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CROSSED WIRES

A Salata Institute-Roosevelt Project Study of the Development of Long-Distance Transmission Lines in the United States

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Preface

The Roosevelt Project launched in 2017 to address the challenges facing workers and communities as our economy decarbonizes and our energy and industrial systems undergo substantial related change, ideally at a rapid pace compared with past major societal transformations. How do regional economies adjust to the decline of a key industry? What happens to the workers in those industries and those in the surrounding economies? How can regional, state, and federal governments anticipate and adapt to industrial decline and to the invention of new industries? What is the role of civil society, foundations, unions, colleges and universities, national labs, and other institutions in helping "energy communities" gain from the clean energy transition? The American experience offers rich and instructive cases of success and of failure in societal transformation that can help the United States – and others - navigate the changes in our economy that will come with evolving energy systems.

The Roosevelt Project stands on three pillars – economy, environment, and equity. These are exemplified by the namesakes of the Project: Franklin Delano Roosevelt's presidency saved the American economy from collapse during the Great Depression; Theodore Roosevelt's presidency recognized and protected the natural wonders of the American continent; Eleanor Roosevelt was an unwavering champion of social equity and justice. These are the lenses through which the Roosevelt Project has examined the societal implications of the clean energy transition.

The Roosevelt Project has conducted three waves of inquiry into equitable energy and industrial transition. The first phase looked at the history of such transitions in the United States in order to provide a foundation of lessons learned. The second phase examined four places in the United States that are facing uncertainty as the energy system changes. The third phase, of which this report is a part, analyzes large-scale changes that are needed in critical areas of the economy.

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This study is one of three investigations into the challenges and opportunities in critical parts of the American energy sector: long-distance electric transmission, strategic metals and minerals, and low-carbon steel. Each presents key infrastructure and industrial challenges that must occur for the United States to take full advantage of the nation's low-carbon energy resources.

- **Grid:** A significant expansion of long-distance transmission capacity is needed to connect remote wind and solar resources to major urban and industrial users and represents an important part of the solution to meeting major electrification demands of the new economy.
- **Minerals:** Electrification of transportation, steel, buildings, and other end uses (such as AI-driven data centers) will require expanded access to critical minerals, such as lithium, cobalt, nickel, copper, rare earths and many others. Extraction and processing of these minerals present environmental challenges, including for frontline communities and tribal lands.
- **Steel:** Decarbonizing steel has proved difficult and slow. Solutions will need integration of community, workforce, competitiveness and trade priorities.

We hope that the Roosevelt Project will continue to inform the debate about simultaneously advancing social equity and the clean energy transition.

Ernest J. Moniz

Cecil and Ida Green Professor of Physics and Engineering Systems Emeritus, MIT
13th U.S. Secretary of Energy
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Executive Summary

To meet growing electricity demand, the United States will need to increase the capacity of its long-distance transmission lines by 25 percent over the next two decades. Taking full advantage of wind, solar, and hydroelectric power resources will also require doubling the nation's network of long-distance transmission lines. Meeting these targets will allow the United States to capture the economic potential of these resources and decarbonize its energy system.

This study and its companion, *Four Case Studies of Long-Distance Transmission Development* [1], examine the regulatory, political, and social factors that shape long-distance transmission development. Our aim is to describe how transmission lines are planned, permitted, sited, and built in the United States. Drawing on these insights, we identify ways to improve transmission development so that the nation can meet its electricity goals in a way that is attuned to the needs of American communities, the environment, and our national economy. **We highlight five core findings:**

1. The United States needs a national vision and coordinated plan, akin to Eisenhower's interstate highway system, to guide long-distance transmission development. Such a vision can direct federal planning initiatives and make plain the broader economic and environmental opportunities at stake.

2. Current planning, permitting, and siting processes are insufficient to meet national needs in an appropriate time frame. Multi-state transmission lines often take a decade or more to progress from the initial proposal to the final set of permits. This long lead time means it is highly unlikely that electric grid development will keep pace with growing electricity demand or increasing environmental pressures.

3. Regulatory obstacles make it difficult to obtain permits in a timely manner. Long-distance transmission projects that span state lines face a fragmented regulatory process across multiple jurisdictions. In many cases, long-distance transmission lines benefit places far from where they are located, leading state public utility commissions to discount much of the benefit of new transmission lines.

4. Public engagement in the planning and siting of long-distance transmission lines happens too late in the process. This limits the ability of companies to learn from communities and receive public input about the design of transmission lines. Companies and state governments can address this problem, but it will require changes to how they approach and engage with impacted communities and the broader public.

5. There are significant economic benefits to building long-distance transmission lines that tap into the nation's considerable wind and solar energy potential. Such development can help reduce energy costs, decarbonize existing industries, and allow new industries, especially electricity-intensive high tech, to flourish.

[1] [Forthcoming]. Four Case Studies of Long-Distance Transmission Line Development. A Salata Institute Report, Harvard University, 2024.

Recommendations

1. The national government should advance a common vision for transmission infrastructure development that articulates the collective economic, health, and social implications of a new electric grid.

2. Development in a federal system is challenging. Interstate and inter-regional lines are needed, but permitting, siting, and planning are usually done within states. The Federal Energy Regulatory Commission or Congress should reform regional and interregional transmission planning processes to align with the vision advanced by the national government.

3. Companies should treat communities and local land holders as partners and engage with them as early as possible—perhaps even in the design stage of a transmission line—and maintain that engagement throughout a project's duration.

4. State governments should involve the public in setting goals for transmission development and establish public evaluation and assessment processes that include a broad set of stakeholders.

5. State governments should also provide a clearinghouse of information about proposed projects within their borders that includes basic facts about the location of powerlines, the surrounding environment and communities, economic and environmental costs and benefits, and other proposed locations.

6. The Department of Energy (DOE) should perform an assessment of the entire development cycle of transmission lines with the goal of (1) identifying where and how developments get stalled and (2) reducing project timelines without sacrificing environmental standards.

7. DOE and the National Renewable Energy Laboratory (NREL) should embark on a series of national-scale studies of the economic, environmental, and social implications of different grid technology choices, including collocation with existing infrastructure, above-ground versus buried installations, line capacity, optimization technologies, and inter-connections. Such a study will better inform local and state governments, RTOs, companies, and citizens about the nature of the choices we face.

8. Expanding interregional transmission requires significant financing. The US Congress should reconsider tax credits for transmission development, rather than just renewable energy generation.

9. Improving the long-term efficiency and resiliency of the grid will require ensuring we have access to next generation technologies and systems to support it. Legislators should encourage domestic production of grid technology components, such as transformers, and invest in higher education to train a new grid workforce.

10. Legislators should also explore the possibility of incentives for grid-related firms to partner with veterans' groups, community colleges and other educational institutions serving lower income communities, and a broad range of civil society institutions to create pathways for enhancing the diversity of the grid workforce. The Bureau of Labor Statistics (BLS) should keep detailed records of specific employment and wage data for grid-related occupations to better inform policy and training programs.

