Power-Lined

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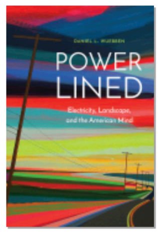


Conclusion

THE FUTURE OF THE POWER-LINED LANDSCAPE

The preceding chapters traced forms and functions of electricity and American landscape, and called attention to the wires where these two social constructs coalesced. The proliferation of overhead, long-distance electric infrastructure was marked by technical leaps and culture shocks. The pervasive lines used to keep distant markets and communities *in touch* interrupted the individual's access to the energy stored in the magnetic, wild, *untouched* landscape. Some Americans read telegraph and power lines as proof that their city or town was "on the line" and visibly powerful; generations later, pushing the lines out of sight or getting "off the grid" would be increasingly difficult. Electric lines repeatedly unsettled idealized visions of landscape, including the wilderness, cityscape, the suburban neighborhood, and the family farm. Representations of overhead lines in paintings, poems, novels, and films endorsed and simultaneously challenged the popular coupling of electricity and progress. As electric networks imposed a new order on the land, an increasing reliance upon, and addiction to, electricity and electric technologies contributed to an expanding, ubiquitous wire-scape.

Our grid is a massively complex and technologically advanced marvel, but the financial, bureaucratic, and social traditions that intersect it limit our ability to rewire energy practices. Efforts to build a better grid will require interdisciplinary analysis of electric transmission's diverse impacts, including costs, environmental damage, and aesthetic practice. The way toward a smarter, more equitable, and more aesthetically satisfying experience of transmission lines is not to turn the design or management of energy systems over to artists and academics. However, the solution, or solutions, is also not as simple as favoring engineering or aesthetics, renewable energy or nature, progress or heritage, economics or environment. Rather, the problem is the entangled infrastructural and emotional forces that undergird electricity *and* American landscape.

The Power Line Piece of the Infrastructure Puzzle

Citizens of developed nations overlook the more banal parts of their infrastructure, such as pipes, wires, and undersea cables. In a seminal chapter on infrastructure and modernity, Paul Edwards argues that "mature technological systems—cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, buildings, even computers in the majority of their uses—reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt."[1] While I contend that transmission and distribution lines are almost as remarkable as trees and dirt, it is also clear that in recent years energy infrastructure has drawn more consideration—often because of its failures.

Since 2001 the American Society of Engineers has given the nation's electricity grid a grade of D or D+. While for most of us, the grid is powerful and reliable, others view it as an inefficient machine. One study suggests Americans suffer from more power outages than any other developed nation.[2] Another points out that part of the network loses power 285 percent more often than it did in 1984. Significant outages are also on the rise: 15 in 2001, 78 in 2007, and 307 in 2011.[3] These hours- and days-long outages further hinder productivity and require more extensive repairs. Losing power for even a few minutes can damage sensitive machinery and electrical components. Overall the total cost of power outages on the economy is estimated to be between $80 and $188 billion a year.[4]

Some outages are the result of outdated transformers and power lines. Approximately 70 percent of the nation's transformers and 70 percent of its high-voltage transmission lines are more than twenty-five years old. Most of this equipment has a thirty-year lifespan, and significant rebuilds are under way. At the same time, the costs of outdated and inefficient infrastructure are mounting, and engineers, energy experts, and scholars have been sounding the alarm.

Most customers only notice infrastructure when it fails. For as long as wires have been strung overhead, the forces of nature have intermittently brought them down. Between 2003 and 2012, 679 severe weather events, including record-setting blizzards and hurricanes, downed thousands of miles of transmission and distribution lines and caused considerable deaths and other losses. In 2017 utilities reported seventy-two severe weather outages that affected at least fifty thousand customers for an hour or more.[5] The Department of Energy predicts that the average cost of weather-related power outages is between $18 and $33 billion every year. With the recent string of devastating hurricanes, the annual costs of outages seem poised to cross the high-water mark. Multiday outages have crippled power systems around the Gulf of Mexico and throughout the southern United States. After hurricane Maria, Puerto Rico was without power for months, and it could take years before power on the island is fully restored.[6]

Severe weather and "acts of God" wreak focused havoc, but incremental climate change also strains and damages the grid. Faulty or fallen transmission lines have sparked a number of wildfires in the West. The *LA Times* reports that power lines have been the leading cause of California wildfires in recent years.[7] Droughts threaten hydroelectric and thermal generating plants that require freshwater. Heat waves spike the use of air-conditioning, adding to the risk of overloads.[8] As the earth warms and the intensity and frequency of extreme weather increases, many of the lines we currently rely upon will be susceptible to storms, flooding, fire, and drought.

Ironically, with its reliance on coal, the energy industry has been a primary culprit and victim of climate change. In 2016, 17.5 percent of all residential electricity use was spent on space cooling and 9.1 percent on space heating. That year the U.S. electric power industry produced 1.925 million metric tons of carbon dioxide, or 39 percent of all energy-related carbon emissions. Of these, coal produced 1.364 million metric tons, or 71 percent.[9] Although hydroelectric dams on Niagara Falls, across the West, and throughout the southeastern United States shaped the first decades of electrification, coal provided the bedrock of the modern power grid.

