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LUMPY SOCIAL GOODS IN ENERGY DECARBONIZATION: WHY WE NEED MORE THAN JUST MARKETS FOR THE CLEAN ENERGY TRANSITION

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To avoid the worst consequences of global climate change, the United States must achieve daunting targets for decarbonizing its electric power sector on a very short timescale. Policy experts largely agree that achieving these goals will require massive investment in new infrastructure to facilitate the deep integration of renewable fuels into the electric grid, including a new national high-voltage electric transmission network and grid-scale electricity storage, such as batteries. However, spurring investment in these needed infrastructures has proven to be challenging, despite numerous attempts by regulators and policymakers to clear a path for market-driven investment. Unchecked, this problem threatens to artificially limit complementary investments necessary for the clean energy transition. In this Article, I lay out a theoretical framework that explains the tepid development in certain necessary infrastructures for the energy transition. I argue that clean energy infrastructure is a part of a classically lumpy social good. Lumpy social goods are those that realize all or most of their value contingently upon the assembly of multiple

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components necessary to produce the good. In this case, the complementary components to be assembled are high levels of renewable generation, on the one hand, and transmission and storage infrastructures necessary to integrate those generation sources into the smooth operation of the grid, on the other. The lack of sufficiently concrete coordination of these complementary projects drives investors into an unproductive Assurance Game, despite efforts by the Federal Energy Regulatory Commission to grease the gears for transmission planning. This theory not only helps clarify the root causes of past policy failures, but it also points the way to the kinds of policies that can help overcome these dynamics and accelerate investment. It also illuminates a weakness in energy markets' ability to respond to the climate crisis, which may necessitate changes to foundational policies.

INTRODUCTION

Energy systems are undergoing sweeping transformations in response to the need to decarbonize rapidly to avert the worst consequences of climate change.[1] The sociotechnical challenges driving these transformations are daunting by any measure. The United States would need to reduce greenhouse gas emissions to 80 percent of 1990 levels by 2050—the so-called "80 X 50 goal"—in order to do its part to keep atmospheric concentration of carbon dioxide to less than 450 parts per million.[2] This goal, in turn, is necessary to avert heightened impacts of climate change, such as heat waves, water shortages, and coastal flooding, which become realities after warming exceeds 2 degrees Celsius.[3]

These high-level targets obscure the complexity of the task of achieving them. Every sector of the economy will have to drastically lower its emissions. As a practical matter, that probably means that transportation will need to be substantially electrified[4] and the electric power sector will itself have to transition from a primarily fossil-fuel-based system to one featuring a portfolio of low-carbon generation.[5] Moreover, all of this would have

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1. *See* Frank W. Geels et al., *Sociotechnical Transitions for Deep Decarbonization*, 357 SCIENCE 1242, 1242 (2017) (stressing the "multidimensionality of the deep decarbonization challenge" and offering a "'sociotechnical' framework" to "accelerate low-carbon transitions" across various systems and sectors).

2. JOHN C. DERNBACH, *Introduction*, *in* LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES 1, 2–3 (Michael B. Gerrard & John C. Dernbach eds., 2019).

3. DEEP DECARBONIZATION PATHWAYS PROJECT, 2015 REPORT: PATHWAYS TO DEEP DECARBONIZATION 3–4 (2015), https://www.iddri.org/sites/default/files/import/publications/ddpp_2015synthetisreport.pdf [https://perma.cc/L6BX-UGBJ] (noting that the Deep Decarbonization Pathways Project aims to keep warming below 2 degrees Celsius, as recommended by the Intergovernmental Panel on Climate Change (IPCC), and works through "backcasting" to identify specific steps that nations can take to achieve that goal); Brad Plumer & Nadja Popovich, *Why Half a Degree of Global Warming Is a Big Deal*, N.Y. TIMES (Oct. 7, 2018), https://www.nytimes.com/interactive/2018/10/07/climate/ipcc-report-half-degree.html [https://perma.cc/5WSP-XRER] (noting the global community has mostly resigned itself to an expected increase of 1.5 degrees Celsius in global temperatures).

4. *See* Huang Wang & Wenying Chen, *Modelling Deep Decarbonization of Industrial Energy Consumption Under 2-Degree Target: Comparing China, India and Western Europe*, 238 APPLIED ENERGY 1563 (2019) (finding that electrification of the transportation sector will be a critical factor).

5. Jesse D. Jenkins et al., *Getting to Zero Carbon Emissions in the Electric Power Sector*, 2 JOULE 2498, 2498 (2018) ("Virtually all credible pathways to climate stabilization entail twin challenges for the electricity sector: cutting emissions nearly to zero (or even net negative emissions) by mid-century, while expanding to electrify and consequently decarbonize a much greater share of global energy use.");

to happen as the electric sector grows to nearly twice its current capacity to accommodate predicted growth in demand.[6] If the United States achieves the overarching goal of averting the worst consequences of climate change, it will only be because we fundamentally reimagined and reconstructed our electric system from scratch in a fraction of the time it took to build in the first place.

