Research

The Cost of Upgrading Electricity Transmission

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Executive Summary

- The Biden Administration's goal for the United States to generate 100 percent carbon pollution-free electricity by 2035 will require significant modifications to the transmission system.
- Congressional Democrats' Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act sets the same goal while providing more policy specifics, and while the bill includes proposals to improve the planning and permitting of transmission facilities, it would do little to expedite the development of transmission facilities.
- The construction of new transmission facilities would cost an estimated $314 to $504 billion in capital costs on top of the estimated $1.8 to $2.1 trillion in new generation costs necessary to attain the 2035 goal, leading to higher bills for consumers.

Introduction

The Biden Administration has committed the United States to generating carbon pollution-free electricity by 2035.[1] Achieving this goal will require the country to invest an unprecedented amount in generation infrastructure, and it may require the widespread use of technology that the power sector in the United States does not yet employ commercially, as discussed in earlier American Action Forum (AAF) research.[2] But new generation facilities are not enough. The development of carbon-free generation necessitates modifications to the transmission system to accommodate not only the projected increase in demand, but also the distributed and intermittent nature of renewable resources.

This analysis builds upon the prior research, which estimated the generation cost to meet the 2035 goal, by estimating the transmission cost incurred to serve the potential generation resource mix. Like the prior research, it relies on the provisions of congressional Democrats' proposed Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act to provide policy pathways to achieve the Biden Administration's goal, as this bill shares the same 2035 goal but provides more policy specifics. The analysis finds that, as with new generation, transmission investment would need to increase dramatically, approximately $500 billion in total, in coming years to support the shift to a carbon pollution-free electricity sector. Further, while the CLEAN Future Act includes provisions that attempt to address issues involving planning and permitting, these preliminary steps take years and involve multiple agencies and levels of authority. This Russian nesting doll of interconnectedness and authority poses a hurdle to federal involvement, and the CLEAN Future Act's years-long efforts to improve agencies' years-long processes are unlikely to support meeting the administration's 2035 goal.

Transmission Development

Transmission lines—which connect states, utilities, and system operators—are typically planned by state regulators or independent system operator/regional transmission operators (ISO/RTOs) and permitted by states. State public utility commissions engage in planning processes with utilities whose service areas are located within the state to ensure consistent and adequate delivery of electricity. Similarly, independent system operators/regional transmission operators (ISO/RTOs) engage in planning with the utilities that have chosen to participate. According to the Federal Energy Regulatory Commission's (FERC) Order 1000, utility transmission providers "must participate in a regional transmission planning process that…produces a regional transmission plan; Local and regional transmission planning processes must consider transmission needs driven by public policy requirements established by state or federal laws or regulations…;"[3] In short, modifying a transmission system involves several agencies at multiple levels of government.

Transmission projects involve three elements: a spur (the transmission line that extends from a generation facility), a point of interconnection (POI), and the existing bulk transmission system. "Generation project developers typically incur costs for spur and POI investments. Generators might also incur network-upgrade costs if an interconnection study identifies necessary bulk system expansion. However, a generation project developer typically will not incur costs from projects developed via the transmission planning process."[4] The interconnection of new generation facilities, however, further complicates the planning of the transmission system as a whole.

While all three elements may exist upon completion of construction, a facility cannot simply begin operating and introduce electricity to the grid. Generally, generation projects enter an interconnection queue where the system's managing authority, whether it be the local utility or the ISO/RTO, determines a facility's impact on the existing system through a series of studies. At the end of 2020, over 755 gigawatts (GW) of generator capacity and 200 GW of storage were in an interconnection queue in the United States awaiting approval. Most of the capacity (~680 GW) is produced by renewable energy sources. In 2019, for example, about 24 GW of [5] Only 24 percent of projects that enter the queue will begin operation, however, because most projects are withdrawn. And the duration of time spent in queues "increased from ~1.9 years for projects built in 2000-2009 up to ~3.5 years for those built in 2010-2020," according to one study.[6] A majority of projects that enter the queue are not constructed because developers submit projects as they are planned in order to reduce wasted time before a facility's in-service date, and many prove unviable before they are constructed.

Carbon-Free by 2035

The Biden Administration committed the United States to produce electricity that is 100 percent carbon pollution-free by 2035 in its submission to the United Nations in accordance with the Paris climate agreement. To accomplish this goal, all existing fossil fuel-fired generators would be retired or alternatively, those that are still cost effective to operate would be outfitted with carbon capture technologies. Additional renewable resources, battery storage, and nuclear generation would be developed to meet the demand for electricity. Analysis of this goal found that it would cost approximately $2 trillion. Due to the relatively remote locations of renewable resources, however, the success of this transition rests on the expansion and modernization of the transmission system to bring carbon-free electricity to population centers.