This high-energy, transportable, and storable fossil fuel has been a more reliable energy source than falling water, wind, or sunshine. Coal can be mined, shipped, and stockpiled near a power plant; it offers kilowatts on demand. Without coal the U.S. power industry and the nation's status as a global power might not have been possible.

The market systems and social practices built around cheap, readily available coal helped to divorce electricity consumption from production. Consumers did not see the coal burned to generate electricity heated, cooled, and lit expanding metropolises. Instead, they saw the long-distance transmission lines string out the suburbs. The use of coal in the electric utility industry peaked in 2010. It may never recover, as the cost of natural gas and large-scale renewable has dropped considerably.

In addition to the move away from coal, four other forces are encouraging grid upgrades and energy transitions: sustainability, competitiveness, integration, and security. Concerning sustainability, it seems clear that expanding economies and rising populations cannot permanently scrape and burn the earth's coal dead bones and create radioactive waste for the next century without catastrophic effects. Engineers and world leaders are actively seeking long-term and sovereign solutions to their energy needs. Meanwhile, renewable generation is becoming cheaper and more competitive. Large solar plants and wind farms are appearing with more frequency on the landscape and the seascape. The upfront costs for renewables are falling, forcing the retirement of older, less cost-effective generating plants (especially coal and nuclear).

Deep-rooted coal infrastructure and the efficiency and low cost of natural gas suggests that the United States will not abandon fossil fuels anytime soon. It should also be noted that solar panels, wind turbines, and other forms of renewable, or "clean," energy have their own dirty secrets.[10] In 2014 a report in *Nature* revealed that in China, one of the global leaders in renewable energy output, "production of polysilicon and silicon wafers for solar panels creates dangerous by-products, in particular silicon tetrachloride and hydrofluoric acid, which are being discharged into the environment after inadequate waste treatment."[11] The copper mining practices that support renewable energy also inflict significant environmental damage. Conservation is critical; we can individually and collectively consume less energy and produce less waste. At the same time, a thicker renewable portfolio and a less centralized, more distributed bulk transmission system should also speed the retirement of the greatest energy polluters.

Bringing cleaner energy sources online will require a different grid. For starters the future grid must be more adaptable. This means sending and receiving variable loads from multiple points: traditional power plants, large-scale renewables, smaller community wind farms, rooftop solar panels, home battery systems, and electric vehicles. The so-called smart grid will utilize millions of software sensors, microprocessors, and automation devices attached to switches, circuit breakers, and bus bars. The information gathered across the grid will "allow transmission lines to communicate with each other."[12] The smart grid promises to decrease transmission losses and provide network operators the ability to more quickly and efficiently shift loads based on weather, demand, and other unforeseen fluctuations. The next generation of power networks will also have more capability to instantly adjust thousands of connected thermostats one or two degrees at various times of day to reduce the need for standby power plants and the risk of overloads. Research suggests individuals and communities will be leery of letting a utility control when and how they use electricity.[13] If thousands of customers agree to periods of slight discomfort and the grid can more heavily rely on large-scale renewable power, utilities could decommission some the standby plants that they maintain only for the warmest days, when demand for air-conditioning spikes.

A final piece of the infrastructure puzzle is security. This is not a new concern. Morse worried that vandals might destroy his first telegraph line if he strung it aboveground. In the late nineteenth century sneaky wiretappers, so-called overhead guerrillas, and wire sabotage in the West laid bare the vulnerabilities of overhead lines in crowded metropolises and unsettled frontiers. A surprising number of bombings and other small attacks on outdoor transmission towers and substations in the 1970s caused numerous blackouts, especially in California. In 1982 Amory and L. Hunter Lovins published *Brittle Power*, a report that considered how a coordinated attack might spark blackouts across the continent. They concluded that attacking energy facilities was arguably the cheapest and most effective way for military forces and terrorists to inflict widespread damage and chaos.[14] While not often publicized, the grid and those tasked with protecting it face significant threats. In 2017 U.S. utilities reported twenty-four cases of sabotage and vandalism to the Department of Energy; five of these acts disrupted service for 30,766 customers.[15] The damage could be much worse. In 2012 Defense Secretary Leon Panetta warned that a terror attack on the transmission grid could either cause or accompany "the next Pearl Harbor" for the United States.[16] As the grid goes digital, engineers worry that a virus or act of cyber warfare could potentially trigger cascading failures. If so, restoring power would mean containing and neutralizing the threat and rebuilding sections damaged by severe swings in voltage. Equally unsettling, in 2018 the Pentagon announced that a widespread cyber attack on American infrastructure could merit the use of the nation's nuclear arsenal.