Introduction

The electricity grid in the United States stands as one of the great success stories of the nation's industrial development in the 20th Century. Over the course of the past 100 years, the grid developed from uncoordinated networks of wires in just a few cities into a highly reliable system that delivers electricity to nearly every household in America, as well as supporting commercial, manufacturing, and industrial sectors of the economy. At the beginning of the 21st Century the electricity infrastructure of the United States must be renovated and expanded substantially to meet growing demand and maintain reliability and low prices. More important still is the need to reduce greenhouse gas emissions dramatically and quickly over the next 25 years, and that may require doubling or tripling the capacity of the electric grid.

Reducing greenhouse gas emissions will require fundamental restructuring of the US electric grid because the areas of the continent with the highest capacity to generate electricity using wind, solar, and dams are far from the industrial and urban centers. These changes in the scale, location, and configuration of the electric grid will bring social and political conflict. The choice of wind or solar power located far from existing industry or cities means that the US will favor the firms that operate those distant generators over local powerplants, which in most cases operate using natural gas or coal. Approximately 200,000 people work at electric powerplants fueled by coal or natural gas, and most of these are relatively high-paying, unionized jobs.[i] Of course, there will be new transmission, wind, and solar jobs created, but not in the same locations. Companies that operate existing powerplants and people who work at those powerplants will, naturally, oppose proposed changes. Building a new network of long-distance transmission lines that connect areas with high potential wind and solar generation requires traversing thousands of miles of land – farmland, tribal land, rural communities, and ecosystems. Even groups that are sympathetic to the decarbonization effort find the scale and extent of these long-distance transmission lines difficult to accept.[ii]

This study examines the legal and political institutions and the social context within which transmission lines are built in the United States, and the challenges that an aggressive expansion of the grid face. We focus on one aspect of the grid: long-distance transmission lines. Several recent studies – specifically, the Department of Energy's National Transmission Assessment of 2023, the National Renewable Energy Lab's 2023 Transmission Study, and Princeton's Net Zero Study – offer a technological road map for different ways that the United States can develop its long-distance electricity transmission system to help the US meet energy and climate goals. The scale of development called for in the DOE, NREL, and Princeton assessments is ambitious, but not impossible. These studies are the starting point for this inquiry. They lay out a picture of *what* the future electricity transmission system might be.

This study examines *how* we get there: the process for developing, scrutinizing, and approving long-distance transmission lines. We examine, side-by-side, the regulatory, economic, and social challenges that arise with the development of long-distance transmission lines. These different layers and aspects of long-distance transmission lines speak to one another, though they are often analyzed in isolation. The first chapter of this study lays out the institutional context of grid development and, in broad terms, the technical architecture envisioned by DOE and NREL. The second chapter lays out the existing regulatory landscape that will govern the planning, siting, and permitting of such an infrastructure development. The third chapter examines the economic benefits of developing a grid that meets Net Zero goals and considers possible workforce and supply constraints. The fourth chapter explores the role the public may have in the creation of a 21st century electricity system in the United States.

It is evident to us that the current, fragmented processes for developing long-distance transmission lines are out of alignment with national energy and climate goals. Transmission projects around the country today have taken at least 15 years to get from the design stage to the final project approvals. That is simply an unreasonably long lead-time. Reform of the process should follow a simple goal: shorten development times from 15 years to 10 years, or perhaps 7 years, without sacrificing equity or environmental standards.

The essential lesson of this study that local communities and the public broadly should be treated as a partner in the development of new electric transmission infrastructure. In tandem with this study, we have explored transmission line developments in four different areas of the country. These states and locales are currently grappling with the challenges presented by developing long-distance, high-capacity transmission lines. Three of these cases are specific transmission lines: (i) the New England Clean Energy Connect (NECEC) powerline in Maine, (ii) the Grain Belt Express powerline extending from Kansas to Indiana, and (iii) the Gateway West powerline connecting Wyoming to eastern Oregon. One case study examines an alternative process: the Texas Competitive Renewable Electricity Zone (CREZ). All four cases involve very different developers and very different strategies taken by those developers to build long-distance transmission. In all four cases, the marginalization of community and public preferences fueled opposition and delayed the process. We draw lessons from these cases, especially in developing recommendations for how to improve public engagement in the permitting and siting processes.

CHAPTER 1

Institutional Context and Architectures of a Future Grid

The US electricity grid is a complicated technical, economic, and political system. Technically, the grid consists of transmission lines, substations, transformers, and storge that link power plants generating electricity to end use consumers. Economically, the electricity grid is managed by companies that buy and sell electricity for delivery to consumers. Many states participate in competitive wholesale markets for electricity in which load-serving entities (usually a local utility) buy power from generators; some states are served by a monopoly firm that owns generation and transmission. Politically, the electricity grid is the product of and is constrained by thousands of different organizations that make decisions regarding its development and operation, including public utility commissions (PUCs), state legislatures and agencies, Regional Transmission Organizations (RTOs), and the Federal Energy Regulatory Commission (FERC). All of this is nearly invisible to the over 140 million households and millions of companies who get their electricity at the flick of a switch.

For all its complexity, Americans are generally happy with the existing electricity system in the United States. In a survey conducted by YouGov for this report, 80 percent of the public rated the electric grid as excellent or good. It is the highest rated infrastructure system in the United States, more highly regarded than our highways, airports, water and sewer systems, and even the internet. Americans' satisfaction with the existing electricity grid reflects the remarkable success of the system to deliver electricity reliably, nearly everywhere across the continent, at reasonable prices. That success reflects the value of long-run planning and development and reforms that have improved the efficiency of the system. Simply put, we are reaping the benefits today of the over development of powerlines in the 1950s to the 1970s and in institutional and market reforms in the 1990s and 2000s.

The United States electric grid, however, is at an important juncture. First, we are approaching the limits of existing transmission capacity. The National Renewable Energy Laboratory (NREL) projects that the US needs to increase its electricity generating capacity at least 25 percent by 2050 simply to meet rising demand. [iii] Second, we now face a new challenge. Substantially reducing greenhouse gas emissions in the US economy -- potentially, achieving a Net Zero economy by 2050 -- requires decarbonizing electricity generation itself *and* expanding the electric grid to facilitate decarbonizing transportation, industrials, and other sectors. [iv] That may require doubling or tripling US long-distance transmission capacity.

I. Institutional Architecture

The electricity transmission system of the United States is nested within economic and political institutions that determine who can build what, where, and why.

A. Industrial Organization

Historically, the US electricity system consisted of local and regional utilities that provided all power in a given area. Usually, these monopolies were vertically integrated, owning generation, transmission, and local distribution. In order to provide reliable service, these local monopolies often had to over develop infrastructure, leading to large amount of excess capacity, which still might not be enough to meet peak demand. Up until the 1980s, nearly all electricity was provided through such monopolies.[v]

Restructuring of state and federal electricity markets, especially the creation of regional electricity markets, radically altered the economic and political institutions through which electricity is distributed. Starting in the 1990s, the Federal Energy Regulatory Commission (FERC) issued a series of orders that opened utility-owned transmission lines to competing power plant developers and allowed for the creation of interstate power markets. New regional transmission organizations, formed by utilities, administer these markets and plan transmission expansion across their territories.

Over time, six regional markets have been formed under FERC's rules and subject to FERC regulation. These are California Independent System Operator (CAISO), Independent System Operator of New England (ISONE), Midcontinent Independent System Operator (MISO), New York Independent System Operator (NYISO), PJM Interconnection, and the Southwest Power Pool (SPP). In addition, Electric Reliability Council of Texas (ERCOT) operates most transmission in Texas and is regulated by the state of Texas.