Like the earlier research focused on generation development, this analysis uses the provisions of the CLEAN Future Act to provide a policy roadmap. The Act includes a four-part "national policy on transmission," which states that (1) the planning, siting, permitting, and operation of an electricity transmission system should facilitate the development of a decarbonized electricity supply and reductions in greenhouse gas emissions; (2) demand-side and supply-side technologies should be considered in developing the new grid; (3) overcoming regulatory and jurisdictional barriers to cost-effectively deploy clean energy resources is in the public interest; and (4) the Department of Energy, the Federal Energy Regulatory Commission, other relevant agencies, and national laboratories "should facilitate and advance cost-effective investments in the Nation's electric grid system, including the bulk electricity transmission system" by accounting for a broad range of quantifiable benefits of decarbonizing the electricity sector, promoting cost-allocation accounting methodology that allocate cost based on the benefit of regional and interregional transmission solutions, and prioritizing such solutions.

These policies attempt to address several outstanding issues in the development of transmission in the United States. First, bringing new transmission facilities into operation by planning, siting, and permitting takes many years, as demonstrated by the complex process outlined above. Second, interstate transmission lines benefit geographically disparate stakeholders, such as wind farms in the Great Plains and consumers in the Midwest, leading to complex interstate cost allocation. Third, demand-side technologies create additional complexity in infrastructure development by altering the traditional flow of electricity throughout the day, which is already complicated by renewable resources' intermittent nature.

"National Interest" Now "High Priority"

The CLEAN Future Act reinvigorates the National Interest Electric Transmission Corridor (NIETC) program as the High Priority Interstate Transmission Corridors (HPITC) program.[7] Section 216 of the Federal Power Act (FPA) calls on the Secretary of Energy to designate NIETC to expedite the construction of electric transmission lines. The NIETC was signed into law as part of the Energy Policy Act of 2005 and granted the Federal Energy Regulatory Commission (FERC) the ability to expedite transmission permitting in the corridors.

The Department of Energy (DOE) conducted a study to determine which regions to designate and in 2007 concluded that the Los Angeles and New York metropolitan areas both experienced congestion and were designated NIETC. A variety of groups jointly sought to prevent the imminent construction of transmission lines in the NIETC due to the eminent domain authority granted to the FERC by challenging the implementation of the program. The designations were found to be "arbitrary and capricious" by the Ninth Circuit because DOE failed to complete environmental review under the National Environmental Policy Act (NEPA). As a result, no transmission projects benefitted from the FERC's expedited permitting under NIETC.[8]

The ruling indicates that NEPA review would be completed in designating the now-named HPITC. The changes to NEPA review made by the Trump Administration to reduce its complexity are undergoing review by the White House Council on Environmental Quality, which suggests that the Trump Administration's rule will be amended. As a result, the Biden Administration has extended the period during which agencies consider the institution of new NEPA processes by two years.[9] Should the HPITC become law it will likely be subject to the existing NEPA standards that result in years of review.

The amendments to Section 216 that would result in HPITC have been proposed due to concerns regarding capacity constraints and congestion on the electric grid. In particular, they aim to address the difficulties in connecting the growing number of renewable resources, which are often located in remote areas, to the grid. The proposed amendments include the addition of congestion “with a particular focus on the integration of renewable energy resources” to the conditions qualifying a region for designation. In addition, the proposed amendments expand the scope of regions that may be designated by not only applying to those that are currently experiencing capacity constraints and congestion but also to those that “could be used to improve the integration of renewable energy resources.” This language broadens the DOE’s reach in designating regions as HPITC.

The proposed legislation maintains the FERC’s ability to exercise eminent domain to take possession of land if the transmission developer fails to secure an agreement with the landowner in the HPITC. With the Supreme Court’s recent decision in *Penneast* to uphold the FERC’s power of eminent domain when permitting natural gas pipelines, the agency’s ability to exercise eminent domain for transmission projects in the face of state disapproval appears to be strengthened.[10] As a whole, the amendments to NIETC resulting in HPITC may not expedite the construction of transmission lines for several years, but they ultimately give the federal government increased authority in their siting.

Agency Actions

The bill calls for the FERC to produce a report for Congress, create an Office of Transmission, create a transmission siting assistance program, hold technical conferences, and initiate rulemakings. The FERC would report to Congress on its efficacy in promoting the development of new transmission technologies. The newly formed office would review regional and interregional transmission plans submitted by utilities. Technical conferences would focus on reviewing the processes for regional and interregional planning. As a result, rulemakings would follow to address transparency in regional planning and cost allocation in interregional planning.