While this social project sounds almost too big to complete, it bears noting that we have made enormous strides toward decarbonizing in a very short time and often without the support of national political leadership. This trend is likely to continue, if not accelerate, in large part because industry restructuring has opened the doors for increasingly cheap renewables to compete on an open market for power generation.[7] For the past several decades, Congress, the Federal Energy Regulatory Commission (FERC), and some states have taken steps to restructure vertically integrated utilities and open up both wholesale and retail electricity markets where, theoretically, the fittest sources

TRIEU MAI ET AL., NAT'L RENEWABLE ENERGY LAB'Y, RENEWABLE ELECTRICITY FUTURES STUDY: EXECUTIVE SUMMARY (2012), https://www.nrel.gov/docs/fy13osti/52409-ES.pdf [https://perma.cc/A7UM-62SF].

6. Jenkins et al., *supra* note 5, at 2506 ("Across global decarbonization scenarios produced by 18 modeling groups, for example, electricity demand increases 20%–120% by 2050 (median estimate of 52%) and 120%–440% by 2100; electricity supplies 25%–45% of total energy demand by mid-century and as much as 70% by 2100. In the United States, electricity use could increase 60%–110% by 2050 as electricity (and fuels produced from electricity, e.g., hydrogen) expand from around 20% of final energy demand at present to more than 50% by 2050.").

7. Bill Ritter, Jr., *Market Forces Are Driving a Clean Energy Revolution in the US*, THE CONVERSATION (Apr. 20, 2018, 6:37 AM), https://theconversation.com/market-forces-are-driving-a-clean-energy-revolution-in-the-us-95204 [https://perma.cc/5FA7-BFDL]; BLAIR G. SWEZEY & YIH-HUEI WAN, THE TRUE COST OF RENEWABLES: AN ANALYTIC RESPONSE TO THE COAL INDUSTRY'S ATTACK ON RENEWABLE ENERGY 4 (1995), https://www.nrel.gov/docs/legosti/old/20032.pdf [https://perma.cc/2KFE-FRKM] (noting that coal advocates in the 1990s argued that "'open and direct competition' in electricity markets" would price out renewables but that in reality "the renewable energy industry welcomes truly open and fair competition" because "true competition will provide electricity customers with the ability to choose from an expanded number of electricity suppliers offering alternative services, ones that will include renewables," a situation "akin to shopping at a supermarket"). An illustrative case study is from Texas, where restructuring of energy markets has driven a boom in wind and, increasingly, solar. *See* Chris Lewis, *Cost-Competitive Renewables Poised to Grow in Deregulated Texas Market*, CLEAN ENERGY FIN. F. (Sept. 4, 2019), https://www.cleanenergyfinanceforum.com/2019/09/04/cost-competitive-renewables-poised-to-grow-in-deregulated-texas-market [https://perma.cc/44LF-6PBT].

of power prevail.[8] In some of these areas, clean energy technologies are quickly outcompeting fossil-fuel-based sources of generation, even without subsidies from state governments.[9] On at least one occasion, Texas, one of the most thoroughly deregulated markets, received 48 percent of its electricity from wind.[10] Moreover, consumers and investors favor clean energy, even when it is not necessarily the cheapest source of power in the

8. *See* Emily Hammond & David B. Spence, *The Regulatory Contract in the Marketplace*, 69 VAND. L. REV. 141, 143 (2016); David B. Spence, *Can Law Manage Competitive Electricity Markets?*, 93 CORNELL L. REV. 765, 770 (2008). To be sure, a substantial number of states have not restructured, and even in these states, enormous strides have sometimes been made, often due to state Renewable Portfolio Standards or integrated resource-planning mandates. *See State Renewable Portfolio Standards and Goals*, NAT'L CONF. STATE LEGISLATURES (Aug. 13, 2021), https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx [https://perma.cc/UM2F-E55C]; AM. WIND ENERGY ASS'N, *AWEA Utility Integrated Resource Database*, AM. CLEAN POWER (Jan. 2019) (on file with author). In addition, some states that are traditionally regulated fall within an RTO or ISO region with operative wholesale power markets, and these states have cooperated with these entities in pushes to decarbonize regional grids. The Midcontinent Independent System Operator (MISO) is a case in point. *See MISO: Avoiding the Mess Facing Other Wholesale Competitive Electric Markets*, POWER (Jul. 1, 2017), https://www.powermag.com/miso-avoiding-the-mess-facing-other-wholesale-competitive-electric-markets [https://perma.cc/35T4-VBAA] ("In the MISO system, most of the states' utilities continue to be vertically integrated monopolies, with the responsibility for providing adequate generation to meet retail distribution load. That's unlike the prevailing model to the east, where generation and distribution are separate entities, and the ISOs determine resource adequacy."); *id.* ("MISO, Bear noted, also has been able to provide broad responses to major public policy issues. Wind power is an example. In 2005, MISO had about 300 MW of wind capacity. Today, the system supports 17 GW of wind, or about 8% of the system's generating portfolio. Coal has dropped from 65% of generating capacity to about 35% in MISO's footprint, and gas generation has risen from 10% to 43%. Nuclear makes up a steady 8%.").