Forecasting energy policies or predicting how the grid will function in 2030 or 2050 seems futile. Politics, fluctuating fuel prices, climate change, war, terrorism, self-driving electric vehicles, massive storage batteries, and killer apps connected to the internet of things promise that our relationship to energy will significantly change in ways that are difficult for energy experts to anticipate. Ideally, the future grid will be more secure, more adaptable, and will offer communities and individual consumers more decisions about what type of energy—coal, natural gas, solar, wind, hydro, geothermal—puts power into the grid and how we take it out. What does seem certain, for better or worse, is that the grid will require overhead wires to transmit bulk power.

Investment in transmission infrastructure has risen steadily over the past decade. In 2016 capital expenditures reached $21 billion. The Edison Electric Institute forecast that transmission investment would peak at $22.5 billion in 2017 and then taper off slightly.[17] Further transmission investments could make the grid more sustainable, more secure, and more efficient. In 2016 Alex MacDonald and colleagues at the National Oceanic Atmospheric Administration built a model to show how a nationwide network of high-voltage direct current lines operating near 765 kilovolts could meet current and future U.S. energy demands. In their model this vast network would transmit energy from giant wind farms and solar fields located in central regions of the continent to the more populated and energy demanding coasts. Although a 100 percent renewable system may not be possible and even an 80 percent renewable portfolio may suffer from interruptions on cloudless or windless days, being able to ship renewable power from any point in the country would take advantage of economies of scale and limit the risk of running out of power. The research team concluded that a sustainable, secure, nationwide electric power grid could satisfy national demand and reduce carbon emissions by 80 percent from 1990 levels.[18]

In terms of epic infrastructure projects, this high-voltage, nation-spanning system would be on par with the interstate highways built in the 1950s. Such a system would reap significant economic and environmental benefits as well as make renewable energy a more permanent part of our lives. It would lessen transmission losses and mitigate the potential havoc caused by failures, storms, and attacks. The investment would likely pay dividends. While the United States has the scientific, technological, and engineering expertise to build such a massive system, other constraints may be too great. As one energy expert explained, "The problem is not rooted in technology, but rather in the way that the U.S. power system is organized legally, politically, economically, and culturally."[19]

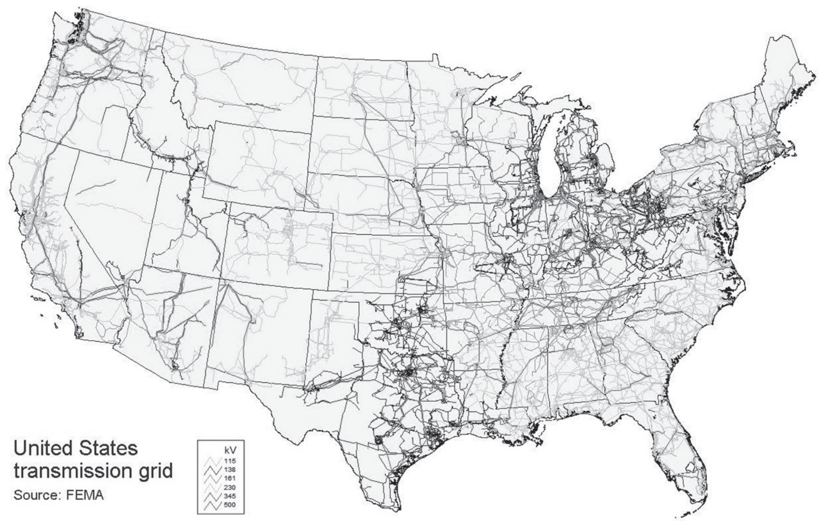
The gridlock is both a cause and result of the balkanized system. In 2018 the Federal Energy Regulatory Commission, the National Energy Reliability Council, and 51 other state and city commission oversaw the development and operation of U.S. energy infrastructure. Such oversight may seem necessary, considering that in the same period 192 investor-owned entities controlled 80 percent of the entire transmission infrastructure in the United States. By comparison, however, 76 percent of Americans received their broadband Internet service from just four corporations—Comcast, Charter, AT&T, and Verizon.[20] The sheer number of electricity-generating sources is astounding. At the start of 2017 the United States had almost as many significant generating facilities (8,084) as it did Starbucks stores (8,222).[21] Not all of these are major plants, but they can each produce at least 1 megawatt, or approximately enough electricity to power a thousand homes. They connect to 600,000 circuit miles of transmission lines, 240,000 of which operate above 230 kilovolts.[22]

The vast web of transmission lines that stretch across the North American continent are divided into three interconnections: Eastern, Western, and Texas (fig. 24). The Eastern connection is further divided into eight subregions from Florida to Ontario. System operators, power pools, and reliability councils work within and sometimes across regions. The operators, pools, and councils can have distinct specifications and market designs. Transmitting power from neighboring states, such as from Utah to Colorado, is a challenge. Many regions seem woefully splintered. Recalling Thoreau's critique of the telegraph, electric messages and live video-streams can be sent and received all the way from Maine to Texas in milliseconds; however, it is difficult to send bulk power from Maine to New England.

