READY-TO-GO TRANSMISSION PROJECTS 2023

Progress and Status since 2021

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Grid Strategies

With support from Americans for a Clean Energy Grid

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Americans for a Clean Energy Grid

Grid Strategies

TABLE OF CONTENTS

Executive Summary

This report updates our 2021 report on *ready-to-go* transmission grid projects and identifies 36 high-voltage transmission projects that are ready to begin construction in the near future, including some regional project portfolios comprised of multiple individual projects. Many of these projects have achieved key regulatory approval milestones and are ready to begin construction. Many others could benefit from policies that improve how transmission is paid for and permitted, as some are still waiting for key permits while many more are still looking for mechanisms to recover the cost of building the project. While these projects would provide major benefits to electric sector reliability and decarbonization, still many more such projects will be required to cost-effectively meet our country's growing electricity needs. Given the long lead time required to permit and build transmission, improvements to how we plan, pay for, and permit transmission are urgently needed to enable these projects and more like them to proceed to construction.

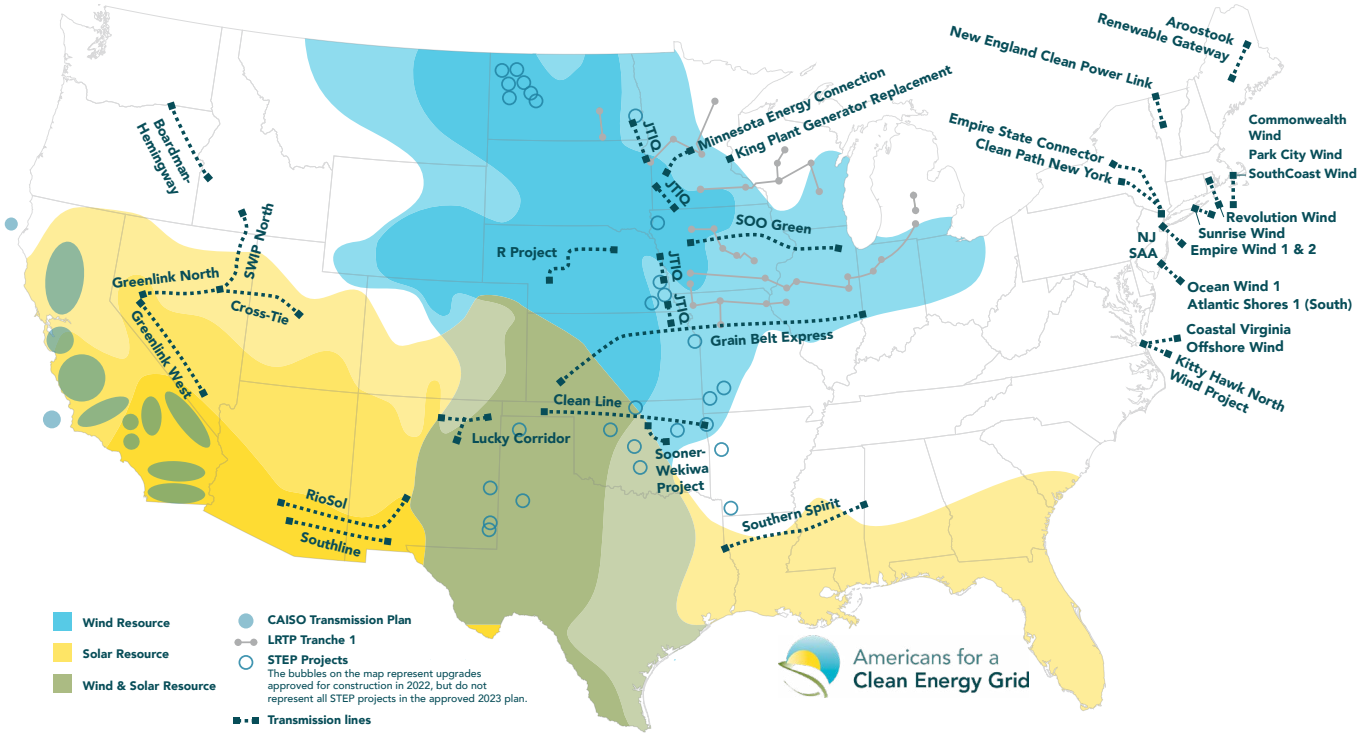
Among these projects are major regional or interregional lines that, if built, would improve system resilience and reliability by increasing transmission capacity between regions. The need for increased interregional transmission capacity has been highlighted by recent extreme weather events. For example, a lack of strong transmission ties with neighboring power systems was a primary factor contributing to the blackouts during Winter Storm Elliott in December 2022 and Winter Storm Uri in February 2021, as well as other recent electric reliability events.[1]

These shovel-ready infrastructure projects can be a significant driver of domestic job creation and economic development across the country. We estimate the transmission investment itself can create around 1.3 million jobs, while deployment of the wind and solar resources enabled by the lines would create additional 2 million jobs, bringing the total job creation benefit to around 3.3 million jobs. As indicated in the map below, most of these lines are designed to access high-quality wind and solar resource areas. We estimate these 36 projects could interconnect around 187 gigawatts (GW) of new renewable energy capacity, almost doubling America's wind and solar generation resource mix by 87% from current levels.

1 Michael Goggin and Rob Gramlich, "Observations on Winter Electric Reliability Event in South Central U.S.," (February 17, 2021), available at: https://energycentral.com/c/gr/observations-winter-electric-reliability-event-south-central-us.

In addition to the reliability, economic development, and job creation benefits, there are other compelling reasons why the power grid should be a primary focus of infrastructure policy. A report card from the American Society of Civil Engineers gives America's power grid infrastructure a grade of C minus,[2] noting that much of the grid is aging and congested. American consumers pay billions of dollars per year in higher electric bills because transmission congestion chokes off access to lower-cost sources of electricity. Congestion costs in the US have nearly doubled since the previous version of this report was released in 2021.[3]

FIGURE 1 **Transmission projects *ready-to-go***



2 American Society of Civil Engineers, *A Comprehensive Assessment of America's Infrastructure*, (2020), available at: https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report.pdf.

3 Richard Doying, Michael Goggin, and Abby Sherman, "Transmission Congestion Costs Rise Again in the U.S. RTOs," (July 2023), available at https://gridstrategiesllc.com/wp-content/uploads/2023/07/GS_Transmission-Congestion-Costs-in-the-U.S.-RTOs1.pdf.

If completed, the projects identified in this paper would add approximately 10,000 miles and 132 GW of transmission capacity to America's transmission system. For reference, the current US transmission system contains approximately 240,000 circuit miles of transmission that operate at 230 kilovolts (kV) and above,[4] so these new projects only add about 4% to the total mileage of the high-voltage transmission system. However, most of the proposed lines are extra-high voltage, which allows them to carry more power with lower losses than typical existing transmission lines. As a result, these grid expansion projects increase the transmission system's capacity by about 15%.

The expansion from the 22 projects in the 2021 report to the 36 projects *ready-to-go* in this report reflects expanded market interest in transmission, but much of the growth is from new transmission projects to interconnect offshore wind projects in the Northeast and MidAtlantic.[5] However, new projects serving a range of purposes have also emerged in other regions as well. Significant load growth, increasing US manufacturing, data center demand (fueled recently by Artificial Intelligence), customer demand for clean generation, and increasingly favorable economics for renewable energy due to market trends as well as the Inflation Reduction Act and other policies, are likely driving greater market interest in transmission.

The 2021 report's 22 *ready-to-go* high-voltage transmission projects were projected to add around 60,000 megawatts (MW) of new renewable capacity, increasing the country's wind energy resources and creating approximately 1.27 million jobs. Since that report, 10 of the 22 projects identified have begun construction while two projects have been put on hold and thus are no longer included in our list. The 10 projects under construction are expected to add approximately 19,500 MW of new generation. Relative to other projects that have not yet moved forward, these 10 successful projects had an easier path to cost recovery because their costs were either allocated to the generators using the line or were allocated to ratepayers by state regulators. In contrast, projects with more diffuse benefits or that are located in regions with less workable cost-allocation policies continue to struggle to move forward, indicating that additional reforms to transmission cost-allocation policies are necessary. Moreover, many of these successful projects had been under development for more than a decade before beginning construction, underscoring the need to reform and streamline permitting processes.

4 Theodore U. Marston, "The US Electric Power System Infrastructure and Its Vulnerabilities," (June 15, 2018), The Bridge, National Academy of Engineering, Volume 48, Issue 2, at 31-39, available at: https://www.nae.edu/File.aspx?id=183084.

5 The 2021 report grouped three transmission projects to interconnect offshore wind into a single line item in the list of 22 projects, whereas this report treats individual offshore projects as distinct projects. As a result, if one is interested in tracking the number of projects over time, the 2021 report included 24 distinct projects while this report includes 36 distinct projects.

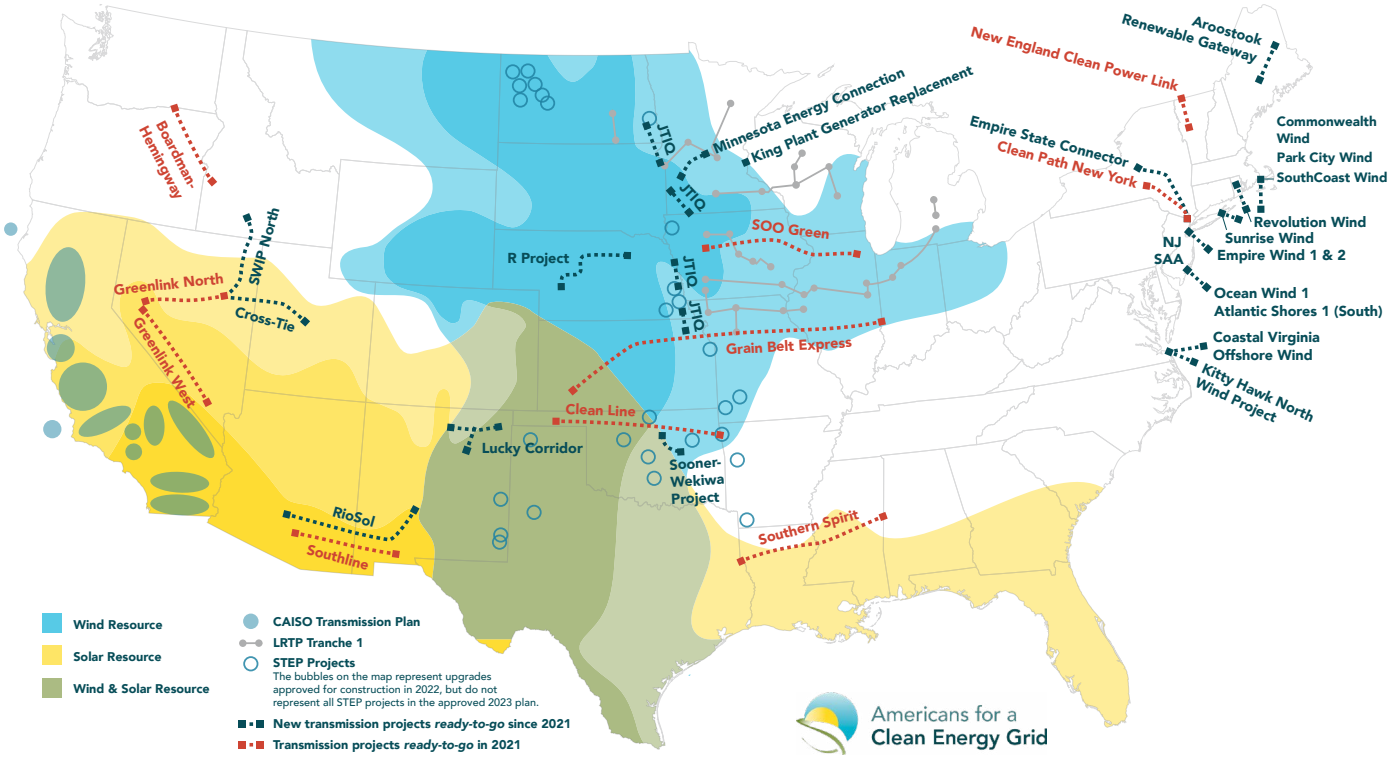
Further, recent movement on the permits for these projects also suggests that the pace of federal permitting has improved as internal and interagency delays holding up some projects have been resolved.