9. U.S. ENERGY INFO. ADMIN., LEVELIZED COSTS OF NEW GENERATION RESOURCES IN THE *ANNUAL ENERGY OUTLOOK 2021*, at 6–7 (2021), https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf [https://perma.cc/UF8H-JTH8].

10. Katherine Tweed, *Wind Surges to Nearly 15 Percent of Texas Power Supply*, GREENTECH MEDIA (Nov. 29, 2016), https://www.greentechmedia.com/articles/read/wind-surges-to-nearly-15-percent-of-texas-electricity-generation [https://perma.cc/DG43-QY4T] (noting a day in March 2016 where wind supplied 48 percent of load for one hour of the day). While this became fodder for fundamentally dishonest scapegoating in the aftermath of the Texas blackouts in February 2021, in reality, that crisis was caused by a confluence of factors unrelated to reliance on wind, such as Texas's attempt to isolate itself from interstate grids to avoid federal regulation, inadequate winterization of equipment, and shortages of natural gas caused by extreme winter weather. *See* Jesse Jenkins, *A Plan to Future-Proof the Texas Power Grid*, N.Y. TIMES (Feb. 18, 2021), https://www.nytimes.com/2021/02/18/opinion/future-proof-texas-grid.html [https://perma.cc/4266-W9G4].

short run, and they pressure utilities and market managers to drive change forward.[11] Many of today's problems can be traced not to markets, but to what energy law scholar Joshua Macey calls "zombie energy laws"—hold-outs from the prior era of traditional rate regulation that encumber the smooth operation of market forces in restructured regions.[12] On one account, the challenge is one of marketcraft[13]—simply figuring out the best methods for clearing the brush and allowing the forces of supply and demand to push us toward a decarbonized future.[14]

11. *See* Jill E. Fisch, *Making Sustainability Disclosure Sustainable*, 107 GEO. L.J. 923, 925 (2019) ("[I]ssuers are modifying their operations in response both to investor demands and to the claim that sustainable business practices lead to improved economic performance."); Madison Condon, *Climate Change's New Ally: Big Finance*, BOS. REV. (Jul. 28, 2020), http://bostonreview.net/science-nature/madison-condon-climate-change%E2%80%99s-new-ally-big-finance [https://perma.cc/CGA6-83UB] (detailing efforts by institutional investors like BlackRock to encourage corporations to improve their performance on climate- and sustainability-related metrics).

12. Joshua C. Macey, *Zombie Energy Laws*, 73 VAND. L. REV. 1077, 1080–81 (2020) (arguing that "vestigial remnants" of the public utility regulation model, the certificate of public convenience and necessity, the filed rate doctrine, and rate regulation in certain states "entrench incumbent market power and prevent the deployment of renewables").

13. *See* STEVEN K. VOGEL, MARKETCRAFT: HOW GOVERNMENTS MAKE MARKETS WORK (2018) (analyzing how governments create and manage markets); *see also* William Boyd, *Ways of Price Making and the Challenge of Market Governance in U.S. Energy Law*, 105 MINN. L. REV. 739 (2020) (discussing the ways that law and policy shape markets in the energy space).

14. *See* Jonas J. Monast, *Electricity Competition and the Public Good: Rethinking Markets and Monopolies*, 90 U. COLO. L. REV. 667, 681–83 (2019). This general view can be seen in efforts to get the Southeast, one of the only areas where markets are not operative, to create a regional transmission organization to manage transmission and operate a wholesale power market in the region. The region's refusal to open up market competition is viewed as favorable to incumbent utilities' use of costly fossil fuel generation at ratepayer expense. *See, e.g.*, Sarah Spengeman, *To Rid the Grid of Coal, the Southeast U.S. Needs a Competitive Wholesale Electricity Market*, FORBES (Aug. 25, 2020, 7:00 AM), https://www.forbes.com/sites/energyinnovation/2020/08/25/southeastern-us-competitive-electricity-market-could-save-384-billion-spur-massive-clean-energy-growth-create-400000-new-jobs [https://perma.cc/D52F-CQCN]; Stephen Shparber, *Are Regional Transmission Organizations the Future for Renewables in the Southeast?*, RENEWABLE ENERGY WORLD (Aug. 28, 2019), https://www.renewableenergyworld.com/2019/08/28/are-regional-transmission-organizations-the-future-for-renewables-in-the-southeast [https://perma.cc/8YNZ-D23R]. Some academics have offered a more skeptical and nuanced analysis of whether competitive wholesale markets support renewable energy. *See, e.g.*, Shelley Welton, *Rethinking Grid Governance for the Climate Change Era*, 109 CALIF. L. REV. 209 (2021). This account is supported by the many traditionally regulated states, such as Minnesota, that have activist public utility commissions, energy offices, legislatures, or governors—such states, despite resisting the full push to a market framework for the electricity sector, have achieved arguably just as much, if not more, in the realm of decarbonization. *See, e.g.*, Stephen