Not all utilities joined the RTOs. Outside of the six RTOs and ERCOT, there is no entity responsible for the markets, and there is not a centralized market either. These other markets are the Southeast, the Northwest (Idaho, Montana, northern Nevada, Oregon, and Washington), and Southwest (Arizona, southern Nevada, New Mexico, and Utah). In general, each region is served by vertically integrated utilities. The Southeast Market is dominated by Southern Company and the Northwest by PacifiCorp. Even still, in two-thirds of the country today regional markets and transmission are administered by an RTO.

One of the largest issues for the next phase of grid development is inter-regional connections. We have not one grid, but several regional grids. Each region engages in its own planning process and manages its own market. Both the technical and institutional boundaries of the grid limit the efficiency of the grid to operate as a truly national electricity system and market. The results are higher prices for consumers and diminished reliability, especially when there are severe weather events that increase consumer demand and disrupt the supply of power. The lack of interconnections is a massive restriction on the nation's ability to develop a new electricity grid that links western solar and midwestern wind resources to the eastern grid.

Building sufficient transmission capacity and improving interconnections across the regional boundaries are essential for improving the stability, capacity, and competitiveness of the regional markets. Current inter-regional planning efforts are in their infancy and need to be scaled up to meet projected demand increases and net zero goals.

B. Politics of the Development Process

Each RTO has its own decision-making and planning processes, and distinctive cultures. By all accounts, the utilities remain the central players to the RTO process. Our interviews have suggested that the utilities try to protect their market share in the RTO arena. New long-distance lines can reduce the profits of the incumbent utilities and generators. The utilities often make it hard for new entrants, and, when a change in the market is coming, they use their position with the RTOs to insulate themselves. For example, a merchant firm that owns an inter-regional line may have to pay for upgrades to utility-owned assets that are needed to accommodate the merchant project. For utility projects upgrade costs are shared across the region. That distinction affects how the merchant is treated in determining who pays what (cost allocations), which in turn affects whether lines get built in the first place.

The tensions between states are evident in public meetings about transmission siting. The policies of one state can become a source of resentment in the other. A case in point is the NECEC line in Maine. This line would connect hydro power from Hydro-Quebec to a connection in Lewiston, Maine. The state of Massachusetts put out an RFP to build the line in order to access hydro power to meet it greenhouse gas goals. Opposition to the line before the Maine state legislature and the Maine PUC, as well as discussion of the project within ISO NE, highlighted the out-of-state initiative driving the line and concerns that Maine absorbed the economic, social, and environmental cost of a project that helps Massachusetts meet its greenhouse gas emission limits. These tensions among state interests within the regional markets are already present in planning discussions.

Over the coming decades, there will be a mismatch between the political process and the projected electricity development. Energy and industrial development necessarily create conflicting interests that must be worked through in the state legislatures, the state Public Utility Commissions, and the RTOs. However imperfect those processes are, the simple fact is that the boundaries of those institutions do not line up with the sort of development that is required to decarbonize the grid. The misalignment between the institutions and the projected development will make the process for planning, permitting, and developing long-distance electric transmission lines a complicated, expensive process.

The fact that a power line will have to go through many different institutions whose constituencies do not align with the powerline, and likely do not benefit from it directly, will create openings and opportunities for opponents to powerlines. In particular, the incumbent utilities and generators have a strong incentive to oppose any new entrants into their market. This should come as no surprise; companies are doing what they can to survive economically and to serve their own constituencies, the investors and shareholders who own their companies. In fact, they have a fiducial responsibility to maximize their profits.

Our federal system, however, stacks the deck against what we as a nation want to achieve: a more efficient, economical, reliable, and environmentally sustainable electricity grid.

There are two key pressure points in the political system that govern the development of the grid: (1) permitting, and (2) public engagement. Legal and regulatory delays in permitting are a critical source of delay. In some instances, lack of state government capacity (e.g., sufficient staff in the relevant offices to examine permits in a timely manner) is itself a source of delay. Fueling many of current legal and regulatory fights, though, is public discontent over the planning and development process.

Perhaps the most difficult nut to crack in this respect is the very first step in the process. The earliest stages of development are usually heavily focused on the engineering design and finance of a project. These early phases often do not include effective public engagement. As a result, new projects often come out of the design and selection process blind to potential objections from communities – and bereft of the kinds of relationships that can help in solving the inevitable problems that projects face.

II. Technical Aspects of Grid Architecture

The grid consists of both long-distance and local electricity systems. This study focuses on long-distance transmission. The long-distance systems are high voltage powerlines that move electricity from generators to urban areas and commercial and industrial facilities. The local portions of the system consist of substations, capacitors, local lines, and other technology that distributes electricity to consumers. There are also substantial opportunities to improve the efficiency, reliability, and cost of the local systems, such as smart grid technologies, and in doing so reduce greenhouse gases.

We take as given the assumptions of the most important studies of grid development, including the National Renewable Electricity Lab's (NREL) 2023 study *Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035*,[vi] the Department of Energy's *National Transmission Needs Study*,[vii] and Princeton Universities 2020 study *Net-Zero America: Potential Pathways, Infrastructure, and Impact*.[viii] These studies foresee the need for substantial build-out of utility-scale wind onshore in the Plains and offshore along the East and West Coasts and of utility-scale solar in the Southwest. The Princeton *Net-Zero* study further envisions substantial connections internationally between the US and Canada in order to access wind and hydropower. New wind, solar, and hydroelectric generating capacity would have to be connected to the largest urban areas and industrial centers of the United States using long-distance high voltage powerlines that cross state and even regional boundaries.

Decisions about long-distance transmission lines will have substantial implications for the scope and scale of the electricity systems in the United States.

Scope. Scope refers to the mix of generating technologies available. Much of the current electricity system in the United States was developed for fossil fuel and nuclear power generation. The location and configuration of existing transmission lines reflects the current generation portfolio. Decarbonizing the US electric grid requires a very different mix of generating technologies. Reports from NREL, DOE, Princeton, and other modeling exercises show a similar overall picture. The highest potential wind, solar, and hydroelectric generation are not close to urban and industrial areas. That means that the United States will need to develop a large number of transmission lines that integrate the electricity grid, that cross state lines and regional boundaries especially running east-west, and that are much higher capacity than existing powerlines. It is unknown how much of that additional capacity can be met by locating powerlines along existing rights of way (e.g., highways and railways) and the feasibility of burial of powerlines to ease public opposition.

One important near-term recommendation is that DOE and NREL embark on a series of national-scale studies of the economic, environmental (including land use and pollution), and social implications of different grid technology choices. Key factors in such a study include collocation with existing infrastructure, above-ground versus buried installations, line capacity, optimization technologies, and inter-connections. More continuous study of these dimensions of grid development will better inform local and state governments, RTOs, companies, and citizens about the nature of the choices we face.

Scale. Scale is the magnitude of projected transmission development. According to the US Energy Information Agency, the current electricity system consists of 7,300 power generators connected through more than 160,000 miles of high-voltage transmission lines that ultimately provide power to 145 million customers.[ix] There are millions of miles of low voltage powerlines inside cities and other power generation sources, such as small-scale solar.

