting point for yearly RPS and CES targets across all 48 states.[41] These targets were verified and augmented for any states omitted from the LBNL report or any legislative changes and executive orders issues prior to April 2024.[42]

RPS targets often include different "classes" or "tiers" of renewables, which account for a portion of the overall RPS target. Where distributed generation (DG) represents a separate RPS class or tier, the percentage allotted to DG is subtracted from the overall RPS percentage as the focus of this study is large-scale resources. The remaining RPS percentage, including any technology-specific classes or tiers, is treated as the state RPS demand.

Some states have CES goals in addition to or in place of an RPS. CES goals establish requirements for load-serving entities to provide carbon-free energy or achieve emission reduction targets. Where relevant, carbon emission reduction targets are converted to carbon-free electricity needed to meet the CES target.

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[41] RPS & CES Nominal Percentage Targets (XLSX) (last updated June 2023)

[42] The exception is Vermont whose Renewable Energy Standard (RES) was updated in June 2024 and is reflected in the analysis.

States with CES or carbon emission reduction targets may establish requirements for one or several years in the future. For example, Illinois's CES requires the state to use 100% carbon-free electricity by 2050 and does not include requirements for intermediate years. To estimate intermediate CES and carbon emission reduction targets needed to achieve these targets, the analysis calculates the annual incremental clean energy requirement as a linear rate to reach the CES or carbon emission reduction target, starting at the current percentage of clean energy produced and consumed in the respective state.

Table 7 details the states with RPS, CES, or carbon emission reduction targets. In the case that a state has multiple targets, the target with the greater volume (MWh) of compliance is utilized.

Table 7: States with RPS, CES, or Carbon Emission Reduction Targets[43]

States with RPS Targets	States with CES Targets	States with Carbon Emission Reduction Targets
AZ, CA, CO, CT, DE, IL, MA, MD, ME, MI, MN, NC, NH, NJ, NM, NV, NY, OH, OR, PA, RI, UT, VA, VT, WA, WI	CA, CT, IL, MA, ME, MN, NM, NV, NY, VA, WA, WI	CO, LA, NC, OR

Renewable Portfolio Standard and Clean Energy Standard Compliance Status

To establish a basis for future RPS and CES compliance, it is necessary to first understand the current level of compliance in the state. The most recent and publicly available compliance reports for each state or load-serving entities in the state were reviewed to determine whether the state or load-serving entities are in compliance with RPS requirements for a given year. The required compliance level (MWh) for each state was recorded along with the number of renewable energy certificates (RECs) used for compliance. The difference between these two values provides the MWh of shortage or oversupply.

The compliance results provide a current snapshot of whether states are meeting their RPS and CES targets. If a state is undersupplied or oversupplied, the shortage or surplus of RECs is carried into future years and influences the volume of additional renewables needed to meet compliance.

[43] Sources include Lawrence Berkley National Laboratory, *Renewables Portfolio Standards Resources,* June 2023; state legislation and executive orders; and Database of State Incentives for Renewables & Efficiency (DSIRE).

Jobs and Economic Benefits

To provide further context on the benefit of interconnection reform, jobs and economic benefits of increased renewable deployment are quantified. Jobs and economic benefits are determined utilizing the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model for solar and onshore wind, based on the increased number of such projects brought online due to interconnection reform. The states where jobs and economic benefits are assessed are detailed in Table 5.

Demand Forecast

Future demand for electricity determines the quantity of renewable energy needed to achieve RPS and CES targets. Recently released demand forecasts indicate that demand growth projections have increased significantly, due to expansion of domestic manufacturing, data center growth, electrification of transportation and heating, and large-scale decarbonization efforts, including hydrogen electrolysis. According to the Electric Power Research Institute's (EPRI) July 2023 report, *Reindustrialization, Decarbonization, and Prospects for Demand Growth*, since January 2021, electricity demand has grown by more than 13,000 GWh/year as a result of new or expanding manufacturing facilities.[44] EPRI's May 2024 report, *Analyzing Artificial Intelligence and Data Center Energy Consumption*, projects US data center energy demand to account for up to 9.1% of demand by 2030, compared to 4% today.[45]

The 2023 Grid Strategies report, *The Era of Flat Power Demand is Over*, provides insight into utility load forecasts and utilities' responses to increasing demand growth.[46] The report indicates an increase in forecast demand over the next five years, from 2.6% in 2022 filings to 4.7% in 2023 filings. The 2023 Grid Strategies report also notes that from 2022 to 2023 the 5-year national forecast for peak demand increased by nearly 50%, from a 0.63% Compound Annual Growth Rate (CAGR) to 0.93%.

Given the rapid pace and the degree to which ISO, RTO, and utility demand forecasts are being revised to reflect increased expectations for demand growth, this study utilizes a high-demand forecast as the most realistic central case. The state-specific high-demand forecast methodology is outlined below.