The 36 lines we identify in this new report are a mix of Alternating Current (AC) and Direct Current (DC), with DC generally used for lines that are longer or at least partially underground or underwater. These projects are described in more detail in the following section.

Projects Currently *Ready-To-Go*

We find 36 large-scale regional or interregional transmission projects are currently *ready-to-go*. This section describes our criteria for categorizing projects as *ready-to-go* and describes the projects that qualify. Each project on our list does not necessarily equate to a single line; in some cases, a project refers to a portfolio of lines, such as the Midcontinent Independent System Operator's (MISO) first tranche of 18 regionally planned lines (see MISO LRTP Tranche 1) or the MISO-Southwest Power Pool's (SPP) Joint Targeted Interconnection Queue projects which includes 4 new lines (*see* JTIQ Projects).

FIGURE 2 **Transmission projects new since 2021**



Projects *Ready-To-Go*

The following projects currently qualify as *ready-to-go*:

TABLE 1 **Details of proposed projects**

REGION	PROJECT NAME	YEAR PROPOSED	MILES	KILOVOLTS	AC/DC	COST $B
CAISO	CAISO Transmission Plan – multiple projects	2023	~460	Varies	AC/DC	$7.3
ERCOT-Southeast	Southern Spirit	2009	400	500	DC	$2.5
MISO	King Plant Generator Replacement	2021	15	345	AC	$0.05
	LRTP Tranche 1	2022	2000	345	AC	$10.3
	Minnesota Energy Connection	2021	160	345	AC	$0.48
	SOO Green	2019	349	525	DC	$4.0
MISO-SPP	JTIQ Projects	2022	395	345	AC	$1.9
New England	Aroostook Renewable Energy Gateway	2022	140	345	AC	$2.9
	Commonwealth Wind	2018	75	220-345	AC	$0.85
	NE Clean Power Link	2013	150	320	DC	$1.6
	Park City Wind	2018	60	220-275	AC	$0.56
	Revolution Wind	2016	42	275	AC	$0.49
	SouthCoast Wind (Formerly Mayflower Wind)	2019	145-211	320/200-345	AC/DC	$0.83
New York	Clean Path New York	2021	175	400	DC	$3.5
	Empire State Connector	2017	265	320	DC	$1.5
	Empire Wind 1	2018	46	230	AC	$0.57
	Empire Wind 2	2018	35	230	AC	$0.83
	Sunrise Wind	2017	25	320	DC	$0.64
Northwest	Boardman to Hemingway	2007	290	500	AC	$1.2
	Cross-Tie Transmission Line	2016	213	500	AC	$0.67
	Greenlink North	2020	235	525	AC	$0.81
	Greenlink West	2020	351	525	AC	$1.61
	SWIP North	2016	275	500	AC	$0.55
PJM	Atlantic Shores 1 (South)	2019	99	230-275	AC	$1.05

REGION	PROJECT NAME	YEAR PROPOSED	MILES	KILOVOLTS	AC/DC	COST $B
	Coastal Virginia Offshore Wind	2016	71	230	AC	$1.83
	Kitty Hawk North Wind Project	2019	55	275	AC	$0.55
	Ocean Wind 1	2017	143	275	AC	$0.76
	State Agreement Approach: NJ Offshore Wind	2022	~100	Varies	AC	$1.08
Southwest	Lucky Corridor	2007	179	115/345	AC	$0.08
	RioSol	2006	550	500	AC	$1.3
	Southline	2010	240	345	AC	$0.8
SPP	Clean Line	2009	500	600	DC	$1.2
	Grain Belt Express	2010	800	600	DC	$7.0
	R Project – Gentleman Station to Holt County	2012	226	345	AC	$0.42
	Sooner-Wekiwa Project	2021	80	345	AC	$0.1
	STEP Projects	2023	817	Varies	AC	$2.24
Total			**9,976**			**$64.04**

Description of projects:

CAISO

CAISO Transmission Plan – CAISO's 2022-2023 $7.3 billion transmission plan includes 45 AC and DC transmission projects designed to deliver over 30 GW of new generating capacity to CAISO's grid over the next 10 years.[6] The plan arose from CAISO's annual transmission planning process which proactively plans for the future needs of CAISO's grid as well as California's policy goals by developing holistic regional transmission projects that provide multiple benefits to the grid.

ERCOT/Southeast

Southern Spirit – Merchant DC line connecting the Electric Reliability Council of Texas (ERCOT) grid with Southeastern power markets through a proposed converter station in Mississippi.[7] The project received approval from FERC in 2011 that allows the project to interconnect with ERCOT while continuing to exempt all transmission providers and entities within ERCOT from FERC regulation. The project is still seeking approval in Louisiana and Mississippi.

MISO

King Plant Generator Replacement – New 345-kV AC line connecting new generation to the grid at Xcel's retiring Allen S. King coal plant utilizing MISO's generator replacement interconnection process. The project was included as part of Xcel's Integrated Resource Plan.[8]

6 CAISO, "2022-2023 Transmission Plan," available at: http://www.caiso.com/InitiativeDocuments/ISO-Board-Approved-2022-2023-Transmission-Plan.pdf.

7 Pattern Energy, "Southern Cross Transmission Fact Sheet," (2020), available at: https://southerncrosstransmission.com/wp-content/uploads/2020/10/SC_factsheet_2020.pdf.

8 MNPUC, "Order Approving the 2020–2034 Upper Midwest Integrated Resource Plan of Northern States Power Company d/b/a Xcel Energy with Modifications," available at: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId=%7B202C2F80-0000-C11A-BA52-EC8AB5636CD4%7D&documentTitle=20224-184828-01.

Long-Range Transmission Planning (LRTP) Tranche 1 – MISO's first of four planned subregional or regional portfolios of transmission projections. Tranche 1 is a $10.3 billion portfolio of 18 lines meant to connect over 50 GW of new generation in the MISO North subregion. The plan has approved cost allocation, but the individual projects must still obtain state approvals and in some cases federal permits. MISO's LRTP process utilizes scenario-based planning to proactively prepare for future grid needs and a changing resource mix. Based on these scenarios MISO develops a portfolio of transmission projects with multiple benefits leading to the first of several large-scale regional transmission investments.[9]

Minnesota Energy Connection – New 345-kV AC line connecting new generation at retiring Xcel Sherco coal plant utilizing MISO's generator replacement interconnection process. The project was included in Xcel's Integrated Resource Plan[10] and Xcel has filed for a Certificate of Need for the project with the Minnesota Public Utilities Commission.[11]

SOO Green – Underground merchant DC line running along an existing railroad right-of-way from Iowa to near Chicago.[12] The project was proposed in 2019 and permitting for the project is progressing, but a primary delay is PJM considers the line to be a generation project and is processing the line in its interconnection queue process, which is currently paused until 2024.[13]

MISO-SPP

Joint Targeted Interconnection Queue (JTIQ) Projects – Four 345-kV AC transmission lines and one transmission upgrade at the Midcontinent Independent System Operator (MISO)-SPP seam meant to connect at least 28 GW of new generation, reducing pressure on the interconnection queues of both RTOs. MISO and SPP are currently working on a

9 MISO, "Long Range Transmission Planning: Tranche 1," available at: https://cdn.misoenergy.org/20220325%20LRTP%20Workshop%20Item%2002%20Tranche%201%20Portfolio%20and%20Process%20Review623633.pdf.

10 MNPUC, "Order Approving the 2020–2034 Upper Midwest Integrated Resource Plan of Northern States Power Company d/b/a Xcel Energy with Modifications," available at: https://efiling.web.commerce.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId=%7B202C2F80-0000-C11A-BA52-EC8AB5636CD4%7D&documentTitle=20224-184828-01.

11 https://knsiradio.com/2023/03/22/xcel-files-to-build-transmission-lines-to-future-sherco-solar-site/

12 *See* https://www.soogreenrr.com/.

13 Mike Hughlett, "St. Louis Park company behind novel $2.5B Soo Green Line underground power line project," Star Tribune, October 2021, https://www.startribune.com/st-louis-park-company-behind-novel-2-5b-soo-green-line-underground-power-line-project/600102958/?refresh=true.

cost-allocation process that could be filed at FERC in 2023.[14] In May 2023, the Minnesota Department of Commerce, MISO, SPP, and participating transmission owners requested DOE Infrastructure and Jobs Act (IIJA) Grid Resilience and Innovation Partnerships (GRIP) funding to defray up to 50% of the costs of constructing the projects.

New England

Aroostook Renewable Gateway – New LS Power AC transmission line connecting Longroad Energy King Pine wind farm to ISO-NE grid in Maine.[15] The Maine PUC approved the plan, and the Massachusetts Department of Energy Resources directed the state's investor-owned utilities to purchase up to 40% of the wind generation.[16]

New England Clean Power Link – Merchant DC line mostly running under Lake Champlain and into Vermont, delivering Canadian power to New England.[17] First proposed in 2013, the project received its required permits and ISO-NE authorization to interconnect, but could not secure power contracts with Massachusetts. This led to the project being shelved in 2017, until Vermont Governor Phil Scott expressed support for the project early in 2023 and the project applied for the U.S. Department of Energy's (DOE) Transmission Facilitation Program.

New York

Clean Path New York – Merchant underground DC line delivering renewable energy from upstate and western New York to New York City.[18] The project is a joint venture between New York Power Authority, energyRe, and Invenergy, and has contracted with the New York State Energy Research and Development Authority.

Empire State Connector – Merchant DC line, delivering renewable resources from upstate to downstate New York along existing rights-of-way.[19]

14 MISO-SPP, "SPP-MISO Joint Targeted Interconnection Queue Cost Allocation and Affected System Study Process Changes," available at: https://www.spp.org/documents/68518/spp-miso%20jtiq%20study%20updated%20white%20paper%2020221220.pdf.

15 LS Power, "Aroostook Renewable Gateway," available at: http://www.lspgridmaine.com/.

16 Ethan Howland, "Maine PUC OKs 1-GW Longroad wind farm, LS Power transmission line amid equity and cost concerns," Utility Dive, February 1, 2023, https://www.utilitydive.com/news/maine-puc-longroad-wind-farm-ls-power-transmission-line/641699/.

17 TDI New England, "New England Clean Power Link: Project Development Portal," available at: http://www.necplink.com/.

18 *See* www.CleanPathNY.com.

19 oneGrid, "Empire State Connector," available at: https://empirestateconnector.com/.

Northwest

Boardman to Hemingway – PacifiCorp and Idaho Power AC project to allow Wyoming wind delivered via Gateway West to fully reach the Pacific Northwest.[20]

Cross-Tie Transmission Line – AC line connecting Utah and Nevada, tying in Greenlink North with the Gateway South Project and potentially TransWest Express, increasing the ability for California, Nevada, Utah, and Wyoming to import and export renewable energy.[21]

Greenlink North – New NV Energy AC line across northern Nevada, would enable the interconnection of new renewable resources and connect Greenlink West with the existing One Nevada project. Cost recovery has been approved through the state regulatory commission.