The Renewable Transition Meets the Urge to Go Underground

Stakeholder engagement, public perceptions, and aesthetic impacts, far from trivial details, remain significant barriers to widespread reform of the U.S. power grid. If federal government and the utilities agreed upon a multitrillion dollar plan to modernize the grid, developers would still "face opposition from landowners who would not want their property bisected or their views obstructed by unsightly power lines."[23] Individuals and communities may want to invest in renewable energies and link to a transcontinental grid, but they are also likely to resist modifications that require *seeing* more overhead transmission infrastructure.

For many stakeholders adjusting their own aesthetic attitudes or finding ways to reframe the lines in the visible landscape is not as attractive as a simple mandate: put the lines underground. Underground lines, many customers assume, would be safer from storms and attacks. It would seem to eliminate the noise made by the lines and the potential health risks of living near them. Underground lines also do not seem to blight the landscape. Anticipating the urge to take lines underground, the Edison Electric Institute regularly publishes a report titled *Out of Sight, Out of Mind*. The title stresses the overarching dichotomy the utility industry



24. Map of North American Regional Reliability Councils and Interconnections, ca. 2011. Wikimedia Commons. Created from data by the Federal Emergency Management Agency via the National Renewable Energy Laboratory.

wants to maintain between *sight* and *mind*. The title seems resigned to accept the lines' aesthetic limitations. Sure, no one likes to look at the lines, but no matter how unsightly the lines may appear, keeping them within sight means also keeping them in mind, which means paying attention to environmental impacts and efficiency. The report weighs fairly the various costs and benefits and incorporates externalities about specific lines and environments into its calculations. Underground lines may be less likely to fail during wind-, rain-, or snowstorms, but finding and fixing problems with lines underground is more difficult and time-consuming, which might in turn lead to longer outages than if the lines were overhead and could be quickly diagnosed and fixed. Underground lines are also not secure from floods and earthquakes. *Out of Sight, Out of Mind* reconfirms the role of aesthetics, explaining that the primary driver of the desire to move lines underground will remain "improved aesthetics and the hope that underground electrical facilities will provide greatly enhanced electric reliability."[24] Again, it is not an accident that "improved aesthetics" is linked to the "hope" of reliability. Aesthetic disgust with the lines is valid, yet from the industry's standpoint, remedying it may not improve reliability enough to bear the costs of putting the lines underground.

The uncertain impact of aesthetic improvements and extreme cost of underground solutions drives the industry's preferred dichotomy of *sight* and *mind*. That dichotomy is not necessarily made in the public interest; the utility and its organizations make their arguments based heavily on maximum efficiency and profits. Nevertheless, each severe storm and power outage inspires the media to take up the underground issue. The headlines follow a familiar pattern: "If Power Lines Fall, Why Don't They Go Underground?" (NPR, 2012), "What Would It Cost for the U.S. to Bury Its Power Lines?" (*Fortune*, 2017), and "Isn't It Better to Just Bury Power Lines?" (CNN, 2017).[25] Like the industry report, these articles question the costs and benefits, the logistical tangles and potential financial burdens. Building new underground lines cost six to ten times more than overhead, requiring $500,000 to $2 million *per mile*, depending on voltage, geography, and population density. Communities therefore must consider whether putting lines out of sight is worth incurring a massive debt.

If customers will resist more overhead lines and will not pay inflated electricity bills to take them underground, what might make overhead lines more acceptable? A 2009 survey by Saint Consulting Group observed that support for new lines rose from 46 to 83 percent when "respondents are asked specifically about high-voltage transmission lines delivering wind power."[26] Other anecdotal cases corroborate these findings. In 2003 Xcel Energy announced plans to build a transmission line through rural Minnesota to carry renewable wind energy to market. Rather than resist the new lines, some farmers wanted the lines or substations moved nearer to their land. They hoped to decrease the interconnection costs for their wind turbines. For this group the new transmission line promised to increase their personal profit margins.[27] Xcel Energy touted this finding as a signal that renewables could change attitudes about transmission lines, but without a direct incentive, most home and landowners will continue to resist.

Numerous studies suggest that opposition to new power grids varies.[28]

Still, public opposition seems statistically balanced across North America and Europe. In one of the largest surveys of its kind, residents from twenty-seven European countries were asked how they would react to a new overhead transmission line and were given different reasons for why the line was necessary. Even if the proposed line would deliver renewable energy or provide economic advantages, 34 percent of respondents indicated they would "definitely not accept the new project without opposition." When tested against the alternative scenarios, the researchers concluded that ancillary information about specific environmental or economic benefits of a line could improve public acceptance by a few percentage points, but the percentage of respondents likely to select "definitely not accept" or "probably not accept" would still be significant.[29]

In 2016 I conducted a study using the same scenarios used in the European study. Although 54 percent of the (admittedly small) sample of eighty-two participants in Omaha, Nebraska, indicated that overhead lines "do not bother me," 32 percent of the respondents said they would definitely oppose a new transmission line if it was sited near their home, and 33 percent said they would probably oppose it.[30] The existing lines in a metropolitan or suburban area may be ignored; the idea of new lines that deliver environmental or economic benefits may be welcomed; nevertheless, overhead lines will remain anathema to a substantial part of the population.