How big is the task of building an electricity grid that taps the enormous wind and solar energy potential of the country? The *NREL 2023* and Princeton *Net-Zero* project that the United States will need to <u>double</u> or <u>triple</u> the size of its electricity grid. The *NREL 2023* report, for instance, projects that building a 100% clean electricity system will require 330 to 420 terawatt miles of interregional transmission capacity (depending on the scenario) compared to 161 terawatt miles today. Ultimately, the calculation of how many miles of transmission lines are needed will depend on the capacity of those lines, the directionality of the lines (one-way or two-way), the need for redundancy, and other engineering, design, and political factors.

The scale of grid development envisioned in the NREL, Net Zero and other projections will require a massive commitment of land. An assessment by the Samantha Gross of the Brookings Institution summarized existing studies and existing land utilization and concluded that renewable energy uses far more land than fossil fuels for every BTU of energy produced, and additional transmission built for wind and solar development would affect far more people and communities than does the location of existing fossil fuel generation. The right of way for transmission lines, according to the NREL study, is between 20,000 and 30,000 square kilometers (7,500 to 12,000 square miles). That is roughly the same footprint as the total land of all currently disturbed coal beds. It is only a fraction of the land used for livestock grazing and feed, which covers 41 percent of the land of the United States.

Land availability has substantial implications for the configuration, cost, and speed of development of electric power lines. The scale of land required for transmission and generation in a 100% renewable grid may create conflict with other activities that use the same land, especially agriculture. Currently, proposed long-distance powerlines are creating conflict between transmission developers and cattlemen and farming corporations in the Midwest, and these conflicts mobilize agricultural interests against powerline development, as arose with the Grain Belt Express line.

Conclusions

Building a new electricity grid on a national scale requires a clear vision of the project before us – akin to Eisenhower's vision of the Interstate system. Without such a vision, it is hard to justify why anyone would bear the burdens, displacement, and environmental damages associated with any given project that benefits some other community.

The institutional and technical architecture of the electricity system reveals three big pressure points for an expansive development of transmission lines in the US.

First, inter-state and inter-regional connections are weak. Decarbonizing the grid will require building an extensive network of national, inter-connected long-distance lines. The markets, the political organizations, and the lines themselves are not aligned to allow such development to proceed smoothly, if at all.

Second, an uneven pathway is hard to balance. This is most abundantly clear when a line runs through one state to serve the communities in another state. Inter-state rivalries arise and the state through which the line runs does not necessarily value any of the benefits that happen in the receiving state. We have no way currently of balancing the interests in two different states.

Third, public engagement is happening far too late in the planning and development process. That is fueling dissatisfaction, distrust, and opposition to developments. The next two chapters consider these matters in greater depth within the context of regional networks.

Utility Regulation and Permitting

Transmission development is driven primarily by investor-owned utilities (IOUs or utilities). IOUs typically expand the grid on a project-by-project basis based on a patchwork of industry-driven project evaluation methods, state permitting regimes, and federal environmental and land-use laws. The regulated project review process pushes utilities to pursue smaller projects that do not require industry collaboration and need fewer permits from government officials. Because Congress has never set transmission development objectives, such as expanding the system to meet clean energy targets, most development focuses on meeting short-term needs rather than achieving any long-term vision of our energy future.

There Is No Consensus about the Benefits of New Transmission

The legal architecture that governs nearly all transmission development was designed for IOUs, privately owned companies that have state-granted monopolies over electricity distribution to consumers. Historically, an electric utility built, owned, and operated all electric power infrastructure within its state-granted territory. States enacted laws in the early twentieth century that aimed to foster the industry's expansion while also protecting consumers from exploitation by utilities that enjoy the exclusive right to deliver power to local consumers. To varying degrees, states' utility laws have evolved over the past century, but the twin aims of promoting the power sector's development while also protecting consumers remain at the heart of the regulatory framework.

As applied to transmission development, public utility laws allow a utility or other developer to recover the costs of a new project through consumers' rates, as long as the project is needed to provide reliable and affordable service. To determine whether a transmission project meets that standard, industry and regulators apply benefit-cost analyses. But there is no agreement on the relevant benefits and costs. Across states and regional utility industry alliances, regulators and IOUs may subject a single project to numerous analyses that consider different benefits and beneficiaries and adopt inconsistent views on environmental impacts.

Industry-run transmission planning processes tend to focus on quantifiable benefits and costs that accrue to electricity consumers. These "in-system" benefits and costs are typically reflected in the prices paid by consumers. For instance, consumers reimburse utilities for project construction costs, plus a profit margin set by regulators, but those costs may be offset by lower power prices if the new transmission project enables delivery of cheap electricity. Transmission can provide other in-system benefits, including improved reliability and operational efficiency.

Many costs and benefits are not explicitly accounted for by industry because they are difficult to quantify or do not directly affect electricity system costs. For instance, new transmission can generate construction jobs and revenue for local governments, but it can also harm wildlife and impact local landowners. If these broader effects on society are considered at all, they may be accounted for by state regulators reviewing a permit application. In addition, for some projects, state and federal environmental and land-use agencies assess various impacts and may require additional permits. Their one-sided evaluations focus on potential harms without considering project benefits.

Projects that traverse multiple states must typically pass a benefit-cost test in the industry-led planning phase and then separate benefit-cost analyses in each state that permits construction of the project. In addition, the industry shares project development costs among utilities and other market participants in proportion to the benefits each party in the region is expected to receive from the project. That calculation may be premised on other benefit metrics and can trigger disputes among parties that want to reduce their share of regional project costs. Parties that oppose projects may seek to stymie their construction by protesting cost allocations at FERC and in federal court.

By contrast, some small projects contained within a single utility's footprint within one state are built without any government approvals or industry-run benefit-cost analyses. The stark difference in the level of scrutiny applied by industry and regulators to large-scale, multi-state projects as compared to low-voltage, single-utility projects pushes the industry to over-invest in small-scale projects.

Joint Transmission Development Among IOUs Faces Financial and Other Obstacles

Approximately 40 IOUs, with a collective market capitalization of about a trillion dollars, own most of the nation's high-voltage transmission. These utilities share a common business model that is designed to sustain their profitable monopolies over local power delivery. Regulated rates fund the IOUs' operations and provide a government-set profit margin on infrastructure spending. The ratemaking formula incentivizes IOUs to build transmission lines and other assets needed to supply power to consumers.

The incentive to deploy capital does not necessarily persuade IOUs to share transmission development costs. Dollar-for-dollar, small projects paid for by a single utility's ratepayers are less risky and more profitable than projects paid for by regional IOUs. IOUs typically earn the same profit margin for all transmission investments, regardless of their size or who pays. Moreover, the complexity and extent of the regulated transmission development process pushes utilities to favor single-state projects that do not require any utility industry coordination and need fewer permits from regulators. In this section, we explain how utility-run processes for planning transmission expansion and allocating the costs of new development bias IOUs in favor of a single-payer model where an IOU has unilateral control over project selection and financing.