This Article, though, takes issue with the idea that these market reforms alone are capable of completely carrying us the rest of the way.[15] It does so by closely examining the legal and economic barriers to fostering necessary investments in complementary energy infrastructure that would allow full development of clean energy resources. There is near complete agreement among policy experts and industry analysts that deep penetration of clean generation technologies necessitates massive investments in certain facilitative technologies—high-voltage transmission lines and grid-scale storage assets (mainly batteries)—that can smooth over inherent limits on the dispatchability of often remote and intermittent renewable generation facilities.[16] Yet, despite this problem being widely recognized and addressed by FERC in a series of orders directed at transmission planning and storage incentives, the progress has been disappointing. Unless something changes drastically, system parameters will prevent the realization of much of the nation's raw renewable potential. There simply will not be a grid capable of managing the unique challenges of an energy portfolio centered on clean energy.

In this Article, I contend that a root cause of sluggish investment in facilitative technologies is the "lumpiness" of the social good of a clean grid. Regulators, policymakers, and academics are searching for solutions that would speed up the development

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Lacey, *Momentum Builds Behind Utility 2.0: Will Minnesota Be the Next State to Reform Utilities?*, GREENTECH MEDIA (Jul. 31, 2014), https://www.greentechmedia.com/articles/read/will-minnesota-be-the-next-state-to-reform-utilities [https://perma.cc/584E-VJSP] (discussing Minnesota's efforts to foster renewable energy adoption by its utilities, including Xcel Energy).

15. For a particularly clear statement of this optimistic view about the market paradigm, see Rich Glick & Matthew Christiansen, *FERC and Climate Change*, 40 ENERGY L.J. 1, 14–15 (2019) (arguing that FERC has ample statutory authority to use market reforms—specifically, those designed to "ensur[e] a level playing field for similarly situated actors," "enhanc[e] competition," and "promot[e] cooperative federalism"—to facilitate the energy transition). Scholars are increasingly pushing back on this paradigm, emphasizing the role that government can and must play in planning for the clean energy transition. *See, e.g.*, Alice Kaswan, *Energy, Governance, and Market Mechanisms*, 72 U. MIAMI L. REV. 476 (2018); Welton, *supra* note 14; William Boyd & Ann E. Carlson, *Accidents of Federalism: Ratemaking and Policy Innovation in Public Utility Law*, 63 UCLA L. REV. 810 (2016); Felix Mormann, *Enhancing the Investor Appeal of Renewable Energy*, 42 ENV'T L. 681 (2012).

16. *See, e.g.*, MAI ET AL., *supra* note 5, at iii ("RE Futures finds that increased electric system flexibility, needed to enable electricity supply-demand balance with high levels of renewable generation, can come from a portfolio of supply- and demand-side options, including flexible conventional generation, grid storage, new transmission, more responsive loads, and changes in power system operations.").

of this clean grid, such as overcoming difficulties with siting transmission lines,[17] clearing barriers to participation of storage in wholesale markets as a generation asset,[18] or pushing in the direction of treating transmission and distribution, like generation, as a competitive enterprise.[19] However, this Article suggests that they need to look deeper. In the energy world, deep penetration of renewable generation capacity is worthless if the grid is not capable of integrating it, and the converse is true as well. Major interregional transmission or storage investments could lose most of their value if the renewable energy they were built for fails to materialize. These realities make investment in a clean grid a lumpy social good: a social good is "lumpy" if it only delivers value when irreducibly complementary parts are "assembled."[20] To put this fundamental point another way, the energy transition is like a bridge or a jigsaw puzzle: unless and until all the necessary pieces come together, the project as a whole and the individual pieces themselves are of substantially less value. To date, energy scholarship and policymaking have not identified lumpiness as a discrete problem for energy markets in the energy transition. This Article closes that gap.[21]

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17. *See, e.g.*, AVI ZEVIN ET AL., BUILDING A NEW GRID WITHOUT NEW LEGISLATION: A PATH TO REVITALIZING FEDERAL TRANSMISSION AUTHORITIES 9 (2020) (describing federal statutory provisions that allow federal regulators to bypass state roadblocks to the siting of transmission lines, but which have not been used to date to site any interstate transmission lines); Alexandra B. Klass, *Transmission, Distribution, and Storage: Grid Integration*, *in* LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES, *supra* note 2, at 527, 540–44.

18. Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, 162 FERC ¶ 61,127 (Feb. 15, 2018) [hereinafter Order 841].

19. Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, 136 FERC ¶ 61,051 (Jul. 21, 2011) [hereinafter Order 1000]; *see also* Ari Peskoe, *Is the Utility Transmission Syndicate Forever?*, 42 ENERGY L.J. 1 (2021) (arguing that a central reason interregional transmission is not being built is because of incumbent utilities' use of their state-granted monopoly territories to work as a "syndicate" to control transmission and prevent the introduction of competition).

20. *See infra* Section II.A. I borrow the concept of lumpiness from Lee Anne Fennell, whose work centers on property rights but has deep implications for energy law and policy. *See* LEE ANNE FENNELL, SLICES AND LUMPS: DIVISION + AGGREGATION IN LAW AND LIFE (2019); Lee Anne Fennell, *Lumpy Property*, 160 U. PA. L. REV. 1955 (2012).

21. Other scholars have generally hinted at the problem I focus on. *See, e.g.*, William Boyd, *Public Utility and the Low-Carbon Future*, 61 UCLA L. REV. 1614, 1618 (2014) ("The planning, sequencing, and financing of hundreds of billions of dollars in new investments needed to modernize the electric power grid and build new low carbon generation will require a level of certainty regarding cost recovery

The lumpiness of the social good of building a clean grid matters for investment decisions being made right now. When the value prospect of utility-scale renewable generation is contingent on large-scale development of facilitative infrastructure by separate actors with their own incentives and regulatory environment, the result is mutual uncertainty about whether the total value of the "lump" will ever materialize. This mutual uncertainty can artificially suppress investment in each complementary component of the clean grid below what it would be were it possible to coordinate the investments. The resulting mutual uncertainty about whether complementary and necessary investments will ever be made inevitably alters and distorts the operation of market forces, as investors in renewable generation may rationally default to a risk-dominant strategy that leaves a more socially optimal, coordinated clean grid on the table.[22]

Markets are no answer to this problem. Markets are effective instruments for finding the lowest-cost sources of electricity generation today or in the very near future, but these prices reflect deep uncertainties about whether there will be sufficient investments in transmission or storage.[23] In the absence of price signals reflecting the value of the entire lump—the renewable generation *with* the facilitative technologies they rely on—the incentives for investment in generation are lower than they might be with a firm societal commitment to revamping the grid.[24] Likewise, without certainty that potential clean

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that markets alone will have difficulty providing."). But this Article unpacks the reasons for this market failure at a more microeconomic level and focuses on one key part of decarbonizing the electric grid—namely, the building of high-voltage, interregional transmission capable of delivering renewable energy from the remote areas where its potential is highest to the population centers where it needs to be used.

22. *See infra* Section II.A.

23. Geels et al., *supra* note 1, at 1242–43 ("[A]ccelerated low-carbon transitions in electricity depend not only on the momentum of renewable energy innovations such as wind, solar PV, and bio-energy but also on complementary innovations, including energy storage (e.g., batteries, flywheels, compressed air, and pumped hydro); smarter grids (to enhance flexibility and grid management); demand response (e.g., new tariffs, smart meters, and intelligent loads); network expansion (to increase capacity, connect remote renewables, and link to neighboring systems); and new business models and market arrangements (such as energy-only markets and capacity markets to ensure system security).").

24. Jenkins et al., *supra* note 5, at 2509 ("Given the challenges now facing available firm low-carbon resources, it is tempting for policymakers, socially conscious businesses, and research efforts to bet exclusively on today's apparent winners: solar photovoltaics (PV), wind, and battery energy storage. That would be a mistake. As this review indicates, several obstacles must be overcome to cost-

generation will be developed, transmission and storage development is likely to be limited, since such infrastructure only pays off if there is sufficient energy to justify it. While contracting can and does reduce the uncertainty created by markets to facilitate some of these transactions,[25] at least on a piecemeal basis, the costs of such transactions at a societal scale across thousands of players are high.[26] This chicken-or-egg problem (who builds what first?) can only be overcome in iterative fashion, which operates far too slowly, given the impending threat of climate change.