Greenlink West – New NV Energy AC line connecting southern and northern Nevada via a path through the western part of the state, which would also enable the interconnection of renewable resources along its path.[22] Cost recovery has been approved through the state regulatory commission.

SWIP North – AC Merchant project connecting Idaho and Wyoming wind resources to Nevada and California solar resources and loads, interconnecting with the proposed Greenlink North project and the existing One Nevada line.[23]

Offshore wind projects

This item accounts for the underwater transmission to interconnect the first phases of proposed offshore wind projects under federal permitting in New Jersey, New York, New England, and Virginia, as well as onshore AC upgrades being built in New Jersey under the State Agreement Approach.[24] While other offshore transmission projects will likely be developed to meet state requirements, only the first phase of offshore projects that have begun federal permitting are included in this report as these projects are in relatively advanced development and have signed interconnection agreements, while in many cases the type of interconnection for subsequent projects is still being determined.

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20 Idaho Power, "Boardman to Hemingway: A Clean-Energy Pipeline," available at: https://www.boardmantohemingway.com/.

21 TransCanyon, "Cross-Tie Transmission Line," available at: https://www.transcanyon.com/projects/Cross-Tie-Transmission-Line/default.aspx.

22 See https://www.nvenergy.com/cleanenergy/greenlink.

23 LS Power, "Southwest Intertie Project (SWIP) North," 2016, https://www.caiso.com/Documents/GreatBasinSouthwestIntertieProject-NorthOverview.pdf.

24 Cables bringing offshore wind onshore are assumed to contribute $762 to the cost of transmission per kW of offshore wind capacity, per the cost of offshore wind electrical infrastructure indicated in Tyler Stehly, Philipp Beiter, and Patrick Duffy, *2019 Cost of Wind Energy Review*, (December 2020), available at: https://www.nrel.gov/docs/fy21osti/78471.pdf.

Atlantic Shores 1 (South) – AC line connecting over 1500 MW of offshore wind generation to New Jersey.[25]

Coastal Virginia Offshore Wind – AC line connecting over 2600 MW of offshore wind generation to Virginia.[26]

Commonwealth Wind – AC line connecting over 1200 MW of offshore wind generation to Massachusetts.[27]

Empire Wind 1 – AC line connecting over 800 MW of offshore wind generation to New York.[28]

Empire Wind 2 – AC line connecting 1200 MW of offshore wind generation to New York.[29]

Kitty Hawk North Wind Project – AC line connecting 800 MW of offshore wind generation to Virginia.[30]

Ocean Wind 1 – AC line connecting 1100 MW of offshore wind generation to New Jersey.[31]

Park City Wind – AC line connection over 800 MW of offshore wind generation to Connecticut.[32]

Revolution Wind – AC line connecting over 700 MW of offshore wind generation to Connecticut and Rhode Island.[33]

SouthCoast Wind (Formerly Mayflower Wind) – AC line(s) and potentially a DC line connecting 1200 MW of offshore wind generation to Massachusetts.[34]

State Agreement Approach – NJ OSW Wind (Ocean Wind 2 and additional 3742 MW) – A New Jersey and PJM plan to connect 6400 MW of offshore wind to New Jersey.[35]

Sunrise Wind – AC line connecting over 900 MW of offshore wind generation to New York.[36]

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25 Atlantic Shores Offshore Wind, available at: https://www.atlanticshoreswind.com/.

26 Dominion Energy, "Coastal Virginia Offshore Wind," available at: https://coastalvawind.com/.

27 Avangrid, "New England Wind 2 Connector Environmental Notification Form (ENF)," available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/15705277.

28 Equinor and BP, "Empire Wind," available at: https://www.empirewind.com/.

29 *Id.*

30 Avangrid, "Kitty Hawk Wind," available at: https://www.kittyhawkoffshore.com/.

31 Ørsted, "Ocean Wind 1," available at: https://oceanwindone.com/.

32 Avangrid, "Park City Wind," available at: https://www.parkcitywind.com/.

33 Ørsted & Eversource, "Revolution Wind," available at: https://revolution-wind.com/.

34 Shell and Ocean Wind, "SouthCoast Wind," available at: https://southcoastwind.com/.

35 PJM, "New Jersey Marks Milestone for Offshore Wind Using PJM's State Agreement Approach," October 2022, https://insidelines.pjm.com/new-jersey-marks-milestone-for-offshore-wind-using-pjms-state-agreement-approach/.

36 Ørsted & Eversource, "Sunrise Wind," available at: https://sunrisewindny.com/.

Southwest

Lucky Corridor – AC project being co-developed by the New Mexico Renewable Energy Transmission Authority (NM RETA) and Lucky Corridor LLC (Ameren Transmission Company) adding transmission capacity in northern New Mexico.[37] The project was originally proposed in 2009.

RioSol – SouthWestern Power Group AC project being co-developed with NM RETA that utilizes mostly the same route as SunZia, delivering New Mexico renewable resources to Arizona and New Mexico and points westward.[38] The project was originally proposed in 2006 along with SunZia. Additional details are provided in the SunZia description.

Southline – AC project between southern New Mexico and Arizona, which will facilitate renewable development.[39] Initially proposed in 2010, the Southline project received all necessary federal permits in 2016 and state processes were completed in 2017. It is expected to begin construction around 2025.

Southwest Power Pool

Clean Line – Originally proposed in 2009 by Clean Line Energy Partners to deliver renewable energy from the Oklahoma Panhandle to Southeast markets, the Oklahoma portion of this DC merchant line was purchased and is now being developed by NextEra Energy.[40]

Grain Belt Express – Invenergy merchant DC line connecting four states across 800 miles to deliver renewable energy from Southwest Kansas to interconnection points in Missouri and Indiana. Proposed at 5,000 megawatts, Grain Belt Express would be the highest capacity transmission line in the U.S., and link four balancing authorities (SPP, AECI, MISO and PJM) with bi-directional capability. Phase one of the project (Kansas to Missouri interconnection points) is undergoing federal review by the U.S. Department of Energy (DOE) Loan Program Office, with a decision expected in fall 2024.[41]

R-Project – AC project in Nebraska that will increase reliability, relieve congestion, and provide additional opportunities for renewable development.[42] One of the required permits was for incidental taking of the American burying beetle, because the project cross-

37 Lucky Corridor LLC, "Lucky Corridor," available at: http://www.luckycorridor.com/index.html.

38 RioSol, "RioSol," available at: https://riosol.energy/.

39 Western Area Power Administration, "Projects," available at: https://www.wapa.gov/transmission/TIP/Pages/projects.aspx.

40 Michelle Froese, "NextEra Acquires Oklahoma Portion of Plains & Eastern Clean Line Transmission Project," (December 27, 2017), available at: https://www.windpowerengineering.com/nextera-acquires-oklahoma-portion-plains-eastern-clean-line-transmission-project/.

41 Invenergy Transmission LLC, "Grain Belt Express: An Energy Connection for America's Heartland," available at: https://grainbeltexpress.com/.

42 Nebraska Public Power District, "R-Project," available at: https://rproject.nppd.com/project-overview/.

es the habitat of the threatened species. In 2019, after a six-year permitting process, the R-Project received approval from U.S. Fish and Wildlife Service (USFWS) for an incidental take permit under the Endangered Species Act. Opponents filed a lawsuit challenging USFWS's decision, and a District Court agreed with the opponents remanding the incidental take permit to USFWS in 2020. USFWS must now conduct a supplemental environmental impact statement along with revising its Biological Opinion under the Endangered Species Act. Revisions are also needed to the Programmatic Agreement regarding historic properties before USFWS can issue a new Record of Decision.

Sooner-Wekiwa Project – AC project identified by SPP to relieve congestion and provide access to new renewables for customers in Oklahoma as well as Arkansas, Missouri, Texas, and Louisiana.[43] The final route lies within Oklahoma, which does not require regulatory approval if SPP has identified the transmission project as a need.[44]

STEP Projects – Southwest Power Pool's (SPP) $2.76 billion transmission expansion plan (STEP) which includes 260 Integrated Transmission Plan (ITP), ITP20, and AQ transmission line and upgrades. SPP's STEP projects are identified through the regional transmission planning process. The planning process develops a regional portfolio of transmission projects with multiple benefits to the grid.[45]

Methodology

For this 2023 report, we reviewed over 60 large-scale regional or interregional transmission plans and projects. Projects were determined to be large-scale and included for review if the project uses an overhead conductor with a voltage at or above 345-kV, or an underwater or underground transmission line. The projects reviewed for this report were sourced from a wide variety of resources including industry contacts, news reports, project web sites, developers, and various databases such as NERC's Electricity Supply & Demand database.

43 Transource, "Sooner-Wekiwa," available at: http://www.transourceenergy.com/projects/Sooner-Wekiwa/.

44 Rhett Morgan, "Final route OK'd for 76-mile Sooner-Wekiwa electric transmission line project," Tulsa World, updated May 2023, https://tulsaworld.com/business/realestate/final-route-okd-for-76-mile-sooner-wekiwa-electric-transmission-line-project/article_386c43a8-3d8f-11ec-833e-efe3a34c65fe.html.

45 SPP, "2023 SPP Transmission Expansion Plan Report," available at: https://www.spp.org/documents/56611/2023%20spp%20transmission%20expansion%20plan%20report.pdf.

The determination of whether a project is *ready-to-go* relied on two criteria: 1) whether the project is at or near the finish line on the various federal and state permits they may need; and 2) whether the project is actively pursuing the cost recovery, allocation, and/or subscriptions required for the developer to proceed. Inherently some judgment is required. Based on these criteria we excluded over ten significant projects that are in earlier stages of development and not yet far enough along to be considered *ready-to-go*.

This report uses the same transmission benefits assumptions and methodologies of our 2021 report. Further details on the benefits of these large-scale regional and interregional transmission projects along with methodology and assumptions for job creation can be found in the appendix to this report.