A general law of thirds seems to apply to transmission projects: one-third of the public will definitely oppose any nearby, visible transmission line regardless of its potential to lower costs, improve security, or decarbonize; one-third will approve of it (or not care); and one-third will be inclined to oppose it but may be swayed to one side or another by arguments and facts showing the line's potential benefits or setbacks.

How do utilities and transmission companies meaningfully engage the public with new infrastructure projects? A 2015 report from the U.S. Department of Energy on the need for new transmission infrastructure said developers must "engage the public early" and respond meaningfully to concerns to "pre-empt or at least mitigate the impacts of some forms of organized opposition."[31] Early engagement that preempts opposition is not the same as meaningful dialogue. Transmission line owners and operators are often accused of adopting "the rhetoric of deliberative engagement whilst lacking a clear rationale and effective means to incorporate citizen perspectives in long-term network development or specific infrastructure siting proposals."[32] Utilities mail out notices, encourage feedback, and hold public forums, but a significant portion of the public believes that the engineers, executives, regulators, lawyers, and bureaucrats dictate where the line can or cannot go and then use outreach teams or litigation to justify their route.

Power-lined landscapes will continue to be contested spaces framed by incongruous and sometimes conflicting powers. Politicians and community leaders may campaign for "shovel-ready" construction projects and more jobs, but it would be rare to hear a candidate announce an intention to bring more overhead powers lines to her or his constituents. If utilities or government entities fail to effectively address the issue or rely too heavily on the threat of eminent domain, the public will continue to resist change. In the ensuing struggles about transmission routing and design, facts will be culled, packaged, and delivered by utilities and environmentalists, industry associations and consumer groups, and a broad range of federal agencies and nonprofit organizations. Communities and homeowners will receive policy briefs, media articles, and enhanced images and diagrams juxtaposing the new poles and towers with repurposed transmission corridors and rooftop solar installations. Some outreach teams, designers, and engineers will continue to hide their lines, but others could highlight sleek tower designs and even brand their lines with corporate logos. If Apple, Verizon, Amazon, or Google managed the smart grid of the future, would they stamp the lines with their icons?

Whatever future forms and functions the grid adopts, upgrading the most expansive and expensive machine in human history will require an astonishing coordination of science, engineering, finance, and politics. These herculean efforts will need public support. As I mentioned in the beginning of this book, grid literacy is crucial to rewiring the material grid and the social structures embedded within it. As customers and global citizens, we need facts and narratives that apply a balanced mind-set to our many energy needs and problems. Books, reports, infographics, news articles, lectures, and videos can reveal some of the layered operations and far-reaching consequences of charging our phones, adjusting our thermostats, or streaming our favorite videos. However, promoters of the newer, more renewable grid must also address the power line problem.

Fresh angles and new aesthetics can alter ways we see the lines running into our offices, classrooms, libraries, and homes. Understanding voltage drops, kilowatt-hours, power-sharing agreements, and even "shadow prices" (the estimated price for electricity at a point in the power network at a specific time) can demystify the complex and expansive webs that carry current through our walls and above our heads. This enhanced literacy may also inform more creative texts and activities that illicit wonder and excitement for previously unconsidered infrastructure.

Playing a Poetics of Power Lines

Humanities scholars and social scientists are offering novel approaches to energy issues. For instance, Benjamin Sovacool says that to reveal the myths regarding the ephemeral energy systems we all use and predominately overlook is akin to "investigating the invisibility of an already seemingly invisible set of technologies."[33] As long as the lines in the landscape congeal in the background, it is easier to accept myths of wire evil, cancer clusters, and corporate maleficence. Sovacool is one of a growing band of scholars applying a range of social science and humanities methods to electricity systems and practices. The results—conferences, peer reviewed articles, websites, art installations—are painting a more interdisciplinary picture of infrastructure's role in our current and future energy landscapes.[34]

The turn to infrastructure has also captured the attention of various disciplines: literary theory, digital humanities, and anthropology.[35] Paul Edwards clarifies some of the ways scholars might read infrastructure, explaining that these "artificial environments" "simultaneously constitute our experience of the natural environment, as commodity, object of romantic/pastoralist emotions and aesthetic sensibilities, or occasional impediment."[36] Related to these efforts to rethink infrastructure, anthropologist Brian Larkin has suggested that a poetics of infrastructure be applied to social objects such as wires, pipes, roads, and internet protocols. He sees infrastructures as material, circulatory systems that transmit people and goods as well as networks of referents. Larkin imagines infrastructure operating as "concrete semiotic and aesthetic vehicles." Perceptions of the infrastructure's principle forms—or its poetics—are related to their political force, but unique or quirky design features and other "fetish-like aspects" of infrastructures remind us that these systems can circulate meanings "autonomous from their technical function."[37] The millions of tools and materials embedded in our landscapes—glass, steel, aluminum, plastic, or organic light-emitting diodes—attract and shape what it means to be human in a particular age. Common infrastructures can gain a special attraction and symbolic meaning.