If the goal is to reconstruct energy regulation so that it can provide a level playing field for renewable and low-carbon generation of electricity,[27] then lumpiness must be accounted for, and a powerful coordinating force beyond markets needs to be deployed. As it is, FERC's foundational policies only compound the problem or nibble around it. For instance, foundational FERC orders encouraged the functional unbundling of generation and transmission, allowing for greater competition on the generation side while simultaneously increasing the barriers to

effectively decarbonize electricity regardless of whether wind and solar are expected to deliver the vast majority of electricity or we pursue a more diverse portfolio of resources. We cannot assume that public opposition and siting challenges for new, continent-spanning transmission networks can be overcome; that flexible demand will be unlocked at sufficient scale; that wind and solar PV will continue deep and sustained cost declines; or that order-of-magnitude cheaper 'seasonal' storage technologies will become widely scalable. Any one of these things may well happen, but it is far less likely all will be simultaneously achieved.").

25. *See* Herman K. Trabish, *Solar + Wind + Storage Developers 'Gearing Up' as Hybrid Projects Edge to Market*, UTIL. DIVE (Jul. 9, 2019), https://www.utilitydive.com/news/solar-wind-storage-developers-gearing-up-as-hybrid-projects-edge-to-m/556480 [https://perma.cc/48RK-VSP4]; Peter Maloney, *How Can Tucson Electric Get Solar + Storage for 4.5¢/kWh?*, UTIL. DIVE (May 30, 2017), https://www.utilitydive.com/news/how-can-tucson-electric-get-solar-storage-for-45kwh/443715 [https://perma.cc/25KB-UXSQ]. For instance, renewable energy projects have begun to incorporate large storage resources into their bids for Power Purchase Agreements (PPAs), which are contracts for the provision of renewable energy to a buyer. *See* Trabish, *supra*. A good example is the Tucson Electric Power solar-plus-storage project, which offered one of the lowest prices for solar energy in U.S. history by pairing panels with storage and banked on the long-term efficiency of the pairing to keep the offer low. *See* Maloney, *supra*.

26. James M. Griffin & Steven L. Puller, *Introduction: A Primer on Electricity and the Economics of Deregulation*, *in* ELECTRICITY DEREGULATION: CHOICES AND CHALLENGES 1, 10–11 (James M. Griffin & Steven L. Puller eds., 2005) (discussing the ways that vertical integration solves for high transaction costs in interfirm investment in "transaction-specific assets").

27. Ignacio J. Pérez-Arriaga et al., *A Regulatory Framework for an Evolving Electricity Sector: Highlights of the MIT Utility of the Future Study*, 6 ECON. ENERGY & ENV'T POL'Y 71, 79 (2017).

the kind of coordination that could help to overcome lumpiness dynamics in generation and transmission planning.[28] FERC has subsequently attempted to address the lack of incentives for interregional transmission planning[29] and storage,[30] but in none of these actions did FERC appreciate just how much coordination is necessary to overcome lumpiness dynamics. It is not enough to double down on competition in the transmission subsector.[31] Nor will it be enough to clear away some of the state-level process barriers to siting infrastructure if incentives for investment are lacking.[32] I argue instead that the challenge going forward is increasing the coordination of two subsectors that are kept at arm's length from each other by regulatory design. It is no wonder that the problem has gone unremedied: it forces FERC to face problems inherent in its entire approach to regulating the electric power sector that have only become apparent as that sector faces down the social imperative to decarbonize.

Fortunately, there are ways to overcome lumpy barriers to decarbonization without discarding twenty-five years of industry restructuring, but such reforms require approaches that are sensitive to the problem and designed explicitly around remedying it. While there may be more, I identify two approaches that could improve outcomes if FERC and/or Congress were to adopt them. First, following the lead of state and regional pilot projects, regulators could nationalize the kind of "renewable energy development zones" used by some states in the past. Under this approach, regulators and utilities could combine generation, transmission, and storage planning, comprehensively

28. Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities, 75 FERC ¶ 61,080 (Apr. 24, 1996) [hereinafter Order 888]; Regional Transmission Organizations, 89 FERC ¶ 61,285 (Dec. 20, 1999) [hereinafter Order 2000].

29. Promoting Transmission Investment through Pricing Reform, 116 FERC ¶ 61,057 (Jul. 20, 2006) [hereinafter Order 679]; Preventing Undue Discrimination and Preference in Transmission Service, 118 FERC ¶ 61,119 (Feb. 16, 2007) [hereinafter Order 890]; Order 1000, *supra* note 19.

30. Order 841, *supra* note 18.

31. FERC is presently considering whether to revamp its "failed" competitive bidding processes from Order 1000. *See* Ethan Howland, *8 States, DC Urge FERC to Reject EEI, Eversource Call to Drop Competition for Transmission Projects*, UTIL. DIVE (Nov. 29, 2021), https://www.utilitydive.com/news/state-utility-regulators-ferc-competition-rofr-transmission/610608 [https://perma.cc/JC4J-ZJKD].