Progress since 2021 moving projects into construction

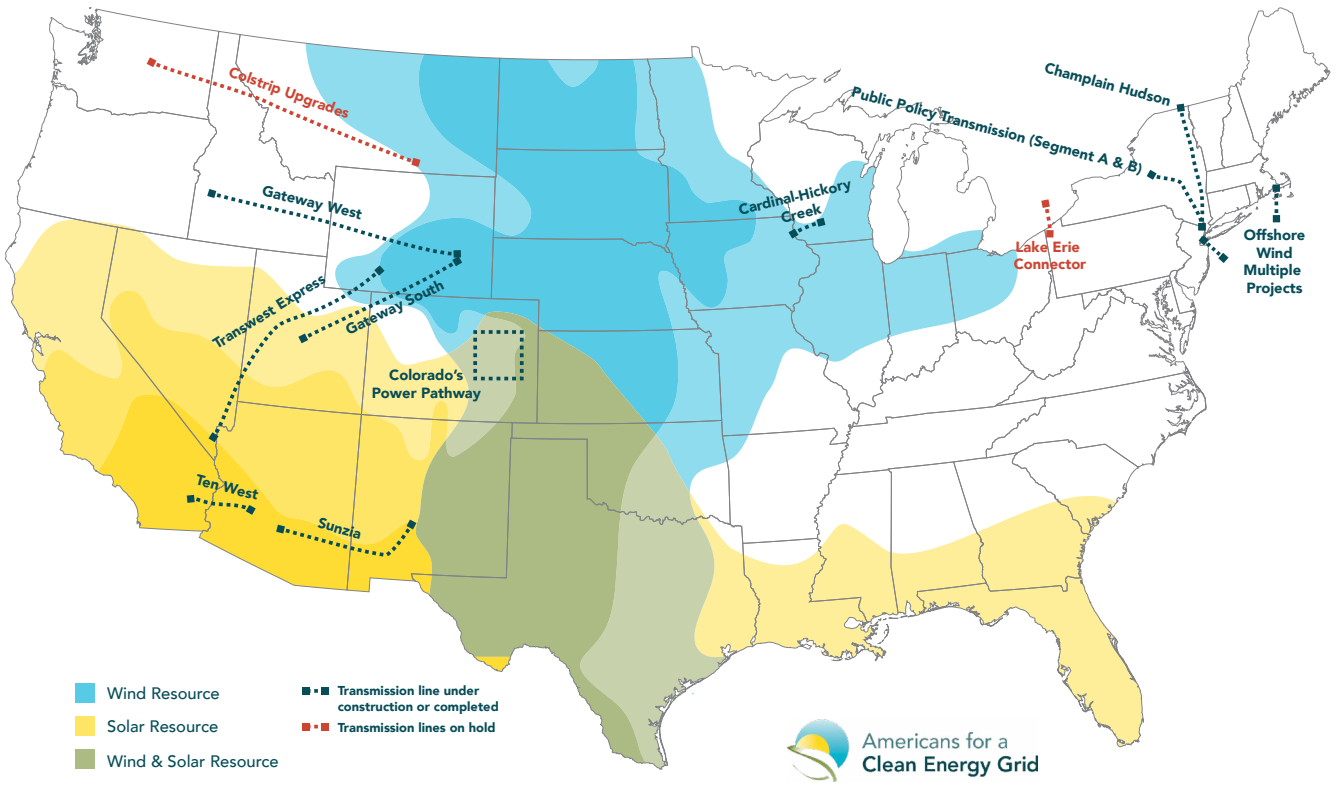
The inaugural 2021 version of this report identified 22 high-voltage transmission projects that could begin construction in the near term if more workable transmission policies were enacted. These projects were estimated to create around 630,000 jobs, while the wind and solar deployment enabled by the lines would create additional 640,000 jobs, bringing the total job creation estimate to approximately 1.27 million jobs. Most of the identified lines are designed to access high-quality wind and solar resource areas, and the previous report estimated these 22 projects could interconnect around 60,000 MW of new renewable capacity, increasing the country's wind and solar generation by nearly 50% from 2021 levels.

Since that report was released, 10 of the 22 projects that were identified as "shovel ready" in the 2021 report have begun construction, and two projects have been put on hold. The 10 projects moving forward could interconnect approximately 19,500 MW of new generation.

A number of projects are moving forward due to federal government approvals. Federal government approval of permits for the Transwest Express, Ten West, SunZia, Vineyard Wind, and South Fork Wind transmission projects was essential for them to proceed to groundbreaking. The federal government is also expected to issue approvals for additional offshore wind transmission projects in the near future.

While it is promising that these projects are moving forward, a large share of the successful projects have been able to sidestep the trickiest cost allocation challenges that continue to plague other proposed lines. A large share of the successful lines – such as Transwest Express, Sunzia, and the offshore wind upgrades – function as large generation tie-lines that are paid for by generators delivering capacity over the lines. Other successful lines, like the New York, Colorado, and Gateway projects, are located within a single state or utility service area, which makes cost allocation easier as the costs are allocated to ratepayers in that discrete state or utility service area. In contrast, the success rate for networked regional and interregional transmission projects has been far lower, likely because the benefits are more broadly dispersed and most regions lack effective tools to plan and allocate costs for such lines.

FIGURE 3 Transmission projects from 2021 report under construction or on hold



Projects under construction

The projects listed below are now under construction.

TABLE 2 **Details of projects under construction**

REGION	PROJECT NAME	YEAR PROPOSED	YEAR BROKEN GROUND	MILES	KILOVOLTS	AC/DC	COST $B
New York	Champlain Hudson	2010	2022	330	300	DC	$6.000
	Public policy transmission	2019	2021	100	345	AC	$1.230
MISO	Cardinal-Hickory Creek	2014	2021	100	345	AC	$0.582
Offshore	Multiple projects	2016 & 2017	2021 & 2022	30	300	DC	$1.902
Northwest	TransWest Express	2007	2023	730	600	DC	$3.000
	Colorado's Power Pathway	2021	2023	560	345	AC	$1.700
	Gateway South	2007	2022	400	500	AC	$1.900
	Gateway West	2007	2020	1000	500	AC	$2.880
Southwest	SunZia	2006	2023	550	500	DC	$3.0
	Ten West	2015	2023	114	500	AC	$0.300
Total				**3,914**			**$22.494**

MISO

Cardinal-Hickory Creek – New AC line from near Dubuque, Iowa to Madison, Wisconsin. This line is the last of Midcontinent Independent System Operator's Multi-Value Projects (MISO's MVPs).[46] As of January 2023, there were 115 renewable generation projects totaling more than 17 gigawatts dependent upon its construction. It has been held up by litigation at the state and federal level, but that appears to be nearing resolution. The co-owner utilities are working with the federal agencies involved in the project to complete their decision-making to allow the project to move forward. The project already has cost recovery authorized through the MISO tariff as it has been included in MISO transmission plans.

46 MISO, "Regionally Cost Allocated Project Reporting Analysis," (January 2021), available at: https://cdn.misoenergy.org/MVP%20Dashboard%20Q4%202020117055.pdf.

New York

Champlain Hudson – Merchant DC line, originally proposed in 2010, mostly running under Lake Champlain and the Hudson River, delivering Canadian power to New York City.[47] The project has cost recovery authorized by the State of New York.

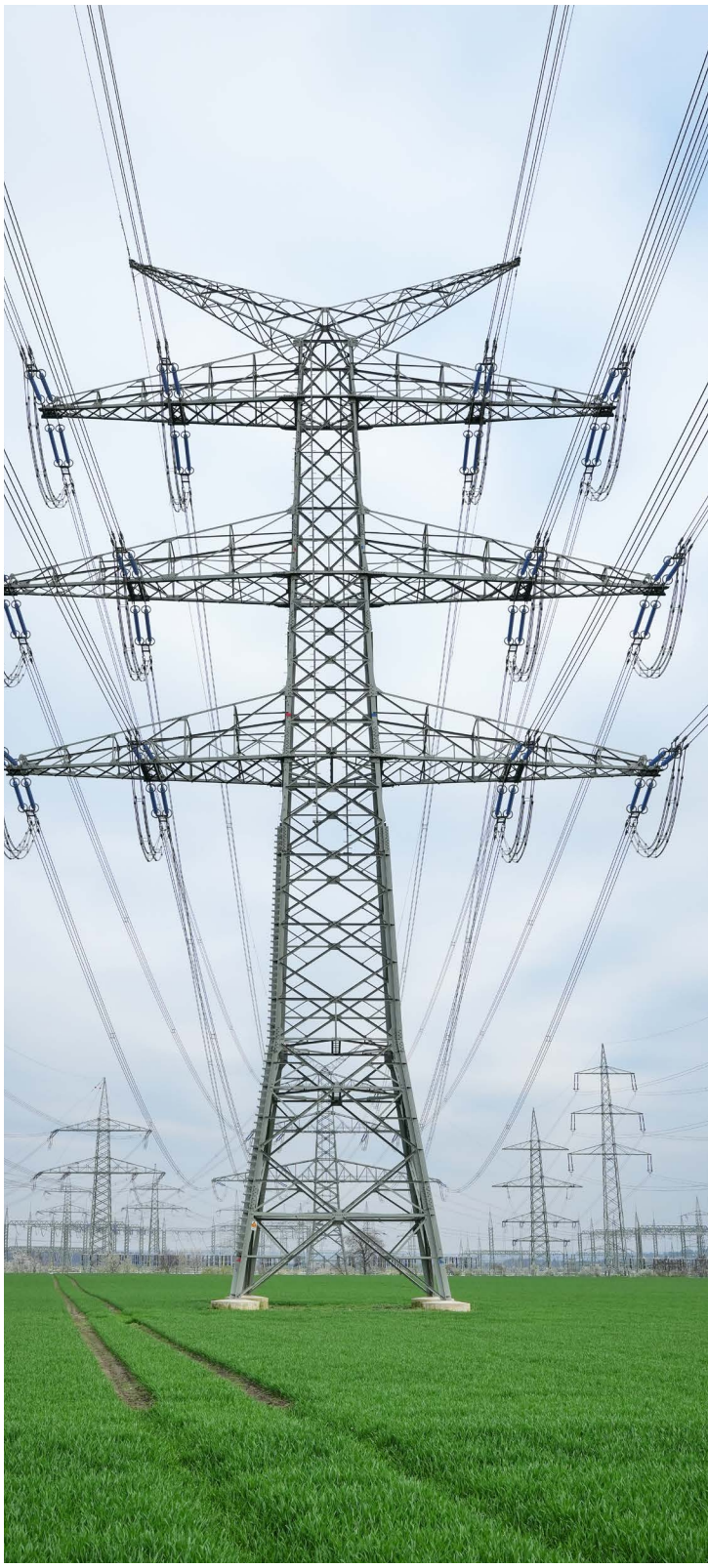
New York public policy transmission (Segments A&B) – Two projects, Central East Energy Connect and New York Energy Solution, to upgrade New York's AC transmission system and interconnect more renewable energy.[48]

Northwest

Colorado's Power Pathway – New AC lines and upgrades proposed by Xcel's Public Service Company of Colorado to interconnect eastern Colorado renewable resources.[49] Cost recovery is through the state regulatory commission.

Gateway South – PacifiCorp AC project to deliver Wyoming wind to Utah and the Southwest.[50] The project has received cost recovery via various state commissions and the relevant federal approvals.

Gateway West – PacifiCorp and Idaho Power AC project first proposed in 2007 to deliver



47 *See* https://chpexpress.com/.

48 NYISO, "NYISO Board Selects Transmission Projects to Meet Public Policy Need," (April 8, 2019), available at: https://www.nyiso.com/-/press-release-nyiso-board-selects-transmission-projects-to-meet-public-policy-need.

49 Xcel Energy, "Colorado's Power Pathway," available at: https://www.transmission.xcelenergy.com/Projects/Colorado/colorado-power-pathway.

50 PacifiCorp, "Gateway South," available at: https://www.pacificorp.com/transmission/transmission-projects/energy-gateway/gateway-south.html.

Wyoming wind to the Pacific Northwest.[51] The project has received cost recovery via various state commissions and the relevant federal approvals.

TransWest Express – DC line to deliver power from Wyoming's proposed Chokecherry and Sierra Madre wind project to a market hub near Las Vegas, Nevada.[52] Costs of this line will be recovered by subscribers including the wind generation owned by the transmission developer. The project will be integrated into the California ISO (CAISO) through a new "subscriber PTO" model.

Offshore wind

Southfork Wind – AC line connecting 132 MW of offshore wind generation to New York.[53] The federal government approved permitting for this project in 2022.

Vineyard Wind – AC line connecting 800 MW of offshore wind generation to Massachusetts.[54] The federal government approved permitting for this project in 2021.

Southwest

Sunzia – Pattern Energy Group DC Merchant project being co-developed with NM RETA delivering New Mexico renewable resources to Arizona and points westward.[55] The project was initially proposed in 2006 by the SouthWestern Power Group. Since then, it went through a seven-year federal permitting process before receiving approval in 2015, but in 2018 the New Mexico Public Regulation Commission rejected SunZia's application. The project filed an amended route with the federal government in 2020 and received final approval in 2023.[56]

Ten West – New AC line between Arizona and California, connecting the Delaney and Colorado River substations and allowing more solar development.[57]

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51 Idaho Power and Rocky Mountain Power, "Gateway West Transmission Line Project," available at: http://www.gatewaywestproject.com/.