State-level demand forecasts for 2024 to 2040 were developed for each RPS or CES state using the most recent available data from the relevant ISO, RTO, or utility. High-demand

[44] Electric Power Research Institute, 2023, *Reindustrialization, Decarbonization, and Prospects for Demand Growth*, available at: https://www.epri.com/research/products/000000003002027930

[45] Electric Power Research Institute, 2024, *Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption*, available at: https://www.epri.com/research/products/3002028905

[46] Grid Strategies, 2023, *The Era of Flat Power Demand is Over*, available at: https://gridstrategiesllc.com/wp-content/uploads/2023/12/National-Load-Growth-Report-2023.pdf

growth scenarios were utilized as available. MISO, ISO-NE, NYISO, and CAISO provide state-level high-demand forecasts. PJM provides utility-level high-demand forecasts across its footprint. To develop state-wide demand forecasts for PJM states, the forecasts of the utilities wholly within the state and the partial share of forecasts of utilities operating in multiple states were aggregated. For states not within an ISO or RTO, the growth rate from the demand forecast of the largest state utility was utilized. If a high-demand growth scenario was unavailable, the 2023 Annual Energy Outlook (AEO) high-demand forecast was utilized. The base scenario demand forecast for each state was scaled up by the percentage increase between the AEO base-case demand forecast and the high-demand forecast for the appropriate Electricity Market Module (EMM) region.

Renewable Energy Operating in 2023

To determine the volume of existing renewables on the system to serve RPS and CES demand, the state or utility RPS and CES compliance reports are utilized. This information is supplemented with industry data on renewables anticipated to achieve commercial operation in the year(s) since the RPS and CES compliance report issuance.

The RPS and CES compliance reports indicate the volume of RECs that are available in a given compliance year to serve RPS and CES demand. Specifically, the compliance reports indicate the volume of REC demand, the RECs available to meet this demand, and whether the state or load-serving entity is compliant, undersupplied, or oversupplied as a result. The number of RECs that are produced and available in the latest year of RPS compliance are, for the purposes of this study, considered the renewable energy supply for that year of compliance. While this figure provides the volume of renewable energy (MWh) consumed in a given year and not the renewables produced, it is an appropriate approximation for this analysis. The volume of RECs used for RPS compliance may include RECs purchased from out-of-state resources or RECs banked from prior years. For the purposes of this analysis, interstate REC purchases and banking of RECs are not considered.

To account for renewable energy projects that achieve commercial operation between the year(s) since the latest RPS or CES compliance report through the end of 2023, an industry database was utilized to estimate state-specific volumes of renewables that came online. Any counterparties who are unlikely to utilize a given project for RPS or CES compliance were removed from the database. These excluded counterparties mainly consist of corporate buyers and universities. The output from projects achieving commercial operation subsequent to the RPS/CES compliance reports was added to the state-specific volume of renewables specified in the RPS compliance report.

Figure 2 summarizes how total renewable energy supply is determined based on RPS/CES compliance reports and subsequently developed projects

Figure 2: Volume of Renewable Energy Operating in 2023 for RPS and CES Compliance

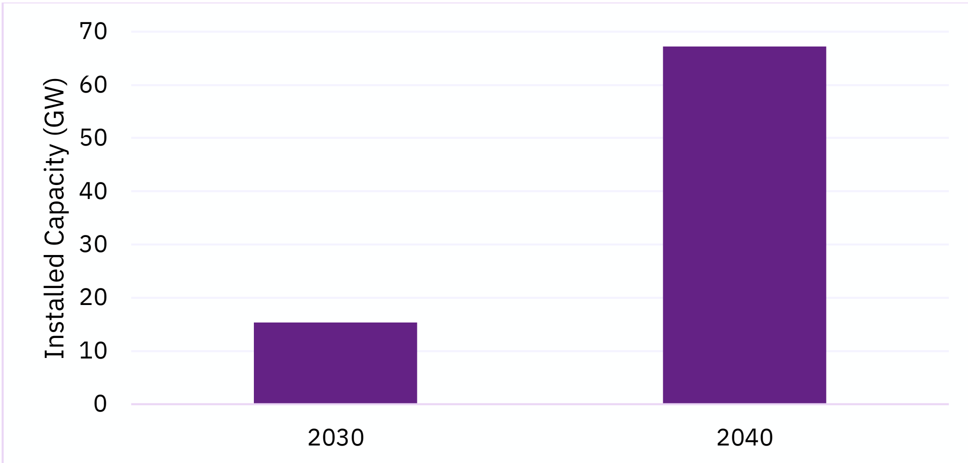
Offshore Wind

Many coastal states have set ambitious targets for offshore wind, which will contribute significantly to compliance with RPS and CES goals. With larger project sizes and higher capacity factors than land-based renewable resources (wind and solar), a single offshore wind project can have a large impact on a state's RPS and CES compliance status. While offshore wind projects must go through the same interconnection process as onshore renewables, other factors are also important determinants of when offshore wind projects come online. Offshore wind is thus included in determining RPS and CES compliance but is omitted from the interconnection queue analysis.