To support Larkin's argument and fold it back into the humanities, I want to conclude by offering two approaches to a poetics of power lines. Calling for a poetics is not a plea for aesthetics alone. Of course, tower and pylon designs may improve, and landscape architects, industrial designers, and utility engineers should follow the general guidelines with regards to rights-of-way, tower designs, and landscape modification that have been advised since at least the 1970s.[38] When possible, limit the use of lattice steel towers, route major lines through existing corridors and industrial areas, keep the taller pivots away from areas of high visibility and high visual quality. And when possible, feather the corridor with trees or shrubbery. The wire-scape should not dominate a landscape.

A poetics is a way of teasing out the lines' layered meanings, learning to read the lines' varied impacts, and accepting electricity as an emotional and visual element in what is, ideally, a balanced pattern. The poetics I am calling for has two branches: one works to understand the lines as actors that intersect and create space; the other encourages viewers to pause and gaze upon these somewhat weird wire networks as forms that occupy "place."

The first has been, and may continue to be, achieved through lines of poetry, descriptions of scenery, video clips, and any other genres and mediums that naturally engage movement through landscape. Since the age of the telegraph, individuals have seen electric lines and imagined them radiating, spreading, or marching across the horizon. The lines seem animated with a smooth, continuous movement. In this mode the moving lines are like projections of thought. The wispy wires and the metallic spires might be repeated like a variable line of code—the mimicked appendages, the filmstrip's cells, the patterned tiles, the bar lines and repeat signs on a music sheet. The poetics of power lines desires more than metaphors; the physical manifestation, siting, and construction must insert the code into the operating systems; the poetic and technical aspects may converge. For instance, consider the code words for the industry-standard bare aluminum 1350 conductors and the aluminum conductor steel-reinforced (ACSR) cables. The .12-inch aluminum cable with thirty-seven wires is "mistletoe," and the .31-inch ACSR conductor with 6/1 stranding is "sparrow." Others aluminum cables are nicknamed "peony," "daffodil," and larkspur"; other ACSR names include "raven," "pelican," and "cardinal."[39] With a spotter's guide or app to identify the wires and match them to their bird and flower names, one might read the lines passing by as creative symbols of the organic and rhythmic landscape. Peony . . . cardinal . . . larkspur . . . jump!

In addition to identification and code work, a poetics of power line movements might also aspire to project the technological sublime. The great engineering achievements of the last two hundred years have been shocking revelations of form and power. The thunderous railroad weaves through the pastoral scenery; the George Washington Bridge leaps from city to the cross-country artery I-80; the Golden Gate, three thousand miles away, presses toward the great blue Pacific; the twenty-story space shuttle launches and then seems toylike against the grandeur of outer space. To match these great achievements and spectacular displays, the function *and* form of power lines must find proportion, suitability, and order. This power infrastructure might illicit interest about the new technologies connected to its edges and channel the viewer's sense of awe and curiosity back to the natural, fluid surroundings of the machine.

A recent competition sponsored by the National Grid in Great Britain received many creative forms to carry the cables—ninety-eight-foot-tall figures running with wires in their hands; deer carrying wires in their antlers; sails; insects; and a "flower tower." The winner of the contest was a sleek white "T-shaped" structure. One anticipates sublime power lines and other aesthetic structures. However, what may be proposed as an art form may also be rebranded as a marketing tool or to support a political ideology. One shudders to think that a real estate developer and politician like Donald Trump might tout the T-shaped tower design as part of the trillion-dollar infrastructure package that the nation needs and most Americans support. A massive, renewable electrification grid in any nation might have sweeping political impacts, but erecting thousands of giant *T*'s to carry power across the Midwest, often referred to in political terms as the "red states," would be an ironic realization of Stalin's declaration that "communism is Soviet Power plus electrification of the whole country." Neoliberal capitalism could mean investor-owned renewable infrastructure plus the government-mandated webbing of the whole country with high-voltage wires.

The National Grid contest also allows us to imagine, as Henry Dreyfuss did, varied creative designs for power lines. While some may correctly read corporate control or cronyism in the shape and design of the new towers, it is also possible that they could act as props for a cinemagraph: giant characters acting out a movement or scene as the driver or train passenger glides past. Or like Thoreau's telegraph harp, the lines might be positioned so as to produce music in certain seasons or times of the day. We might invite visitors to observe our metallic looms stretched toward the horizon or a valley with a colorful loom. The up-and-down flowing motion of the wires and the playful guys and pylons accentuate the stage.

Again, to support imaginative solutions to the power lines problem does not mean complacency with the grid we have inherited or acceptance of the corporate push to privatize, deregulate, and wield eminent domain for private gain. The success of such a poetics is not a given. On the one hand, to present facts or poems about these technically complex systems and some of the utilities' more egregious abuses may illicit a collective shrug—if the electricity is delivered, many would prefer not to think about where it begins or how it arrives or who owns and controls it. Bringing awareness to the lines may also backfire—those who had ignored the lines may begin to see them, realize the negative impacts, and work to bring down the grid. It may seem best to keep the lines muted, but our power lines, whether beauty or blight, cannot be ignored. They represent the difficult truths about electricity and landscape and the ways they shape our everyday lives.