52 TransWest Express LLC, "Critical Grid Infrastructure to Connect the West," available at: http://www.transwestexpress.net/.

53 Ørsted & Eversource, "South Fork Wind," available at https://southforkwind.com/.

54 Vineyard Wind, "Vineyard Wind," available at https://www.vineyardwind.com/.

55 *See* https://sunzia.net/.

56 Daniel Moore, "The 17-Year Saga to Build the SunZia Power Line is a Cautionary Taile," Bloomberg News, March 2023, https://financialpost.com/pmn/business-pmn/the-17-year-saga-to-build-the-sunzia-power-line-is-a-cautionary-tale.

57 State of California Public Utilities Commission, "Delaney Colorado River Transmission Ten West Link Project," (updated December 3, 2020), available at: https://www.cpuc.ca.gov/environment/info/dudek/tenwest/index.htm

Projects on-hold

TABLE 3 **Details of projects on hold**

REGION	PROJECT NAME	YEAR PROPOSED	MILES	KILOVOLTS	AC/DC	COST $B
PJM	Lake Erie Connector	~2014	73	320	DC	$1.400
West	Colstrip upgrades	2008/2010	500	500	AC	$0.227
Total			**573**			**$1.627**

Lake Erie Connector – DC line under Lake Erie, connecting Ontario with PJM, the grid operator in the Mid-Atlantic and Great Lakes region.[58] The project had been under development for approximately 10 years, but ITC Holdings, which purchased the rights to the project in 2014, placed the project on hold citing economic conditions.[59]

Colstrip Transmission System upgrade – Upgrades to increase the capacity on the existing 500-kV AC transmission line from Montana to the Pacific Northwest, as well as on the Bonneville Power Administration's system, which would enable additional delivery of Montana renewable energy to the region.[60] These upgrades were initially announced as being studied by Pacific Northwest Utilities in 2008 and the 2010 BPA Network Open Season process also identified the need for these upgrades. Recently, BPA portions of the potential upgrades, which were put on hold around 2015 because some subscribers dropped out, may be revived. BPA included its part of the Colstrip Transmission Systems upgrades as a scenario in a sensitivity analysis in its 2022 transmission upgrade cluster study. This ad hoc approach of waiting until a critical mass of generators and customers are ready illustrates the chicken-and-egg problem of transmission development taking so much longer than renewable generation development.

What is Working?

The projects moving forward have found a way to recover their costs. Cost recovery is a major challenge and was the most important barrier to transmission identified in our

58 TC Investment Holdings Inc., "Lake Erie Connector Project," available at: https://www.itclakeerieconnector.com/.

59 Corey Morris, "Electricity project between Canada, Erie put on hold," YourErie, updated August 2022, https://www.yourerie.com/news/local-news/electricity-project-between-canada-erie-put-on-hold/.

60 Bonneville Power Administration, "Montana Renewable Resource Development Action Plan," at 35-26, (February 23, 2018), available at: https://www.bpa.gov/Projects/Initiatives/Montana-Renewable-Energy/Documents%20Montana/Planning%20Committee%20MT%20Action%20Plan%202_23%20.pptx.

2021 report. Champlain Hudson has cost recovery authorized by the New York Public Service Commission, something that is possible when a state has a clear energy policy and the line connects generation and load within the state or internationally. This applies to New York's Public Policy Transmission projects as well.

Similarly, Colorado's Power Pathway connects generation with load within that state, and cost recovery is determined by state regulators. PacifiCorp's Energy Gateway projects faced a more challenging cost-recovery situation as they needed multiple states to approve their share of the cost allocation based on the benefits just to the retail customers in those states, despite the projects being developed by a single utility. With that accomplished, the projects are moving forward.

Many of the projects are generation tie-lines ("gen-tie") or radial transmission lines that connect remote land-based or offshore wind areas to the transmission system and appear to be moving forward because load-serving entities have increasing electric load and clean-energy demands and can subscribe to the more easily controllable capacity on the DC or unidirectional lines. While it is promising to see gen-tie and radial transmission lines that are connecting new generation to the grid moving forward, these projects represent an inefficient, piecemeal approach to building out the grid that does not identify more cost-effective transmission investments.

The offshore wind-related transmission projects are largely generator tie-lines where cost recovery is done through bundled transmission and generation contracts with the load they are serving.

TransWest is moving forward in part based on California state policy decisions to procure Wyoming wind to serve California customers as a complementary resource that contributes to resource adequacy in the state. CAISO also developed a new model of cost recovery, called "Subscriber PTO," where costs are recovered from the line's subscribers instead of California ratepayers in order to help the project move forward. Other DC projects are similarly attempting to move forward by having generators contract for capacity on the line to deliver their output to customers, something that is not possible for AC network lines because power flows on the AC network cannot be controlled and include flows from multiple generators to dispersed customers.

The examples above largely exhibit relatively concentrated demand and benefits to identified customers. Many of the projects are generation tie-lines ("gen-tie") or radial transmission lines that connect remote land-based or offshore wind areas to the transmission

system and appear to be moving forward because load-serving entities have increasing electric load and clean-energy demands and can subscribe to the more easily controllable capacity on the DC or unidirectional lines. While it is promising to see gen-tie and radial transmission lines that are connecting new generation to the grid moving forward, these projects represent an inefficient, piecemeal approach to building out the grid that does not identify more cost-effective transmission investments.

In order to optimally buildout the transmission system to meet future needs and maximize transmission investments, more network transmission or large-scale regional transmission plans that use proactive, scenario-based, multi-value planning is needed. These holistic plans include a network or portfolio of new transmission lines that ensures multiple benefits including lower costs for consumers as well as electric system reliability, resilience, and decarbonization for a region.

Significant progress has been achieved for holistic regional transmission plans, with notable examples represented by MISO's LRTP, CAISO's regional plan, and SPP's STEP projects along with its competitive solicitations such as the Minco-Draper line in Oklahoma, Wolf Creek-Blackberry line in Kansas/Missouri, and Crossroads-Hobbs-Roadrunner in New Mexico. These projects represent some of the largest transmission investment opportunities to date and highlight the benefits transmission provides from a reliability and resiliency standpoint while also providing financial benefits to ratepayers. More recently, PJM has announced the beginning of a long-term network planning process, another potentially positive development. However, more needs to be done to advance large regional and interregional network transmission. Many regions have not established processes for planning and paying for regional network transmission, and even many of the successful efforts (such as MISO's LRTP) are taking place on a voluntary basis without clear tariff provisions outlining how these processes will be repeated in the future.

Planning and cost-allocation frameworks for interregional transmission are even less well-developed. While MISO and SPP are advancing the JTIQ portfolio of network lines to more efficiently address interregional upgrade needs repeatedly identified in generator interconnection studies, they have not yet finalized a cost-allocation framework for these projects. Other projects between interconnections are in early-stage development and could provide extensive benefits to users in the Eastern, Western, and Texas interconnections, but there is no clear path for them to recover their costs because their benefits are so dispersed. Despite these barriers, many of the major interregional projects are being planned and developed by independent transmission developers.

National Need for Transmission

Construction of new high-voltage lines has fallen steadily over the last decade.[61] In 2013, the nation peaked by adding approximately 4,000 miles of high-voltage (+345 kilovolt or kV) lines. In that year, a number of lines that had been proactively planned by ERCOT, SPP, and California entered service. The figure below shows the persistent decline in projects since 2013. FERC's transmission planning Notice of Proposed Rulemaking (NOPR) confirms how construction of high-voltage lines is decreasing.[62] Most recent transmission spending has been on smaller lower-voltage lines planned and paid for outside of the regional transmission-planning process. These projects are often sub-optimal, as they are too small to realize economies of scale from higher-capacity transmission and were not designed to optimize multiple benefits through a regional planning process. From 2013 to 2017, roughly half of the authorized transmission investments were approved outside of the regional planning and cost allocation processes, and to date non-RTO regions have not approved a line planned through the regional planning process.[63] In MISO, almost 80% of spending on transmission went to local projects from 2018-2020, and in PJM during that period about two-thirds of spending went to local projects.[64] Recent advances in transmission planning in some regions could begin to reverse this trend. For instance, MISO should see a significant uptick in regional transmission construction relative to local spend in coming years due to the recent approval of the LRTP Tranche 1 portfolio (as well as the potential approval of three additional tranches in the coming years). However, absent a clear federal policy on regional transmission planning and cost allocation, these advancements are expected to be uneven across regions.

61 Jay Caspary, Michael Goggin, Rob Gramlich and Julia Selker, "Fewer New Miles: The U.S. Transmission Grid in the 2010s," Aug. 2022, pg 1, https://gridprogress.files.wordpress.com/2022/08/grid-strategies_fewer-new-miles.pdf.

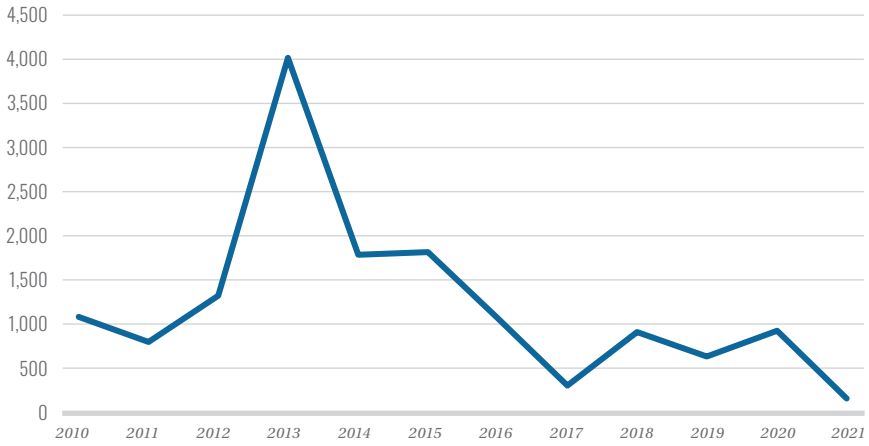
62 Notice of proposed rulemaking, Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection, 87 Fed. Reg. 26,504 (May 2022), P 39-41, https://ferc.gov/media/rm21-17-000 ("NOPR"). Add language from the NOPR to this cite?

63 Rob Gramlich and Jay Caspary, "Planning for the Future: FERC's Opportunity to Spur more Cost-effective Transmission Infrastructure," Americans for a Clean Energy Grid, January 2021, 25-26, https://cleanenergygrid.org/wp-content/uploads/2021/01/ACEG_Planning-for-the-Future1.pdf.

64 NOPR at P 39.

FIGURE 2

Miles of 345 kV+ Transmission Lines Added Each Year[65]



Not only has investment in regional transmission lines been decreasing, but at the same time the need for regional transmission has been increasing due to a variety of factors. These include increasing demand growth, electrification of transportation and other sectors, higher natural gas prices due to European demand, a changing resource mix due to the economics of new renewable generation, increased customer demand for renewable resources, significant utility commitments for renewable energy expansion and decarbonization, and new public policies from local, state, and federal governments promoting carbon-free generation. The aggregation of these trends suggests a shift in the generation mix and significant load growth over the next few decades, both of which will require new transmission capacity.[66]

Numerous independent studies confirm these trends and the need for more transmission capacity. In March 2023, DOE released a Transmission Needs Study Draft finding that additional transmission capacity is needed to connect a changing resource mix to growing demand and to maintain overall grid reliability.[67] The draft report also found scenarios in line with the IIJA and IRA and moderate load estimates required a 57% growth in transmission capacity by 2035 over today's system, while a similar scenario with higher load estimates necessitated doubling US transmission capacity by 2040.[68] Another study from Princeton found that electricity generation capacity must increase between two and four times today's levels by 2050 and that new generation build-out will require doubling or

65 Caspary, "Fewer New Miles," pg 1.

66 NOPR, par. 45.

67 U.S. Department of Energy, "National Transmission Needs Study Draft for Public Comment," February 2023, 106, https://www.energy.gov/sites/default/files/2023-02/022423-DRAFTNeedsStudyforPublicComment.pdf (Needs Study).