These provisions of the CLEAN Future Act would bring attention to transmission issues throughout various parts of the FERC. The duration of rulemakings and programmatic shifts within the agency, however, would not leave industry with any more clarity on the administration’s policies for years to come.

Analysis

The Energy Analysis and Environmental Impacts Division of Lawrence Berkeley National

Laboratory conducted an analysis that relied on various methodologies to calculate the levelized cost of transmission, "Improving estimates of transmission capital costs for utility-scale wind and solar projects to inform renewable energy policy." To determine capital costs, the analysis compared the results of "interconnection studies, actual transmission projects, capacity-expansion simulation models, and aggregated U.S. VRE [variable renewable energy]-related transmission expenditures. Each approach possesses advantages and drawbacks, and combining the approaches lends confidence to the results. The resulting range of average levelized VRE transmission costs is $1–$10/MWh, which is generally lower than earlier estimates in the literature. These transmission capital costs can increase the direct plant-level levelized cost of VRE by 3–33 percent, based on levelized costs of energy of $29–$56/MWh for utility-scale wind and $36–$46/MWh for utility-scale solar."[11]

This analysis relies on these values and applies them to the findings of the preceding generation analysis. To account for the additional cost borne by generators to construct transmission equipment, the estimated generating capacity of wind and solar resources will be elevated by 3-33 percent. The costs of transmission construction are calculated by adding an additional $1-$10/MWh for each new MWh (megawatt hours) of electricity generated.

This analysis does not account for a specific length and voltage of the transmission lines to be constructed, their location above or below the ground, or whether they will be constructed in existing rights of way. It also does not incorporate considerations of redundancy and resilience of facilities. Due to the unknown duration of designating HPITC, as well as the FERC's rulemaking, any benefits that could be associated with these programs are not included within the analysis.

Findings

The previous AAF analysis of generation costs found that meeting the demand for electricity in the future while transitioning to a zero-carbon pollution electricity sector would cost at least $1.8, if employing carbon-capture technology, or $2.13 trillion if shifting entirely to renewable energy. These costs, which are composed of overnight capital costs and operations and maintenance costs, can be expanded further by accounting for additional years of operations and maintenance costs beyond the one year assumed. Transmission costs were not associated with battery capacity because it is assumed to be co-located with wind and solar resources, suggesting the estimated cost would likely be higher.

When the values provided by the Berkeley Laboratory study were applied to the carbon capture scenario and the entirely renewable energy scenario, they resulted in two separate ranges. In the carbon capture scenario, costs associated with transmission would be as much as $314 billion. In the fully renewable scenario, costs associated with transmission would be as much as $504 billion. When comparing the two scenarios, the lower costs associated with the installation of carbon capture on existing combined-cycle natural gas generators can be associated with continued reliance on existing transmission facilities. These values would be increased by accounting for the increased capital costs created by new transmission lines associated with nuclear, geothermal, and hydroelectric power, which are a relatively small portion of projected new generation and are not included. In addition, litigation will drive up costs as impacted communities raise concerns about environmental impact and safety.

On an annual basis, up to $188 billion would need to be invested in both generation and transmission capital during the next 14 years. This value does not reflect the operations and maintenance costs of existing facilities, nor the operations and maintenance costs associated with the newly constructed facilities. According to the Edison Electric Institute, in 2020 utilities spent $132.7 billion on capital expenditures, which "include new renewable generation, new gas-fired generation, gas pipeline upgrades, electric transmission and distribution modernization and expansion, smart-grid deployment, and reliability-related network hardening" rather than simply transmission.[12] The inclusion of costs associated with distribution system development would drive up the value produced in this analysis beyond what is already a 40 percent annual increase in investment.

The cost of transmission infrastructure, whether it be allotted to the generator or the utility that operates the transmission lines, would inevitably be felt by consumers in their utility bills. Capital costs as well as operations and maintenance costs, while subject to the state's ratemaking and the utility's debt, equity, and interest rate on the project, would inevitably increase consumer bills.

Conclusion

Congestion and interconnection issues have proven to be increasingly challenging to the development of clean energy infrastructure, and the policies proposed in the CLEAN Future Act in an effort to reach 100 percent carbon pollution-free electricity by 2035 do little to expedite the construction of transmission lines in the short term. They do, however, result in increased costs to consumers that will only be exacerbated by difficulty in bringing new generation online.

[1]
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[2] https://www.americanactionforum.org/research/the-cost-of-clean-generation/

[3] https://www.ferc.gov/industries-data/electric/electric-transmission/order-no-1000-transmission-planning-and-cost

[4] https://eta-publications.lbl.gov/sites/default/files/td_costs_formatted_final.pdf

[5] https://www.eia.gov/electricity/annual/html/epa_04_06.html

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