If the first branch examines the lines as part of a movement through space, the second branch of a power lines poetics pauses to consider how these structures create place. Electric lines, like poetry, mediate exchanges of social practice. A published, printed page (paper or web based) often holds the lines of a poem in a static embrace. Electric lines rarely seem to be contained within a single, clearly defined place—they span place(s) and become part of a broader pattern. As architect David Leatherbarrow argues, "The task of landscape architecture and architecture, as *topographical arts*, is to provide the prosaic patterns of our lives with durable dimension and beautiful expression."[40]

If architects and artists can achieve this task, then to stand within the power-lined landscape would be to stand within what artist Tony Smith calls "something mapped out but not socially recognized." For Smith, who drove the unfinished New Jersey Turnpike in 1951, abandoned works and surrealist landscapes transmit something more than a function; they produce spaces outside tradition, an "artificial landscape without cultural precedent."[41] To offer a reading of one such unprecedented, artificial landscape, I would like to return to the place connected to the lines that inspired my childhood fascination, the lines positioned above and alongside Blondo Street.

The Final Level of Play

The Omaha Public Power District (OPPD) Arboretum on 108th and Blondo Street satisfies Aldo Leopold's goal of creating "a benchmark, a starting point, in the long and laborious job of building a permanent and mutually beneficial relationship between civilized men and civilized landscape" (fig. 25).[42] This arboretum's starting point was a massive substation designed and built in the 1970s on what had been a twenty-six-acre family farm. For most of the century this slice of Nebraska farmland produced corn, soybeans, wheat, and hay. The utility bought the entire parcel, but the substation's footprint only occupied a few of the twenty-six acres. The remaining land could not be resold to developers, and for decades the utility let everything around the substation and its transmission towers go to grass.

From outside the substation one can see mustard-yellow metal sheds, obelisk-shaped transformers, countless switches, lightning arrestors, and

25. Omaha Public Power District Arboretum, 2017. Photo by Daniel Wuebben.

circuit breakers with six sets of stacked discs splitting from bases the size of heavy metal dollies. The circuit breakers resemble giant metal cacti. All of this humming industrial stuff stands on a rock gravel pad surrounded by a barbed wire fence. One 220-kilovolt lattice steel tower is beside Blondo and carries power southwest toward Dodge Street; the other crosses diagonally across a portion of twenty-two acres around the substation.

In the 1990s Omaha Public Power District's lead arborist and a local landscape architect, John Royster, set about transforming the unused land into an arboretum. The goal was twofold: to offer a public green space and to teach visitors how to select and trim trees and shrubs so they would not interfere with power lines. For utilities across North America, keeping foliage away from their equipment is a costly and endless chore, especially in the summer months when cables expand, lines sag, and tree branches can cause arcs and flashes and trigger blackouts. In other words, for utilities trees often act like weeds—plants that grow where they are not wanted.

The OPPD Arboretum engages the public to be part of the utility's tree care solution. Among the 208 trees species and 201 shrub types, a series of educational displays teach visitors how to select and plant "the right tree in the right place." In addition, access to a gazebo, a small koi pond, rock walls, and wooden bridges has made the site popular with those seeking light exercise, walking their dog, or taking photographs. On warm weekend days dozens of photographers and their subjects spread across the arboretum and pose for baby photos, senior pictures, and family portraits. They enjoy this free, picturesque scenery, and based on photos uploaded to social media, they dutifully crop out the substation and overhead lines. The OPPD Arboretum indicates the potential power of digital images and social media to adjust, frame, and reevaluate how the public engages with the various layers of electric infrastructure. This landscaped and well-maintained green space represents the potential for a "permanent and mutually beneficial" relationship between the energy industry and environmental literacy.

The arboretum's most provocative space, and where I would begin to teach the layperson about infrastructure, may be the least technologically advanced (and least photographed). OPPD's substation plans did not include a patch of forest east of the old family farm. In the 1950s the Nebraska Department of Roads proposed an interstate bypass to wrap around Omaha and link back with the cross-country artery, Interstate 80. The engineers and planners considered building an off-ramp to Blondo Street. The plan never materialized, and other exits directly north and south satisfied the flow of traffic. For decades after the interstate was completed, this strip of land that could have been an off-ramp remained untouched.