68 Needs Study, 106-107.

tripling transmission capacity by 2050.[69] A study from MIT concludes new generation additions and load growth will require nearly doubling the U.S.'s transmission capacity by 2050.[70]

The MIT and Princeton studies, along with several others, also include estimates of additional transmission capacity the country will need. The current US transmission system is about 150,000 GW-miles (a one-mile line that can deliver 10 MW of power provides 10 MW-miles). According to the MIT Study, the amount of additional transmission capacity needed in the US to achieve a net-zero system is approximately 400 teraWatt-kilometers (TW-km) or about 250,000 GW-miles. This estimate does not include generator tie-lines. The report also notes that in high load-growth scenarios the need for additional transmission capacity could double to roughly 800 TW-km. The Princeton Net-Zero study has a slightly higher estimate for its high-electrification, high-renewable scenario. The study estimated 235,000 GW-km of additional transmission capacity would be needed in 2030, 760,000 GW-km in 2040, and 1.3 million GW-km in 2050, which is approximately 150,000, 475,000, and 820,000 GW-miles respectively. The NREL Interconnections Seam study, which only reaches 70% carbon-free electricity, calls for around 110,000 new GW-miles.[71] NREL's Renewable Energy Futures study called for 200,000 additional GW-miles.[72] A recent study for the Eastern Interconnect projected a doubling of transmission capacity to reduce carbon emissions by over 95%,[73] which, scaled to the country, would require 150,000 GW-miles.

69 E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, *Net-Zero America: Potential Pathways, Infrastructure, and Impacts*, interim report, Princeton University, Princeton, NJ, December 15, 2020, https://netzeroamerica.princeton.edu/img/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf.

70 P. Brown and A. Botterud, "The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System." *Joule 5*, no. 1 (January 20, 2021): 115-135, https://doi.org/10.1016/j.joule.2020.11.013.

71 Aaron Bloom et al., *The Value of Increased HVDC Capacity Between Eastern and Western U.S. Grids: The Interconnections Seam Study*, (October 2020), available at: https://www.nrel.gov/docs/fy21osti/76850.pdf.

72 NREL, *Renewable Electricity Futures Study*," (2012), available at: https://www.nrel.gov/docs/fy13osti/52409-ES.pdf.

73 Christopher Clack, Michael Goggin, Aditya Choukulkar, Brianna Cote, and Sarah McKee, *Consumer, Employment, and Environmental Benefits of Electricity Transmission Expansion in the Eastern U.S.*, (October 2020), available at: https://cleanenergygrid.org/wp-content/uploads/2020/10/Consumer-Employment-and-Environmental-Benefits-of-Transmission-Expansion-in-the-Eastern-U.S..pdf.

Are We Building Enough Transmission?

The current list of 36 projects reflects a significant expansion beyond the 22 projects identified in our 2021 report. The new report identifies 25 new projects: 10 have moved into construction, two that are on hold, and 11 that remain on the list from 2021. The movement into construction and the addition of new projects reflects some progress on transmission in the US. These 25 new projects are not necessarily reflective of all the changes over the last two years. For example, 12 of the new projects are associated with offshore wind projects, but our 2021 report grouped three offshore wind transmission projects into a single line item. However, some of the projects, such as MISO's LRTP Tranche 1 or California's 2022-2023 Transmission Plan, represent portfolios of transmission lines that if counted individually would significantly increase the number of lines.

That it is possible to increase transfer capacity by about 15% with a 4% increase in line miles reflects the use of higher-voltage transmission for these 36 projects, enabling the delivery of more power over longer distances. But when compared to the needs found in the studies above, the 22,500 GW-miles added by these 36 projects is just under 10% of the transmission investment needed to cost-effectively decarbonize the power system.

Compared to the estimates of national needs, the transmission progress data in this report suggest the US is underbuilding necessary new high-voltage transmission capacity. The 22 proposed projects identified in the previous report could provide about 17,000 GW-miles of transmission capacity. Those projects would increase US transfer capacity by about 11-12% and add about 8,000 miles – about a 3% increase – to America's existing 240,000 miles of transmission. However, since the release of the 2021 report, only 10 of those projects have begun construction, representing just over 8,300 GW-miles of new transmission capacity.

In this updated report, we estimate there is now roughly 22,500 GW-miles of new high-voltage transmission capacity *ready-to-go* in addition to the 8,300 GW-miles currently under construction. The 36 projects identified in this report would increase transmission

capacity approximately 15% and add approximately 10,000 miles of new lines – about a 4% increase over the current transmission system's miles. That it is possible to increase transmission capacity by about 15% with a 4% increase in line miles reflects the use of higher-voltage transmission for these 36 projects, enabling the delivery of more power over longer distances. But when compared to the needs found in the studies above, the 22,500 GW-miles added by these 36 projects is just under 10% of the transmission investment needed to cost-effectively decarbonize the power system. If one also accounts for the 8,300 GW-miles that are currently under construction, that is still only 13% of the need. Given the extremely long lead times required to plan and permit transmission under current policies, planning for the needed transmission capacity should be underway already.

Are We Building Transmission Fast Enough?

Large regional and interregional transmission lines are notoriously slow and difficult to plan, approve, and construct. The average time from project proposal to start of construction for the projects under way since our last report is almost 10 years. Table 2 above shows the start year for those projects was 2006, 2007, 2010, 2014, 2015, 2016, 2017, 2019, and 2021. For the projects currently on the list of 36 that are close to being construction-ready, the current average time since project proposal is seven years. Most of these projects will require a number of additional years for permitting, cost allocation approval, finding subscribers, engineering and land acquisition, and construction. Meeting national transmission needs in 2030 and 2035 will require significant reforms in how transmission is planned, paid for, and permitted to dramatically increase the number of projects being developed, increase the success rate for projects proposed, and reduce time needed to obtain required approvals and secure cost recovery.

Do we have the policies needed to move projects forward?

Grid Strategies has labeled the key areas of policy reform needed to enable greater transmission investment as the "three Ps": planning, paying for, and permitting transmission. In the last report we noted that many of the projects at or near the finish line on permitting lacked a path to cost recovery. At the time, legislation was being actively developed to provide tax credits and various forms of grants and loans for infrastructure. Some helpful provisions were included by the 117th Congress in 2021-2022 in the Infrastructure Investment and Jobs Act and Inflation Reduction Act, although they fall well short of the need. Other policies are under development at the Federal Energy Regulatory Commission (FERC) and the Department of Energy (DOE).

Transmission policy changes since 2021 include:

Infrastructure Investment and Jobs Act (IIJA):

- ***Transmission Facilitation program.*** This is a well-structured program that allows DOE to use capacity contracts or public-private partnerships to provide up-front "anchor tenant" funding from the government that future subscribers to the transmission would pay back to help overcome the chicken-and-egg problem. However, the program is only funded with $2.5 billion, and the loans must be paid back. Congress should significantly increase funding for this program.
- ***Strengthened federal backstop siting.*** The law provided clarity in response to court decisions that weakened this policy, originally included in the Energy Policy Act of 2005 to counter reliability concerns after the 2003 Northeast blackout. DOE and FERC are now implementing their respective portions of this statutory change.
- ***Grid Resilience and Innovation Partnerships (GRIP) program funding.*** Most of this money appears intended to strengthen existing transmission and distribution systems, but funding can be used for new transmission lines.

Inflation Reduction Act (IRA):

- The Transmission Siting and Economic Development Grants program is a $760 million investment through the Inflation Reduction Act to support states and local communities in the siting and permitting of interstate and offshore electricity transmission lines.
- Allocated funding for loans for national interest transmission lines. These loans can help to reduce the cost of capital for transmission projects in the current high interest rate environment.

FERC regional transmission planning Notice of Proposed Rulemaking:

- The proposed rule would require proactive, multi-value, scenario-based transmission planning following well-known best practices not in wide use today and proposes a process for determining regional cost allocation. The NOPR was released in 2022, but a final rule has not yet been issued.

DOE and other administrative actions:

- Creation and staffing of a new Grid Deployment Office to implement IIJA and IRA financing and permitting tools, with a focus on deployment, as opposed to the more typical research and development focus of most DOE offices.
- DOE lead office role under Section 216(h) of the Federal Power Act, including a proposed rule issued in August 2023 and a Memorandum of Understanding with nine agencies for DOE to be lead agency for federal authorization and permits and set a two-year deadline for federal administrative action on all transmission lines.
- Limited permitting reforms passed in the June 2023 debt-ceiling agreement (Fiscal Responsibility Act of 2023 legislation) including National Environmental Policy Act deadlines and mandating a single agency take the lead on those environmental reviews.

Significant Policy Reforms Still Needed

Congress and the administration have taken only modest steps to address permitting reform; additional actions are needed to improve the challenging policy environment for large-scale regional and interregional transmission in a meaningful way. Very little funding was included in the IIJA and IRA for new large-scale transmission relative to the need.

While the IIJA's Transmission Facilitation Program is a promising new program that may prove beneficial to the construction of new transmission lines, it remains to be seen how its various financing mechanisms will work in practice. The $2.5 billion for the revolving

loan program may not be sufficient to meet the demand for new high-capacity transmission.

DOE's GRIP program's $10.5 billion is broader in scope than just new transmission lines, including grid-hardening efforts and smart grid technology. Overall, the funding is relatively inconsequential given that private industry already spends $25 billion per year on transmission, with much of that spent on small local reliability upgrades.

Based on recent success rates for transmission projects and the many challenges that hinder transmission, we expect less than half of the 36 projects identified in this report will proceed to construction in the near term.

Recent DOE and Administration focus on permitting is helping certain lines get their final approvals, but the breadth of the tools and authorities possessed by DOE are narrow and limit the type and impact of the actions it can take. Providing FERC plenary federal jurisdiction in siting high-capacity transmission lines – similar to the agency's authority over natural gas pipeline siting – is a change that would require amendments to existing law and passage through Congress, but would have a major effect by significantly clarifying and streamlining the siting and permitting process for new transmission lines in the national interest.

A transmission investment tax credit (ITC) was a key policy proposal in our last report. This policy was included in the House-passed Build Back Better Act, but did not survive in the final version of the Inflation Reduction Act that was signed into law. A transmission ITC would help address the challenge of transmission as a "public good" that provides benefits to many parties while creating an incentive for entities to engage in "free riding" on those benefits without paying. For example, state regulators have little incentive to help pay for regional transmission upgrades if they can instead try to make other states pay for those lines, and one group of stakeholders within a regional transmission organization typically fights to allocate the cost of transmission to other groups of stakeholders. The resulting underinvestment in public goods usually must be addressed through public policy that allocates costs to all who benefit. In the case of transmission, an ITC could help by covering 30% of the cost, reflecting the broad benefits of high-capacity transmission and making the remaining cost allocation that much easier. Based on recent success rates for transmission projects and the many challenges that hinder transmission, we expect less than half of the 36 projects identified in this report will proceed to construction in the near term. That would bring the total transmission investment down from $64 billion if all 36 projects proceeded to under $30 billion. With the proposed 30% tax credit, the total federal budget impact of the tax credit for the projects that proceed to construction is likely to be under $9 billion. There may be opportunities in tax bills as soon as the end

of 2023 to pass a transmission ITC.