Regulated planning processes are forums for utility disclosures about investment plans. State-regulated planning tends to focus on power plants, while federally regulated processes culminate in local, regional, or interregional transmission development plans. For all new investments, the utilities' primary objectives are to maintain sufficient infrastructure to meet consumer demand and increase their profits. Federal and state laws can add other goals, such as meeting environmental standards and renewable energy targets. While planning processes generally allow industry stakeholders to comment on utility proposals, public influence is limited by the highly technical nature of electric system planning and the utility's informational advantages. Regulatory oversight also varies widely, and in most planning processes utility discretion ultimately controls.

About thirty states require IOUs to periodically file plans for meeting forecasted consumer demand for electricity. Planning laws and regulations require IOUs to propose a portfolio of resources that can include new power plants, long-term contracts with third-party owned power plants, and conservation and efficiency programs that can reduce consumer demand. These exercises are primarily driven by the IOUs' proposed generation retirements and additions. Transmission investments typically follow generation decisions.

State planning processes do not approve specific IOU investments. Instead, planning considers only a rough approximation of in-system benefits and costs to construct an acceptable portfolio of power supply options and demand reduction programs. Planning processes are nonetheless important because a project's inclusion in a plan can be persuasive evidence in future rate cases or permitting proceedings that consider whether the project is needed to provide affordable and reliable service. State-regulated planning can be the first step in infrastructure development and the first venue where a new IOU transmission project is revealed to the public.

Unlike state regulators that typically review utility resource plans, FERC does not scrutinize transmission plans. Instead, FERC sets high-level planning principles, requires each utility or other transmission provider to file planning process rules consistent with those principles, and reviews those filings to ensure they comply with FERC's principles. For instance, FERC demands that planning meetings be open to industry stakeholders, that utilities accept feedback about their plans, and publish their final plans. But FERC does not follow up to ensure that compliance with these requirements results in efficient transmission investment.

Each IOU has complete control over the contents of its own local plan for development within its retail footprint. Regional and interregional planning are conducted by eleven FERC-approved regional planners that are either alliances of neighboring utilities or RTOs, non-profit entities that are responsible for ensuring reliable operations and planning transmission expansion across a region. Each regional planner uses different benefit-cost frameworks for advancing potential regional and interregional projects and sharing the costs of those projects among participating utilities and other parties. Under FERC's rules, regional planners must consider projects that improve system efficiency and meet state energy policy objectives.

FERC has not dictated how each IOU or each region should assess potential projects. At the local level, each utility sets its own criteria for defining local transmission needs. FERC does not evaluate each utility's local planning criteria or determine whether local investments benefit consumers. At the regional level, FERC reviews the benefit-cost methodologies that planners use to select projects, but FERC has not standardized the benefits or beneficiaries and does not review analyses of specific projects. As a result, regional planners have adopted diverse approaches to project selection.

Despite the obstacles to joint development, a few regions are successfully building new lines. With single-state RTOs, California and New York are able to align transmission development with their states' clean energy laws. Among the four multi-state RTOs, the Midcontinent Independent System Operator (MISO) stands out for its recent $10 billion plan to build high-voltage lines that will accommodate an increasingly renewable system. Elsewhere, individual states are developing transmission in the absence of effective regional planning. Massachusetts lawmakers initiated procurement of a line to bring Canadian hydropower into the region, New Jersey regulators worked with the PJM RTO to develop offshore wind transmission, and the Nevada legislature approved transmission expansions for solar and other clean energy.

Interregional transmission planning is more of a theory than a practice, as few interregional projects have advanced through regulated planning processes in the past decade. One obstacle is the so-called "triple hurdle" that demands potential projects pass three different benefit-cost tests. For instance, in two neighboring RTOs called MISO and SPP, a committee of staff from each RTO periodically recommends projects connecting the two regions. Once a project advances past that initial screen, a project must be approved separately by both the MISO and SPP regional planning processes. After clearing those three hurdles, the two RTOs must then agree on how to split the project costs between the two regions.

Despite vast differences in planning approaches across regions, all regional and interregional planning processes begin at the same starting point. IOU-planned local projects are taken as given and rolled into the higher-level processes. This bottom-up structure preferences each IOU's self-identified projects that it plans based on its own unregulated criteria. By starting the transmission planning process with a baseline of unreviewable IOU preferences, FERC-regulated planning allows local investment to obviate the need for a potentially more efficient large-scale solution.

Regional efficiencies benefit consumers, but IOUs may rationally favor local over regional spending. Unlike their own local projects, regional and interregional development can be scrutinized by RTOs or other parties that have an interest in ensuring projects are completed on time and on budget. RTO-planned projects have been cancelled during development because projected benefits dwindled in response to changing industry conditions. For the developer, cancellation can lead to unrecoverable costs, lost profit opportunities, and wasted resources.

Beyond the financial risks, regional projects may also have strategic downsides. In two-thirds of states, utilities build power plants, as well as local and regional delivery infrastructure. To protect past investments and future opportunities, IOUs may disfavor transmission projects that could benefit their generation competitors. Large-scale projects designed to enable new entry may be overlooked in industry planning processes, despite plausible consumer benefits.

Large-scale project development may also cause utilities to spend money without receiving any profits. The regional planning and cost allocation framework can force a utility to pay for its share of a project that is being developed by another utility or other company. While the developer profits from the project, utilities paying for the project only incur costs. Because paying for another developer's project is not profitable, utilities may oppose regionally beneficial projects. IOU resistance is particularly strong when FERC's rules require an RTO to choose the developer through a competitive process. Developer selection processes threaten the value of IOU monopolies and diminish IOU control over regional decisions.

The potential strategic and financial downsides of regionally planned projects explain why transmission investment has been concentrated in local projects. Local projects are self-planned and often small enough that they can evade regulatory scrutiny. Most IOUs can recover costs without a traditional rate case that would require the utility to demonstrate to regulators that its spending benefits ratepayers. In addition, many small-scale local projects, such as investments that refurbish or reconstruct existing infrastructure, are exempt from state permitting regimes.

A new "merchant" development model avoids many of the perverse incentives that lead IOUs to favor small projects. Merchant developers are not utilities, and they do not provide power directly to consumers or rely on government-set rates. Rather than funding projects through regulated rates, merchant developers negotiate transmission prices with energy buyers and sellers, such as power plants and utilities. This business model is premised on exploiting inefficiencies of interstate markets structured around IOU monopolies. Many merchant projects aim to connect markets, filling gaps left by ineffective interregional planning.

While a handful of merchant projects that move clean energy are under construction and several more are in development, there are no such projects yet in operation. Non-utility financing allows merchants to bypass utility-run planning and cost allocation processes, but merchant developers must navigate a technical process for connecting to the transmission network. Merchant projects wait years in interconnection queues, often behind wind and solar plants that also seek to connect to the system. Like new generators, merchant transmission projects can be saddled with extensive costs for upgrades to utility-owned infrastructure deemed necessary to accommodate their energy injections. Utilities' transmission projects do not face these delays or costs. Merchant projects must also receive state siting permission and pass other permitting hurdles.

State Permitting and Federal Environmental and Land-Use Laws Complicate Development of Large Projects

By the time a developer applies for construction permits, the project has accumulated significant momentum. It has advanced through the developer's own internal and perhaps multiple regulated planning processes and may have secured financing. The project's fate may now depend on whether it can receive construction permits and pass environmental reviews.