32. Some scholars and analysts have pointed to the politically treacherous and veto-gated siting process as a root cause of limited development of high-voltage transmission lines. *See infra* notes 138–144 and accompanying text.

evaluating the potential for renewable energy and allowing the true value of the lumpy good to inform investment and guide approvals.[33] While FERC and the Department of Energy likely have the statutory authority they need to set up the transmission-related aspects of such an approach,[34] Congress would likely need to give federal regulators greater say in generation siting.[35] FERC would also need to abandon, at least to some degree, its agnosticism about the mix of resources in the generation portfolio.[36] The second option is to revisit FERC's approach to cost-allocation and allow transmission and storage developers an attractive return on equity that reflects their specific contributions and offsets the costs of uncertainty. Both of these options would clear the way for meaningful progress in building interregional transmission and clean generation necessary to achieve climate change goals.[37]

This Article begins in Part I with a primer on the arcane world of energy regulation, focusing on how energy markets came to replace the traditional model of public utility regulation and how that shift in governance shapes the investment choices that will, in turn, shape the future of the energy system. I argue that mutual uncertainty resulting from the lumpiness of a clean grid dampens investment in both renewable generation and facilitative infrastructure, since it helps explain why generation and transmission investments are planned in silos without explicit coordinating mechanisms. In Part II, I turn to the main argument, first by drawing lessons from law and economics literature on lumpy social goods, then by demonstrating that the lessons of that literature apply to the energy transition. Specifically, I show that the prospects for rollout of new transmission and storage are cloudier than they should be due to a lack of credible commitments to providing the level of renewable generation that would be necessary to make these massive infrastructure investments worthwhile, and vice versa. Finally, in Part III, I describe existing efforts to facilitate coordination and planning of complementary pieces of the energy transition and show how

33. *See infra* Section III.C.

34. *See infra* text accompanying notes 184–185.

35. *See infra* text accompanying notes 252–256.

36. *See infra* Section III.C.

37. At the very least, FERC should revisit its transmission planning order and express a public policy commitment to developing a national supergrid, optimized with interregional lines and massive storage facilities, and mandate planning around that commitment.

they fall short of overcoming the problem. I then propose different approaches that could be taken to address the lumpiness dynamics standing in the way of a clean energy transition and urge that FERC, perhaps acting with Congress, adopt them.

I. THE ROOTS OF THE PROBLEM: RESTRUCTURING IN THE ELECTRIC POWER SECTOR

The gradual shift over the course of the last century in how participants in the energy system conceive of what they are doing makes for a fascinating story, looping together changes in technical systems, evolving views of economic concepts, and reconsideration of regulatory theory. Section I.A tells the first part of this story: the story of the regulatory compact; Section I.B then recounts the unraveling of that traditional model of regulation. Although electricity is no ordinary marketable commodity, it is increasingly being treated like one by producers, regulators, and consumers. That takeaway, in turn, serves as the jumping-off point for this Article's central contribution—identification of the persistence of lumpiness problems as the newly minted power markets turn to the social task of decarbonization—which I address in Part II.

A. *The Traditional Model: The Regulatory Compact*

For much of the twentieth century, the electricity sector was considered the paradigm of an industry subject to the conditions necessitating a regulatory compact—a unique arrangement in American capitalism wherein firms with certain characteristics possess the right to exclude competitors by submitting to heavy-handed control by regulatory commission.[38] Considered as a

38. Jersey Cent. Power & Light Co. v. FERC, 810 F.2d 1168, 1189 (D.C. Cir. 1987) (Starr, J., concurring) ("The utility business represents a compact of sorts; a monopoly on service in a particular geographical area (coupled with state-conferred rights of eminent domain or condemnation) is granted to the utility in exchange for a regime of intensive regulation, including price regulation, quite alien to the free market."); Boyd, *supra* note 21, at 1643 & n.106 (defining the regulatory compact as the arrangement where, "[i]n return for an exclusive franchise, the right of eminent domain, and an ability to sell electricity at reasonable rates, electric utilities would provide reliable, universal service and forgo some of the profits that might be attainable in the absence of [price] regulation"). Some scholars resist the label "regulatory compact," arguing that its continued use "reinforces incumbents' advantages by erroneously suggesting that the industry must develop within the confines of an imaginary century-old agreement," thereby "dampening the sector's

package of vertically integrated services (generation of electric power, transmission, and distribution to end users),[39] the electricity sector took on the characteristics of network industries, or natural monopolies, meaning that it was economically inefficient for there to be more than one firm providing service over a given territory.[40] If competitors each offered their fully integrated service to the same customers, there would be unnecessary and wasteful duplication of construction of costly network infrastructure necessary to provide service. In such situations, for the customer, it was potentially better for one provider holding an exclusive franchise to do business in a given territory.[41] At the same time, the exclusive franchise gave the incumbent firm nothing short of monopoly pricing power.[42] Consumers could not object to exorbitant pricing since service from the incumbent firm was a take-it-or-leave-it proposition.