Indirectly, the energy tax credits included in the IRA are helping to accelerate renewable deployment and electrification. In some regions these planned generation investments are being incorporated into regional transmission planning models, which helps advance transmission portfolios. In addition, the IRA and new state decarbonization laws are reducing the risk of stranded investment, which is improving the business case for new transmission projects, particularly in non-RTO regions still heavily reliant on commercial demand and point-to-point subscriptions.

FERC's proposed rule on regional transmission planning and cost allocation is the most significant recent policy action in terms of potential impact. Some of the key provisions in the proposed rule must be strengthened in the final rule to accomplish its goals: plans should be based on the anticipated future resource mix using estimates of retirements and additions, and all of the electricity system benefits should be included by planners rather than just provided as options. In addition to finalizing the rulemaking on regional planning, FERC should build on its momentum – and the record – and pursue similar reforms by developing a rulemaking to support interregional transmission planning. To complement these rulemakings, and address the "paying" barrier and public good problem, Congress should clarify and implement processes for FERC to allocate costs of regional and interregional lines. Those large-scale lines, which benefit many people across many states, are the kind of projects that are not moving forward presently. Congressional clarification of FERC's authority over cost allocation and instituting processes for cost allocation and recovery for regional and interregional lines would help spur sorely needed progress.

There are also additional policy levers that Congress and FERC could pull to help facilitate faster and more effective buildout of new transmission. Americans for a Clean Energy Grid's Legislative Principles outlines a number of these potential approaches.[74]

74 ACEG, Legislative Principles to Support Transmission Deployment," April 2023, https://cleanenergygrid.org/wp-content/uploads/2023/04/ACEG-Transmission-Legislative-Principles-0423.pdf.

APPENDIX
Benefits of proposed projects

Investing in transmission gives consumers access to electricity that is more affordable, reliable, and clean. Transmission provides consumers with access to lower-cost forms of electricity generation, including high-quality renewable energy resources. Dozens of studies from grid operators, national laboratories and others have found that transmission investment provides large net benefits – several times greater than the cost. SPP has found significant net benefits already realized from its recent transmission investments, with those benefits expected to exceed costs by a factor of 3.5 over the lines' first 40 years.[75] MISO has also found that its MVP projects offer a benefit-to-cost ratio of between 2.2 and 3.4.[76] Similarly, the National Renewable Energy Laboratory Interconnections Seam study found benefit-to-cost ratios of between 1.8 to 2.9 for various transmission configurations.[77]

PJM has found transmission provides its consumers with billions of dollars in benefits by reducing the cost of producing electricity, increasing competition, reducing the need for power plant capacity, increasing power system reliability and resilience, and enabling the region to take advantage of new low-cost gas and renewable resources. [78] In several other studies, utility consultant the Brattle Group has found that transmission provides a similarly wide array of benefits.[79]

These studies note that many benefits of transmission are difficult to quantify, so they were not accounted for in those analyses. Many of those benefits are discussed below. Transmission is also what economists describe as a public good, in that many of the ben-

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75 SPP, *The Value of Transmission*, (January 2016), available at: https://www.spp.org/documents/35297/the%20value%20of%20transmission%20report.pdf.

76 MISO, *MTEP17 MVP Triennial Review*, (September 2017), available at: https://cdn.misoenergy.org/MTEP17%20MVP%20Triennial%20Review%20Report117065.pdf.

77 Gregory Brinkman, Joshua Novacheck, Aaron Bloom, and James McCalley, *Interconnections Seam Study: Overview*, (October 2020), at 32, available at: https://www.nrel.gov/docs/fy21osti/78161.pdf.

78 PJM, *The Benefits of the PJM Transmission System*, (April 16, 2019), available at: https://pjm.com/-/media/library/reports-notices/special-reports/2019/the-benefits-of-the-pjm-transmission-system.ashx?la=en.

79 Judy Chang, Johannes Pfeifenberger, and Michael Hagerty, *The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments*, (July 2013), at v, available at: https://cleanenergygrid.org/uploads/WIRES%20Brattle%20Rpt%20Benefits%20Transmission%20July%202013.pdf; Judy Chang, Johannes Pfeifenberger, Samuel Newell, Bruce Tsuchida, and Michael Hagerty, *Recommendations for Enhancing ERCOT's Long-Term Transmission Planning Process*, (October 2013), Appendix B, available at: http://files.brattle.com/files/6112_recommendations_for_enhancing_ercot%E2%80%99s_long-term_transmission_planning_process.pdf.

efits of transmission cannot be realized by the party making the investment, so policy is needed to correct for the resulting underinvestment in transmission.

Reliability and resilience

Transmission is critical for reliability and resilience of the power grid, particularly interregional transmission which allows neighboring regions to access greater diversity of resources and share power during increasingly frequent extreme weather events. Increased connections between regions also lower the overall need for generation resources, leading to lower costs for consumers. As noted below, the 36 projects identified in this report enable 132 GW of additional transmission capacity, some of which will allow bidirectional power delivery between at least two regions. Transmission also provides other benefits not typically quantified, including making power markets more competitive, hedging against fuel price volatility and other sources of uncertainty, and more.[80]

FERC has shown an increasing interest in addressing interregional capabilities by hosting a technical workshop, a Joint Federal-State Task Force meeting, and requesting information on the subject in preparation for a potential future rulemaking. In December 2022, at FERC's workshop on interregional transmission, FERC Chairman Willie Phillips said interregional transmission covers many of his priorities: "Reliability and resilience because it strengthens the voltage and minimizes the likelihood of load shedding and … affordability because it allows ratepayers to access lower cost generation, and … sustainability because it accommodates the demand for more clean energy." Commissioner Mark Christie also voiced his support for interregional transmission in a July 2022 Joint Federal-State Task Force on Electric Transmission, stating: "Interregional transfers do have reliability benefits, no question about it."[81] In a recent June 2023 Senate hearing, the head of the North American Electric Reliability Corporation (NERC), the US regulatory authority overseeing grid reliability, echoed these sentiments, stating, "interregional transmission is a terrific way to build resilience and reliability into the grid."[82]

Winter Storm Elliott is among the most recent extreme weather events. The December 2022 event brought near-record low temperatures and wind chills across much of the

80 American Wind Energy Association, *Grid Vision: The Electric Highway to a 21st Century Economy*, (May 2019), available at: https://cleanpower.org/wp-content/uploads/2021/01/Grid-Vision-The-Electric-Highway-to-a-21st-Century-Economy.pdf.

81 FERC, "Fourth Meeting of the Joint Federal-State Task Force on Electric Transmission," July 20, 2022, https://www.ferc.gov/media/webcast-fourth-meeting-joint-federal-state-task-force-electric-transmission.

82 U.S. Senate Committee on Energy and Natural Resources, "Full Committee Hearing to Examine the Reliability and Resiliency of Electric Services in the U.S. in Light of Recent Reliability Assessments and Alerts," June 2023, https://www.energy.senate.gov/hearings/2023/6/full-committee-hearing-to-examine-the-reliability-and-resiliency-of-electric-services-in-the-u-s-in-light-of-recent-reliability-assessments-and-alerts.

Central and Eastern US. In the power sector, record winter electricity demand coincided with the large-scale loss of fossil power plants due to equipment failures and interruptions to natural gas supplies. Parts of the Southeast experienced rolling blackouts as electricity demand exceeded supply, while power prices spiked in many regions. Additional transmission capacity would have protected consumers from those blackouts and price spikes by bringing in power from other regions that were less severely affected by the storm.

The large differences in power prices as Winter Storm Elliott moved west-to-east across the country, plus the economic cost of outages in parts of the Southeast, indicate the value a stronger power grid could have provided during the event. A 2023 report from ACORE finds that in some regions, modest investments in interregional transmission capacity would have yielded nearly $100 million in value during the five-day event, while many regions could have saved tens of millions of dollars. Some of the highest value could be realized by adding additional transmission capacity between the Electric Reliability Council of Texas (ERCOT) and TVA, which would have provided nearly $95 million in value for each additional GW of transmission capacity during Winter Storm Elliott – mostly to TVA customers. That adds to the nearly $1 billion in value such a line, flowing in the other direction, would have provided Texans suffering through outages during Winter Storm Uri in February 2021.[83]

A stronger transmission network provides valuable redundancy in case other lines or power sources are unexpectedly taken offline. This provides national security benefits as well, as electricity is essential for powering a range of emergency services. And a stronger grid is less vulnerable to intentional attacks. The reliability value of a stronger grid is high, as power outages are estimated to cost each US household between $28 and $169 annually.[84]

Providing consumers with access to clean energy

Utilities and corporate customers are increasingly buying renewable energy due to its economic and environmental benefits. Some of the biggest companies in the world and the biggest utilities in the US have significant clean-energy goals driving demand for cleaner generation. From 2016-2022, commercial and industrial corporations signed deals for more than 60 GW of clean-energy generation. In 2022 alone, corporations signed con-

83 M. Goggin and Z. Zimmerman, "The Value of Transmission During Winter Storm Elliot," ACORE, February 2023, https://acore.org/wp-content/uploads/2023/02/The-Value-of-Transmission-During-Winter-Storm-Elliott-ACORE.pdf.

84 American Society of Civil Engineers, *A Comprehensive Assessment of America's Infrastructure*, (2020), available at: https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report.pdf.

tracts for nearly 17 GW of new clean-energy generation. These companies are located across the US, and many are household names including McDonald's, US Steel Corporation, Comcast, BASF Corporation, Nestle, and Walmart.[85]

Utilities are also looking to procure cleaner generation. According to one tracker, "84% of US customer accounts are served by an individual utility with a carbon-reduction target, or a utility owned by a parent company with a carbon-reduction target."[86] Distribution cooperatives, generation and transmission co-ops (G&Ts), investor-owned utilities, and Public Power utilities have all set carbon-reduction goals, as have some of the biggest utilities in the US, including Southern Company, Duke Energy, Dominion Energy, American Electric Power, Northwestern Energy, Idaho Power, Entergy Corp., Ameren Corp., and others.[87]

Yet transmission constraints limit the ability of these utilities and corporations to efficiently tap renewable resources. We estimate that almost 700 million megawatt-hours of additional domestic wind and solar generation will be enabled by the 36 transmission projects discussed herein, comprising a little over 187 GW of additional renewable capacity. If completed, these transmission projects would drive a nearly 87% increase in wind and solar generation from current levels,[88] allowing wind and solar to grow from 13.7% to 25.7% of total US electricity supply.[89]

We conservatively estimate that the roughly 132 GW of additional transmission capacity created by these transmission projects could enable the interconnection of around 187 GW of additional renewable capacity in the US. Based on the ability to use the geographic diversity of wind and solar resources to obtain a more constant output profile, and the complementarity between wind and solar output profiles, it is typically possible for the nameplate capacity of wind and solar attached to a transmission line to exceed the capacity of the line by around 50%. The output of the renewable generators delivered by these transmission lines would also be high, as they access some of the highest quality wind and solar resources in the country. Capacity factors for wind and solar projects developed in many of the resource areas accessed by these lines can exceed 50% and 30% respectively, which is well above average. Transmission constraints are a major limiting factor to the continued growth in wind and solar generation capacity.[90]

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85 Clean Energy Buyers Alliance," CEBA Deal Tracker 2016 through Q1 2023," 2023, https://cebuyers.org/deal-tracker/.