Unsurprisingly, large-scale projects typically require more reviews and approvals than single-state projects located within a utility's local footprint. Projects that traverse multiple states need at least one permit from each state. In addition, projects that cross wetlands, navigable bodies of water, federally owned land, or other areas regulated by Congress or that receive federal funding may need federal permission. Various laws, including the National Environmental Policy Act (NEPA), Endangered Species Act, and Clean Water

Act, outline the scope of review and may set the parameters for approval.

In most states, transmission proposals are reviewed by utility regulators who consider whether a proposed project is "needed." The paradigmatic example of "need" is the utility's expectation that consumer demand will grow, and that existing infrastructure is insufficient to meet that growth. States have found that new lines may also be needed to meet other objectives, such as reducing energy prices, improving reliability, and meeting clean energy goals. State reviews tend to emphasize in-state benefits and costs and may overlook regional considerations.

State regulators' approval generally allows the developer to use eminent domain to acquire land for construction and for hosting infrastructure. In an eminent domain proceeding, a state court or other state body determines the "fair market value" of the property that the developer intends to take. Developers generally prefer to avoid litigation and will negotiate privately with landowners prior to initiating an eminent domain process. Landowners who do not agree to sell can challenge the premise of the taking by, for instance, arguing that the transmission line is not a "public use" that can trigger eminent domain authority under Constitutional law. Historically, only a few courts have held that transmission moving energy out of state does not meet the public use standard. As our power systems have become increasingly interconnected, that argument may be harder to make. Landowners may have better odds of challenging the amount of compensation.

Developers may need additional permits from state agencies to cross state-owned land or due to a project's specific impacts. Each of these regulatory processes opens an opportunity for public involvement and can lead to litigation or political pushback. A handful of states carve out roles for municipalities or counties in the permitting process, although statewide agencies have all authority in most states. Finally, states tend to exempt replacement projects from permitting requirements or provide expedited proceedings for projects below a certain threshold. The state's regulatory retreat incentivizes IOUs to rebuild their existing transmission assets.

Transmission projects that impact land or resources regulated by Congress may need permission from federal environmental and land-use agencies. Federal reviews are more common for projects located in the Western United States where nearly half of all land is owned by the federal government. Transmission projects crossing federal land can require approvals from numerous agencies under multiple statutes that specify different approval standards. Each of these reviews includes public engagement and risks of legal challenges.

Federal laws can trigger consultation and review processes across federal agencies. The National Environmental Policy Act (NEPA) requires agencies to prepare an environmental impact statement (EIS) for any "major federal action significantly affecting the quality of the human environment." Between 2010 and 2021, 46 transmission projects required an EIS, and about a third of those EISs were challenged in federal court. Project opponents can also contest an agency decision not to conduct an EIS.

Conclusion

The regulatory framework for transmission development biases IOUs to consider each transmission project in isolation. While large-scale projects spend years navigating bureaucratic processes regulated by different agencies, smaller projects within the utility's local footprint often glide through abbreviated planning and permitting process with little scrutiny. Advancing a regional or interregional project requires garnering support from utilities that may disagree over a project's benefits, may oppose paying for another developer's project, and may prioritize protecting their own assets over claiming a share of a project's diffuse efficiency gains. Some utilities and other market participants may prefer that there be no regional or interregional development at all. Transmission opponents can object in multiple forums, including regional planning processes. FERC proceedings, permit reviews, and state and federal courts.

CHAPTER 3

Public Engagement

Long-distance transmission lines face intense public scrutiny. The extent and intensity of public scrutiny reflects the profound effects that powerlines can have on individuals and communities. Powerlines go through private property, tribal lands, and federal lands, and they can split communities and ecosystems. Lines can alter the ability of farmers, ranchers, and others who depend on the land as it currently exists to make a livelihood. They require clearing of land and development of easements, such as access roads, that become permanent features of the landscape. Larger transmission towers alter local aesthetics, which can change the meaning and value of not just one parcel of land, but an entire valley, prairie, mountain ridge, riverway, or coastline.

For developers, extensive public engagement and project delays can be costly. Developers must support debt on proposed projects, and, on top of that, they must pay costs associated with regulatory proceedings, legislative inquiries, and court cases. The potential for such delays and regulatory costs may, in turn, dissuade developers from even attempting to construct long-distance projects. For policymakers seeking to meet energy and climate goals, roadblocks to powerline construction act as a brake on the nation's ability to expand its electricity capacity and to decarbonize the economy.

The tension between the plans of developers and the interests of communities in the path of transmission lines is normal. The challenge is to improve the siting and permitting process to align better with the values of residents and communities throughout a region. Doing so, it is hoped, can improve public acceptance of transmission lines, and even make projects more cost-effective, easier to site, and faster to permit. As the work of Nobel Prize winner Elinor Ostrom, reveals, processes that allow wisdom from people and communities to emerge can lead to better, and often faster, infrastructure development.

Public and community engagement is complex and multi-faceted. It is difficult to capture the richness and entirety of this subject in any single chapter. To develop a fuller picture of the ways in which public engagement shapes transmission projects, researchers associated with Harvard's Salata Institute, in collaboration with the Roosevelt Project at MIT, conducted four case studies in different parts of the nation. These inquiries are presented in a companion study, entitled *Four Case Studies of Long-Distance Transmission Development*.

This chapter is organized into three parts. First, what problems arise for people, communities, and firms in the existing permitting and siting processes? Second, what are best practices for when and how people are engaged? Third, what are prescriptive lessons from our interviews with stakeholders in different transmission development projects?

Problems

Any proposal that affects large numbers of people or large swaths of land deserves careful attention to ensure that the development fits with public values and has minimal impacts on other people or the environment. The conflicts over energy infrastructure, however, often seem to spiral out of control, leaving people and firms frustrated with the outcomes.

From the firms' perspectives, the primary problem with the current permitting and siting process is delay. The projects in *Four Case Studies of Long-Distance Transmission Development* took roughly 15 years to get the relevant approvals and through the legal process. All left trails of public distrust in their wakes. In our case studies, public discontent was both a source of delay and a reflection of failures in the process through which projects were vetted.

Community leaders and activists criticized the public hearing process for these projects because it could not incorporate community concerns sufficiently into the design stage. Because public comment typically comes relatively late in the process, developers do not have the opportunity to learn from the community about problems that could provoke significant opposition. Approaching public engagement as an opportunity to learn about the best design of a project can, in fact, lead to better designs with fewer delays. Studies of collaborative decision-making in infrastructure design and siting have found that continuous engagement with communities and improved communication can speed up permitting and siting.[x] Achieving that, however, will require a change in the way in which companies approach communities.

Private citizens, landowners, and local town officials we spoke with repeatedly expressed problems with the basic process of public engagement. They said it often felt *pro forma* or distant from the concerns of the community. Many expressed frustration and, even, anger at the process, the developers, and state officials. Lying behind these concerns are problems of recognitional justice and procedural justice. These are not problems that can be addressed through compensation or redesign of the project. These are feelings of not being heard, of lack of respect, and of failure of the political process. Social scientists have long recognized that such feelings can sow distrust, and, eventually, political discontent and opposition.[xi]

Communities—however narrowly or broadly conceived—can play an integral part in developing long-distance transmission lines. Landowners, farmers, small towns, consumers, environmental groups, and other community voices all help inform how to develop transmission lines in a way that is appropriate to an area. The key questions are when and how developers engage communities in decision-making.