To determine the timing of offshore wind additions by state, state offshore wind targets, project development status, and announced Bureau of Ocean Energy Management (BOEM) wind energy areas were considered. The DOE *Offshore Wind Market Report: 2023 Edition* was used as the baseline for project commercial operation dates. For projects further out in the offshore wind development pipeline, Power Advisory's professional judgement was used to determine reasonable commercial operation dates. The volume of offshore wind to achieve commercial operation is based on current state of offshore wind procurement goals and targets. Not every state with an offshore wind procurement goal or target is assumed to meet its targets, considering state legislative environments, technology commercialization status, and availability of BOEM wind energy areas.[47] The capacity factors for the various offshore wind areas are based on Power Advisory's professional judgment. Based on these inputs, the analysis assumes 15 GW of offshore wind capacity in 2030 and 67 GW in 2040, as depicted in Figure 3.

[47] Specifically, North Carolina, Oregon, Louisiana, California, Maine, and Maryland are assumed to achieved delayed compliance with offshore wind goals.

Figure 3: 2030 and 2040 Cumulative Offshore Wind Capacity



Battery Energy Storage

Battery energy storage holds a critical role in the clean energy transition, enabling grid operators to maintain reliability while integrating greater volumes of renewables. Solar and wind resources are characterized by variability and integration with batteries allows generators to enhance reliability in deficient generating conditions. Though battery energy storage is not the focus of this study, recognizing its importance in the energy transition, the study models the impact of interconnection queue reform on the volume of battery capacity to be deployed.

Interstate Interaction for RPS and CES Compliance and the Impact of Transmission Buildout

Increasing interstate and interregional transmission will facilitate the development of variable renewable generation across larger geographic areas and increase the utilization of renewable energy from the most productive locations. This analysis illustrates the need for and benefits of increased transmission capacity to enable states to achieve their clean energy targets. For example, developers are proposing to build a significant amount of onshore wind in New Mexico and solar in Arizona to harness the favorable wind and solar resources in each state. With increased transmission capacity, this low-cost, high-capacity factor renewable energy can be delivered to consumers in neighboring markets. The eligibility of interstate renewable energy for RPS and CES compliance varies by state.[48] Assessing the role of new interstate trading for RPS and CES compliance is beyond the scope of this study; however, we expect states that have historically bought RECs from one another to continue to do so, and in

[48] For example, in New England, to receive an ISO-NE Class I REC that can be used for compliance, energy must be delivered to the ISO-NE grid.

enhanced volumes.[49] In particular, states with modest demand and/or RPS or CES targets and attractive wind and solar resources will likely see sales of surplus RECs to buyers in states with higher demand and more ambitious RPS or CES targets. Given the requirement by some states for delivery of energy into the purchasing state's market, enhancing interstate and interregional transmission capacity will be increasingly important to support states in achieving their goals.

Corporate Demand for Renewables

In response to stakeholder interest and environmental, social, and governance (ESG) goals, corporate demand for renewables has increased significantly over the past decade. According to American Clean Power's (ACP) report, *Clean Energy Powers American Business*, corporate buyers increased procurement of renewables by an annual average of 73% between 2012 and 2022.[50] As of the end of 2022, the ACP reports that 326 companies have contracted for 77 GW of clean power in the US, with 36 GW of operational capacity. This accounts for 16% of operational US clean power. According to S&P Global, 190 new corporate power purchase agreements (PPAs) totaling 17 GW of renewable generation were signed in the US between February 2023 and February 2024.[51] As clean energy procurement incentives continue to expand, and corporate demand grows – largely due to the rise of AI and on-shoring of manufacturing – corporate procurements are expected to continue to drive additional renewable growth. As there is some uncertainty to the volume and geographic location of future corporate demand for renewables, this study does not specifically address the share of renewables processed through the interconnection queue to address corporate demand versus state RPS/CES demand. As a result, the volume of renewables to meet RPS and CES demand is overstated. However, it is anticipated that corporate demand will be an increasing driver of renewable energy deployment across the country.

Validation of Results

To validate the volume of solar and wind projected to achieve commercial operations under the two scenarios, a baseline share of solar and wind generation for each state was established from the EIA's 2022 US Electricity Profile.[52] For the forecast period, the state-specific demand forecasts and the yearly volume of solar and wind generation were compared to the baseline to

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[49] As this report does not attempt to assess whether states will achieve their RPS and CES targets, interstate trade of RECs is not considered.

[50] American Clean Power, 2023, *Clean Energy Powers American Business*, available at: https://cleanpower.org/wp-content/uploads/2023/01/2022_CorporateBuyersReport.pdf

[51] S&P Global, 2024, *Tech companies pace US corporate renewable procurement as volume nears 75 GW*, available at: https://www.spglobal.com/marketintelligence/en/news-insights/research/tech-companies-pace-us-corporate-renewable-procurement-as-volume-nears-75-gw

[52] See: US Electricity Profile 2022 | United States Energy Information Administration

evaluate reasonableness. If the volume of solar or wind as a share of the total state demand exceeded a reasonable growth trajectory, the volume of interconnection requests entering the queue was adjusted. This approach was utilized to approximate developers' response to market saturation and the declining marginal value of incremental resource additions.