86 Smart Electric Power Alliance, "Utilities' path to a carbon-free energy system," accessed June 2023, https://sepapower.org/utility-transformation-challenge/utility-carbon-reduction-tracker/.

87 *Id.*

88 EIA, "Table_7.2a_Electricity_Net_Generation__Total_(All_Sectors)," available at: https://www.eia.gov/totalenergy/data/browser/?tbl=T07.02B.

89 *Id.*

90 Jay Caspary, Michael Goggin, Rob Gramlich, and Jesse Schneider, *Disconnected: The Need for a New Generator Interconnector Policy*, (January 2021), available at: https://cleanenergygrid.org/wp-content/uploads/2021/01/Disconnected-The-Need-for-a-New-Generator-Interconnection-Policy-1.pdf.

Clean air benefits of transmission

Many studies confirm that large-scale transmission expansion is essential for the clean-energy transition. Transmission delivers low-cost renewable energy to population centers, which helps to improve air quality and benefit low-income communities and communities of color by displacing the need for polluting local generation in those areas. Transmission is also essential for accessing a diverse mix of wind and solar resources by enabling large interregional flows of power.[91]

A study done by LBNL found that new wind and solar generation created benefits of up to $112 billion from 2007 to 2015. These benefits could largely be attributed to increased air quality, which helped avoid up to 12,700 premature mortalities. The study also found an additional $106 billion in cumulative climate benefits over the same period.[92] Other studies found that the health and economic impacts from air pollution are much larg-

91 For example, *see* American Wind Energy Association, *Grid Vision: The Electric Highway to a 21st Century Economy*, (May 2019), available at: https://cleanpower.org/wp-content/uploads/2021/01/Grid-Vision-The-Electric-Highway-to-a-21st-Century-Economy.pdf, Christopher Clack, Michael Goggin, Aditya Choukulkar, Brianna Cote, and Sarah McKee, *Consumer, Employment, and Environmental Benefits of Electricity Transmission Expansion in the Eastern U.S.*, (October 2020), available at: https://cleanenergygrid.org/wp-content/uploads/2020/10/Consumer-Employment-and-Environmental-Benefits-of-Transmission-Expansion-in-the-Eastern-U.S..pdf.

92 D. Millstein, R. Wiser, M. Bolinger, and G. Barbose, "The climate and air-quality benefits of wind and solar power in the United States," *Nature Energy* 2, 17134 (2017), https://emp.lbl.gov/publications/climate-and-air-quality-benefits-wind.

er than previously thought. This research has further shown that improvements in air quality from decarbonization will pay for themselves nearly four times over in public health benefits. According to one researcher, "Over the next 50 years, keeping to the 2°C pathway would prevent roughly 4.5 million premature deaths, about 3.5 million hospitalizations and emergency room visits, and approximately 300 million lost workdays in the US."[93] These avoided health impacts have significant economic consequences. Total savings from avoided deaths is over $37 trillion and the benefits of fewer hospitalizations and emergency room visits are valued at approximately $37 billion. Additionally, as a result of improved public health, $75 billion in value could come from increased labor productivity. These benefits equate to $700 billion annually for the United States, which is much higher than the cost of decarbonizing the energy system. It is important to note that improving air quality has immediate benefits. In 10 years, significant reductions in carbon emissions could enable a 40% reduction in pollution-caused mortality, preventing 100,000 of 250,000 pollution-related deaths annually.[94]

Air pollution impacts from thermal generation plants do not fall evenly across communities. Historically, the nation's energy system has disproportionately harmed low-income communities and people of color, since many of the most polluting power plants are located near low-income areas and communities of color. Compared to the overall population, communities of color are exposed to nearly 1.3 times more particulate matter pollution, which is linked to numerous adverse health issues. The racial disparities persist across income levels.[95]

We estimate the 36 transmission projects we identify as *ready-to-go* would more than double the renewable generation in the US today and eliminate almost 460 million short tons of carbon emissions annually, which is equivalent to removing 90 million cars – or a third of all cars in the US – from the road.[96]

93 D. Roberts, "Air Pollution is much worse than we thought," Vox, August 12, 2020, https://www.vox.com/energy-and-environment/2020/8/12/21361498/climate-change-air-pollution-us-india-china-deaths.

94 Roberts, "Air Pollution is much worse than we thought.

95 ACEG, "Transmission for All Factsheet," 2023, https://www.cleanenergygrid.org/wp-content/uploads/2023/05/Transmission_for_All_Factsheet_2023.pdf.

96 This assumes one car emits 4.6 metric tons of CO2 annually. EPA, "Tailpipe Greenhouse Gas Emissions from a Typical Passenger Vehicle," accessed August 2023, https://www.epa.gov/greenvehicles/tailpipe-greenhouse-gas-emissions-typical-passenger-vehicle.

Jobs

The $64 billion investment in these 36 transmission projects would create around 1.3 million new jobs, including 530,000 direct jobs plus 770,000 indirect and induced jobs. The wind and solar deployment enabled by this transmission investment could create an additional 2 million jobs, bringing the total job creation benefit to around 3.3 million jobs.

That estimate for jobs created from transmission investment is based on the results of following five studies that used economic input-output models to evaluate the direct and indirect job-creation benefits of transmission construction. These results indicate DC projects create around 4 direct jobs per $1 million of expenditure and 11.3 total direct, indirect, and induced jobs, while AC projects create around 11.5 direct jobs per $1 million of expenditure and 27 total direct, indirect, and induced jobs.

TABLE 4 **Studies of job creation from transmission investment**

AC OR DC	CONSTRUCTION DIRECT JOB-YEARS/$1 MILLION	CONSTRUCTION DIRECT, INDIRECT, AND INDUCED JOB-YEARS/$1 MILLION
AC[97]	9 to 14	19 to 35
AC + DC[98]	11.72	NA
AC + DC[99]	4.25	12.5
DC[100]	3 to 4	NA
DC[101]	5.05	11.30

The above estimates do not account for job creation from the wind and solar deployment enabled by the transmission investment. As noted above, the 132 GW of transmission capacity provided by these transmission lines would likely enable around 187 GW of renewable deployment, as installed renewable capacity can often exceed transmission capacity by around 50% due to diversity in renewable output. At a rate of 4 direct jobs per renewable MW and 10.64 total direct and indirect jobs per renewable MW,[102] renewable capacity enabled by this transmission investment would yield an additional 745,000 direct jobs and around 2 million total direct and indirect jobs, bringing total job creation to just under 3.3 million jobs.

Other factors could further expand the job creation associated with this investment. A large-scale and sustained investment in transmission in America would incentivize greater domestic manufacturing of transmission equipment, including conductor cables, tower components, transformers and converters, circuit breakers, and other components. A 2011 Brattle Group analysis indicated domestic content accounted for 82% of

97 MISO, *Economic Impact of MTEP In-Service Projects from 2005-2015*, (July 2015), available at: https://cdn.misoenergy.org/Economic%20Impact%20of%20MTEP%20In-Service%20Projects271136.pdf

98 Dave Swenson, *Economic Impact & Job Creation Relative to Large-Scale, High Voltage Transmission Infrastructure*, (July 2018), available at http://www2.econ.iastate.edu/prosci/swenson/Publications/The%20Interconnection%20Seam%20Study%20Amended%20Title.pdf

99 WIRES and The Brattle Group, *Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada*, (May 2011), available at: https://brattlefiles.blob.core.windows.net/files/6534_employment_and_economic_benefits_of_transmission_infrastructure_investmt_pfeifenberger_hou_may_2011_wires.pdf.

100 Jinglin Duan and Julia Frayer, "Estimating Macroeconomic Benefits of Transmission Investment with the REMI PI+ Model," (May 2, 2018), available at: http://www.remi.com/wp-content/uploads/2018/05/WIRES-modeling_0501_final-v3.pdf.

101 Eric Lantz and Suzanne Tegen, *Jobs and Economic Development from Net Transmission and Generation in Wyoming*, (March 2011), available at: https://www.nrel.gov/docs/fy11osti/50577.pdf.

102 Luigi Aldieri, Jonas Grafström, Kristoffer Sundström, and Concetto Paolo Vinci, "Wind Power and Job Creation," Sustainability, (December 18, 2019), at 16, available at: https://www.mdpi.com/2071-1050/12/1/45/pdf, showing 4.03 direct and 10.64 direct and indirect jobs per MW of wind capacity; and The Solar Foundation, *National Solar Jobs Census 2018*, at 30, available at: https://resources.solarbusinesshub.com/images/reports/206.pdf, showing 3.3 installation and development jobs/MW for utility-scale solar, rounded up to 4 jobs/MW to account for manufacturing and other supply chain jobs.

the total value of transmission investment, with 61% of materials sourced domestically.[103] Brattle estimated that 65% of transmission wires and towers were sourced domestically, while transformers and circuit breakers were 35% domestic. In addition to the policies discussed below, a manufacturing tax credit for high-voltage transmission facilities could further increase domestic content. All transmission construction and operations and maintenance work is inherently domestic, and transmission planning, engineering, and logistics work would also typically be performed domestically. Most transmission jobs are well-paying union jobs. Transmission investment also provides American businesses and industries with access to low-cost, reliable electricity, which further enables employment.

Transmission capacity is also critical in helping shift national economic policy toward an increased focus on onshoring manufacturing to develop domestic supply chains. Development of new domestic manufacturing along with growth in data centers, partially driven by AI, represents the potential for significant economic growth and job growth for the US. The passage of the CHIPS Act and the Inflation Reduction Act both included incentives for domestic manufacturing and production, and the laws are already having an impact. In just one year since the IRA's passage there have been 100 new manufacturing announcements totaling close to $80 billion in investments.[104] These new manufacturing facilities, along with new data centers, often require additional transmission to ensure the grid has the capacity to reliably interconnect significant new industrial loads. However, delays are already beginning to occur. Interconnection requests for data centers have dropped across the country and in Northern Virginia – a national hub for data centers – there is a scramble to meet the soaring power demand as current grid capacity is limited.[105] Some experts estimate that fully electrifying the US's industrial load could more than double current US power demand.[106] The current issues are arising even before manufacturing for microchips and additional electric vehicle production and battery manufacturing facilities fully ramp up, along with hydrogen production facilities. If sufficient transmission capacity is not available, these investments could be significantly delayed or even canceled.

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103 WIRES and The Brattle Group, Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada, (May 2011), at 20, available at: https://brattlefiles.blob.core.windows.net/files/6534_employment_and_economic_benefits_of_transmission_infrastructure_investmt_pfeifenberger_hou_may_2011_wires.pdf.

104 D. McCarthy and M. Virginia Olano, "The US climate law is fueling a factory frenzy. Here's the latest tally," Canary Media, August 2023, https://www.canarymedia.com/articles/clean-energy-manufacturing/the-us-climate-law-is-fueling-a-factory-frenzy-heres-the-latest-tally#:~:text=Here's%20the%20latest%20tally&text=In%20just%2012%20short%20months,80B%20in%20private%20investment.

105 P. Carry, "Dominion scrambles to meet soaring power demand," Prince William Times, August 2023, https://www.princewilliamtimes.com/news/dominion-scrambles-to-meet-soaring-power-demand/article_f475db14-1215-53d9-8130-cb3f83d254cd.html.

106 E. Gimon, "Full industrial electrification could more than double US power demand. Here's how renewables can meet it." Utility Dive, May 2023, https://www.utilitydive.com/news/industrial-electrification-renewable-climate-energy-innovation/651572/.

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