When and How Communities Are Engaged

It is often not immediately obvious how companies and governments ought to engage with local communities. Much of the regulatory apparatus around permitting and siting of infrastructure deploys a top-down approach to public engagement. A common mechanism is to hold meetings at government offices. People may show up to those meetings and express their concerns, and once those meetings have been held, the companies have satisfied the requisite public engagement. Such a format creates a cascade of problems: the location may not be convenient, very few people may attend, the time for commentary may be limited, or the format of the meeting may not elicit deeper engagement with the project. These meetings present the public with a proposal that often feels like a *fait accompli*.

Improving public engagement requires a different approach, one in which communities are treated as partners in developments. Organizations that work closely with communities have developed best practices that we think can help improve public engagement around energy infrastructure development. One example is the Lowlander Center toolkit.[xii] The toolkit is a guide to help communities define their values and lifestyles that may be threatened by climate change. It lays out a set of principles and objectives for the community. It begins with some of the most fundamental questions for a community, for instance, how does the community define itself? What are its boundaries, in both physical and cultural terms? What are its values? What are its goals? The toolkit offers resources that communities can use to work through these principles as they engage with external government agencies or firms proposing developments.

These questions can also help firms and governments understand the wide range of perspectives and communities that may be affected by a development. What are the communities in an area where development is planned? How are they defined? What are their values? *What does a successful infrastructure project look like to you?* The answers to these questions will vary considerably across communities and across certain segments of society.

Before building a project, developers should ask: *What does energy mean for this community?* Often this question is taken to mean the effect of the grid on the immediate location of the proposed transmission line. Grid builders must first understand their project's impact on an area visually, economically, and environmentally. An area may have historic or cultural significance that spans an entire valley or riverway. Discussions of aesthetics and placement should therefore be accompanied by a full understanding of the cultural and historical understandings of a site's significance.

The processes through which communities clarify their own interests and goals and through which companies and governments learn from communities takes care and time. With this in mind, we turn now to are view of some prescriptive lessons we draw from our case studies.

Prescriptive Lessons

There are five areas where public input and engagement can improve the development of transmission lines. These lessons draw substantially on our companion study: *Four Case Studies of Long-Distance Transmission Development.*

(1) Constraints on Development

State and federal governments impose constraints *a priori* on where transmission lines can be placed. These rules can also specify criteria that may be prioritized in the selection of projects. Such criteria include where and how lines are constructed. In all the case studies conducted in conjunction with this analysis, two constraints were repeated by multiple parties.

First, follow existing rights of way when possible. The most obvious approach is to build new power lines along corridors where transmission lines already exist or along highways and major roadways. This could involve increasing the capacity of existing lines or building additional powerlines along the same corridors. Second, install transmission lines underground. In every case, people disliked above ground lines for aesthetic and environmental reasons. The size of the towers and the width of the easements are significant sources of opposition. Many people we interviewed volunteered that they would not object to the developments if they were underground. Simply from the perspective of delay costs, then, burial seems like a wise option and a feature that might be required by a state.

Burial of transmission lines, however, is potentially very costly. New technologies hold the possibility of lowering these costs substantially, perhaps as low as above ground lines. Reducing costs would keep the impact of a new line on electricity prices to a minimum. The SOO Green HVDC Link buries cross-linked polyethylene transmission lines beneath rail tracks, reducing costs and taking advantage of existing infrastructure.

(2) Goal Setting

The starting point of any transmission project is identifying what needs or opportunities may be met by building a line. Such decisions reflect the judgments of engineers, corporate executives, and lawyers who are regulatory experts. Rarely is there a role for public input in setting forth what sort of project states and firms ought to develop at the outset.

The Texas CREZ process provides an interesting contra-point. In the mid-1990s, the state of Texas committed to building a gigawatt of generation and supporting infrastructure, such as transmission. The state and 8 utilities also decided to let the public inform them about what that ought to be. They conducted opinion polls and held a series of deliberative processes in which randomly chosen people (akin to a jury) listened to expert and firm reports about different technologies. This process led to a very strong and clear recommendation: develop wind in west Texas to serve the needs of the state. Although Texas only did this process once, the decisions it made have guided Texas energy development since. Texas now has an installed wind capacity of over 30 gigawatts. The lesson is simple: Engage the public to set broad goals for grid development. There are many different models of public engagement, from deliberative polls to participatory budgeting. They can be used by state PUCs or state and federal political leaders to map out what direction the public wants to go.

(3) Information and Trust

Public support (and opposition) for transmission projects is rooted in people's understanding of what the project is and how it will affect their community, economy, and ecology. Providing complete and readily available information about a project, then, is vitally important to establishing trust in a firm and in a project. This can be quite difficult, as it requires meeting with people in communities to show them the plans, often before they are approved by the PUC. It can be hard for people to find trusted information about a project, especially once the opposition to a project is mobilized.

Here we see an institutional failure. State governments should provide a clearinghouse for information about all proposed (yet to be approved, approved, and rejected) transmission projects. At the very least, such a clearinghouse would provide municipal governments, NGOs, and private citizens some way of gathering information about a project. The information clearinghouse can be funded through additional fees on developers proposing transmission lines, pipelines, and other infrastructure projects.

(4) Meaningful Engagement Throughout the Process

Perhaps the most difficult nut to crack is the very first step in the process. The earliest stages of development of a project are usually heavily focused on the engineering design and financing of a project and often do not include effective public engagement. As a result, new projects often come out of the design and selection process blind to the potential problems and objections from communities, many of which could have been addressed at an early stage of planning. What goes wrong?

Existing institutions and processes make effective public engagement even more difficult, if not impossible. There is a chicken and egg problem for public engagement at the beginning of the planning process. The early phase of development is ideal for public input, but before a plan is selected it is unclear on what the public should have input. And, once proposals are submitted to a PUC they are often difficult to alter substantially. Everyone we spoke with – local citizens, energy companies, RTO representatives – told us that the ideal would be to bring the public in early in the process. The RFP and planning processes are the problem, and it is tough to untangle that process in a way that allows for fuller public engagement.

(5) Limits on Public Engagement

The evidence that the process is not working is time itself. In the case of the three long-distance transmission lines we studied—Gateway West, Grain Belt, and NECEC—it has taken nearly 15 years to move from initial designs to final approval. These delays are not unusual.[xiii] Long, drawn-out permitting fights are exhausting for all involved. That timeframe can be shortened substantially without materially worsening either the quality of the project or the degree of community support and environmental protection. The aim is not to cut the time to gain the relevant permits and site approvals in 6 months, but perhaps 7 years is a more reasonable duration.

The compromise is this: in exchange for a more public-oriented development, permitting and siting process, communities and NGOs would agree to limits on the time to grant permits and other necessary approvals. In exchange for limits on the time to complete permit and siting decisions, developers agree to processes that engage the public in the RFP process and for use of public polling or other participatory mechanisms throughout the design and development process. It is a straight up trade that we think will facilitate a more reasonable timeframe for infrastructure development and ultimately be in the public's interest.

Long-distance transmission lines routinely get stuck. There is no one part or phase in the process that we can point to as the sticking-point. But how a project gets unstuck comes down to information, communication, and engagement. The simple act of establishing priorities in-line with community values will reduce the number of objections to lines later in the process, decrease delays, and help us build the transmission necessary to meet our energy goals.