I grew up in a house built in the 1970s on the opposite side of the interstate, a stone's throw from this forgotten pocket of wilderness. As Omaha spread westward, subdivisions, apartment complexes, shopping centers, and office parks transformed everything around this small forest and the OPPD substation. My mother warned us not to cross the interstate and go into the forgotten forest. When we did, we battled through tall grass and dense shrubs and found a few well-worn footpaths that led to remnants of campfires littered with beer cans, pornography, and anarchist graffiti—telltale markers of 1980s suburban delinquency. Decades later the Department of Roads donated this section of unused land to allow the arboretum to expand. Engineers and landscape architects paved wood chip walking paths through the forest, placed two wooden bridges across its shallow creek, and created an outdoor classroom with a few wooden benches. A local community college professor now regularly brings his botany students here for identification exams. I envision the outdoor classroom as an ideal place for conversations about the confluence of environmental history, transportation infrastructure, and electric power. Such a conversation could treat technology in its true mode, which Martin Heidegger says is "the mode of revealing." As technology is revealed, it aligns with the "bringing-forth" enacted in poetry and physics.[43]

In this old-growth forest it is difficult not to consider the ever-present crashing whorl of interstate traffic. That white noise was present in my home, and I often imagined the interstate was a seashore upon which thousands of metallic seashells were repeatedly beached and unzipped. These days I am not pulled into the grove by nostalgia for traffic sounds. Instead, I go to visit the eastern cottonwoods, Nebraska's state tree and one of the species *not* recommended for planting near power lines. In Willa Cather's Nebraska novel *O Pioneers!* a character muses that the Bohemians who first settled the land were "tree worshippers," to which another responds: "I like the trees because they seem more resigned to the way they have to live than other things do. I feel as if this tree knows everything I ever think of when I sit here." This eastern cottonwood, which once upon a time was surrounded by prairie grass or flat plains and is now bookended by an interstate and electric substation, still seems content to be. When I touch the rough, russet-colored bark of the three clustered cottonwoods that each rise eighty feet or more above earth's surface, I think of all the resigned bodies and systems beneath my feet. Some are decaying, churning into dust. Others are alive, burrowing for sustenance. The branches of mycelium and tree roots are the ancient precursors, perhaps the archetypes, for the wires in our walls and the electrical infrastructure overhead.

Underground roots have a similar shape and function as overhead transmission and distribution lines. Those bifurcating siphons tunnel into soft, loamy dirt, their longest fingers dug 40 or 50 feet below the earth's surface, their elbows ranging outward, some of them exposed on the banks of a nearby ditch. The other, metallic siphons are visible on the woodland's edge—aluminum and steel-reinforced cables hang between 45-foot tall wooden utility poles (which were once Douglas firs, a species harvested for Christmas trees). The network also shines on the clearing's western rise—quarter-inch lines locked to accordion insulators and attached to a 180-foot lattice steel tower.

This lattice steel tower and the exposed roots also serve as reminders: without these appendages the cottonwoods would perish; the grid would go dark. When they operate effectively, roots and lines are often forgotten. *Tree* and *electricity* attract warmer visions and more magnanimous associations. In this arboretum, and most landscapes across the country, attention is reserved for the blooming surprise: thick branches stem from this sturdy cottonwood trunk and reign over the bur oak, hackberry, and maple at their shoulders. Throughout the summer visitors will be drawn to this tree's thousands of waxy, silver-and-green leaves. As summer turns to fall, the leaves will turn bright-lemon, fade, and then drop to the forest floor. That image will grab attention. Visitors will not, unless prodded, turn to consider the field and the transmission tower. We tend to believe that nature is the snapshot of spectacular autumn foliage, not the gnarly ecosystem that feeds such colorful explosions.

Similarly, we are inclined to see electricity as a series of devices and icons: bolts with zigzagging lines, light bulbs aglow, rectangular wall sockets with vertical eyes and round nose that receive our plugs. Our motors, televisions, and various screens are electricity, not the wires hidden inside. Campaigns for energy-saving appliances and nimble electric vehicles with eco-conscious names such as Leaf, Bolt, Volt, and Tesla often ignore the massive, and sometimes environmentally damaging, energy networks these new technologies require to stay charged. The lines in the landscape are not often associated with the electric technologies in operation around us—and even upon and within us—every waking moment of our lives. Some of the electricity in that lattice steel tower, however, allows me to sit in my home across the interstate and type these lines.

To look at the eastern cottonwood and see an ecosystem is analogous to seeing that the electricity in those lines touches every aspect of our lives. To see the forest (as grid) for the trees (as transmission lines) is to appreciate infrastructure as a series of material artifacts, structures with a technological function *and* a social meaning. Their form, distinct from but entwined with their function, conveys a certain intention and agency. The lines, the trees, and all the values we might attach to them interconnect with landscape and create place. The lines transmit physical power; they also send powerful messages—messages that over the course of successive generations seem to shift, hide, evolve, and fluctuate.

Here, then, the romantic analogy linking underground roots and overhead power lines falls apart. The organic roots that sustain this forest spread radially from the tree trunk. Power lines rarely radiate from a center; they join a network that stretches so far and so deep that the grid they serve operates as its own kind of ecosystem. Unlike the swelling leaves above or the veiny roots that burrow below this rich Nebraska soil, the carefully engineered, owned, and managed metallic lines in the thawing field that drop toward the substation and parallel Blondo Street must hide in plain sight, like a bird on a wire. While they may not be natural, or entirely understood, those lines remain curious fixtures and icons that invite further untangling. The power line here is like a clear, thin glaze on the canvas of our historical, aesthetic, and technological milieu. Those webs that span the horizon and range beyond this landscape are electricity made visible; they occupy the razor-thin margin between the seen and unseen.