CHAPTER 4

Interregional Transmission, Economic Development and Workforce Opportunities

Investing in interregional transmission will generate wide-ranging benefits for the American economy and its workforce. Conversations around grid expansion often take for granted the ways in which transmission enables American industries to thrive via access to affordable and dependable energy. Building out new transmission capacity will lower grid congestion and make electricity markets more efficient by connecting consumers to cheaper electricity sources. In the sections that follow, we discuss the potential impact of these developments on a variety of economic sectors and stakeholders. We also consider the opportunities and challenges that grid expansion presents for the American workforce. We highlight the broad range of jobs that come with building out transmission, as well as some of the difficulties around recruiting and retaining diverse talent. Expanding transmission is not simply a technocratic engineering exercise but is also an investment in people, in communities, and in the vitality of the American economy.

Economic Benefits of Grid Expansion

New investment in interregional transmission lines will lower costs and improve efficiency in the electricity market, with far reaching consequences for the economy. According to one study by NREL, expanding transmission lines and grid capacity could generate up to $180 billion in electricity savings, lowering costs for consumers and stimulating growth across industries. Insufficient connectivity across regional electrical grids produces congestion costs, which are ultimately transferred to consumers. Without more transmission capacity, consumers will be forced to buy more expensive electricity because cheaper sources cannot access the market. As the U.S. relies more and more on renewable energy, these costs will continue to increase. While renewable energy will offer consumers cheaper alternatives, there is no guarantee that they will be able to access them.

Another avenue for reducing costs is by limiting the amount of renewable energy that must be curtailed because there is insufficient transmission capacity. Several regional grids have experienced increases in curtailments in recent years. Failing to solve curtailment with new interregional transmission lines will force utilities to overbuild renewable energy generation to achieve the same energy production goals. This, too, will entail higher energy costs.

Expanding connectivity across transmission networks can also produce significant savings. One model compares how national versus state-by-state grids affect the price of electricity in future economies. Under a 100% renewable energy economy, an interregional, nationally optimized transmission system reduces electricity prices by 46%, compared to a grid-optimized state-by-state. These price effects are due to a mismatch between places with renewable energy supply and places where demand is high. Better transmission minimizes these discrepancies across regions, which in turn lowers costs.

Numerous economic sectors would benefit from transmission growth. We consider the impact on data centers and heavy industry.

Data centers are specialized facilities where organizations store their computer systems, servers, and networking equipment; they are the physical infrastructure where data is stored and processed, and where digital services are conducted. Data centers are a major source of revenue for state and local governments and generated more than $2 trillion in economic activity between 2017 and 2021.

Data centers require abundant electricity. The sector currently consumes 22 GW nationally, but consumption is estimated to rise to 33 GW in just a few years. In 2023, grid planners almost doubled the five-year national forecast for electricity demand, from 2.6% to 4.7% growth, and identified new manufacturing and data center facilities as responsible for the uptick. Meeting this challenge will only become more significant as technology companies invest in artificial intelligence. The use of AI models requires 2-3 times more energy than the current data center uses, and training AI models require 5-7 times more energy than current rates. A recent report by Grid Strategies suggests that powering generative AI could require as much as 7.5% of U.S electricity by 2030. However, companies may have trouble developing and deploying AI at scale if they do not have the electricity to do it.

Heavy industry, including the manufacturing and production of steel, aluminum, and other products, remains a major economic engine across the U.S. Manufacturing is also key to achieving national goals, from clean energy targets to advances in computing. To keep these domestic industries thriving, the U.S. must ensure that they have access to steady, cheap electricity. As of 2023, 200 new clean energy manufacturing facilities have been announced, catalyzed by incentives in the Inflation Reduction Act. As a result, parts of the southeast, southwest, and Midwest have already experienced new “near-term load growth.” New transmission is necessary to power these factories and the industrial transformations to come. We now turn to a few key examples from the steel and aluminum industries.

Despite recent declines, the steel industry remains an important contributor to the U.S. economy. It is also extremely energy intensive. While technologies like electric arc furnaces make for greater efficiency, energy still represents 20-40% of the total cost of steel production. As steel producers decarbonize and electrify more of their processes, that figure is likely to rise. The need for new transmission lines to enable steel production is already evident. Transmission buildout is necessary to accompany enhanced steel production.

Aluminum, valuable for its conductivity, malleability, and light weight, is a crucial input into a range of renewable energy technologies. In 2000, the U.S. was the world's leader in primary aluminum production, but it has since dropped to ninth. Energy costs are a major reason for this manufacturing decline. Over the last two decades, aluminum production relocated to Russia, China, Canada, UAE, and other countries with cheaper—but often not cleaner—sources of energy. We see a chance to rebuild the domestic aluminum industry via cheaper energy inputs and newer aluminum manufacturing technologies that can be facilitated through transmission expansion.

Investments in long-distance, high-voltage transmission infrastructure would also reduce the risk of disastrous blackouts that wreak economic havoc. The current grid is vulnerable to overloading and extreme weather events. The temporary loss of energy can be damaging to people's health and safety and can also be financially crippling.

Workforce

Finally, there are considerable workforce benefits that building long-range transmission lines might generate. Building, servicing, and maintaining the grid involves a wide variety of occupations and represents a microcosm of the diverse energy workforce. Grid-related work includes traditional energy infrastructure jobs, such as line workers and transformer specialists, as well as those in associated fields such as cable manufacturing and legal counsel. Some of these jobs—like installing towers and hoist lines—require a mobile workforce. However, other jobs require less mobility and local communities can benefit from adjacent economic development opportunities. Understanding the range and diversity of jobs presented by grid development will be important for moving proposed projects forward. Investing in the grid workforce also presents an opportunity to diversify the energy sector, where women and people of color tend to be underrepresented. Collaborations with existing institutions create pathways for introducing underrepresented groups to job opportunities in the energy sector, ensuring they become vital contributors to the grid workforce.

Expanding the grid workforce will require additional investments in recruiting and training a skilled workforce. Employers say it is challenging to hire workers with the requisite skills, experience, and flexibility to relocate temporarily. Addressing the skills gap will involve creating more training opportunities, designing industry-standard curricula, and developing pre-apprenticeship programs. Advancing these priorities will require a high degree of coordination across firms and industry groups. Such training programs could also serve the dual purpose of incorporating underrepresented groups into the energy workforce. We see opportunities to increase access to specialized and online training programs through partnerships with rural educational institutions that serve many of the communities who will be impacted by grid infrastructure. Upskilling workers and licensure layering—such as a lineman license and a Commercial Driver's License (CDL)—are two additional ways to integrate more workers into this field. As the tools and technologies to build grid infrastructure continue to advance, developing innovative and flexible methods to train the energy workforce will be essential.

The historic investments earmarked for transmission and related activities in the Inflation Reduction Act present an enormous opportunity to advance the nation's economic development and workforce capacity. Seizing these opportunities across a variety of sectors and ensuring equitable access to economic benefits will be the next task.

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[iv] See also the Princeton Net Zero study.

[v] Paul Joskow and Richard Schmalensee, *Markets for Power: An Analysis of Electric Utility Deregulation* (Cambridge, MA: MIT Press, 1988).

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