The regulatory compact solved this problem by playing Solomon. Firms could be granted lucrative exclusive franchises and a guarantee of customers befitting their natural monopoly.[43] At the same time, firms had to accept that a public utility commission would have ultimate control over minute details of their operations, including all building and expansion plans, the rates or prices that could be charged, the types and qualities of

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innovative potential." Letter from Ari Peskoe, Senior Fellow in Elec. L., Harvard Env't Pol'y Initiative, to Quadrennial Energy Rev. Task Force, http://eelp.law.harvard.edu/wp-content/uploads/Harvard-Environmental-Policy-Initiative-QER-Comment-There-Is-No-Regulatory-Compact.pdf [https://perma.cc/89YC-S7JR]. The regulatory compact may therefore be on the wane as an organizing frame, but the natural monopoly characteristics of parts of the electricity sector continue to present very real challenges for regulators.

39. *See Electricity Explained: How Electricity Is Delivered to Consumers*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/electricity/delivery-to-consumers.php [https://perma.cc/V3ZK-4MK2] (Oct. 22, 2020).

40. Griffin & Puller, *supra* note 26, at 2 ("A natural monopoly is simply the case where a single firm can produce the total market output at a lower cost than can a collection of individual competitive firms. Each sector of the industry—the generation at power plants, the high-voltage transmission of power, and the local distribution and metering—has natural monopoly characteristics . . . . Thus single vertically integrated firms were ideally suited to serve the various isolated pockets of demand."); RICHARD F. HIRSH, POWER LOSS: THE ORIGINS OF DEREGULATION AND RESTRUCTURING IN THE AMERICAN ELECTRIC UTILITY SYSTEM 17–18 (1999) (discussing the concept of natural monopoly and its application to the utility industry).

41. Richard A. Posner, *Natural Monopoly and Its Regulation*, 21 STAN. L. REV. 548, 548 (1969).

42. *Id.* at 562.

43. HIRSCH, *supra* note 40.

services provided, and the profits that could be made.[44] Around the turn of the twentieth century, firms like Samuel Insull's Commonwealth Edison in Chicago took to the state governments to obtain expansive and exclusive franchises under the regulatory compact, which allowed them to grow their business without competitive pressures.[45]

At the center of the regulatory compact is the power of a public utility commission to set rates for electricity service.[46] While the Supreme Court recognized early on that certain industries could be treated as "affected with a public interest" and rate regulated,[47] the precise contours of public utility commissions' powers to regulate rates under the regulatory compact were not immediately clear. Since limiting chargeable rates for a provided service could be considered a taking of private property, public utility commissions had to figure out what rates qualified as "reasonable" compensation for these for-profit companies and the methodology for determining those rates.[48] The ability to recover operating costs alone would not provide any incentives to attract investors and build capital assets.[49] But anything above operating costs required public utility commissions to make difficult determinations about what kind of rate of

44. HIRSH, *supra* note 40, at 26–29 (discussing the obligations and benefits associated with the regulatory compact); Boyd, *supra* note 21, at 1638–39; *see* Hammond & Spence, *supra* note 8, at 149.

45. HAROLD L. PLATT, THE ELECTRIC CITY: ENERGY AND THE GROWTH OF THE CHICAGO AREA, 1880-1930, 59–60 (1991); Forrest McDonald, *Samuel Insull and the Movement for State Utility Commission Regulation*, 32 BUS. HIST. REV. 241, 244–46 (1958). For a brief moment, a movement in favor of reclaiming public control over the industry in the form of nonprofit municipal utilities took hold of the imagination of Progressive Era activists and scholars. Shelley Welton, *Public Energy*, 92 N.Y.U. L. REV. 267, 304–07 (2017). But it was not to be. The model that took off was the rate-regulated, private-investor-owned, vertically integrated utility model, and this model still exists to some degree to this day in certain regions of the country. MASON WILLRICH, MODERNIZING AMERICA'S ELECTRICITY INFRASTRUCTURE 95–96 (2017); HIRSH, *supra* note 40, at 15.

46. *Jersey Cent. Power*, 810 F.2d at 1189.

47. Munn v. Illinois, 94 U.S. 113, 126 (1876). *See generally* HIRSH, *supra* note 40, at 15–16.

48. Smyth v. Ames, 169 U.S. 466 (1898) (establishing a rigid set of considerations for determining the "fair return upon the value" of the utility's capital assets that would comport with due process). In *Federal Power Commission v. Hope Natural Gas Co.*, the Supreme Court clarified that the precise methodology of determining a "fair return" is not set in stone and that what matters is the "end result"—so long as the resulting rates are just and reasonable, balancing both the utility's and the public's interests, they can be imposed. *See Federal Power Comm'n v. Hope Nat. Gas Co.*, 320 U.S. 591, 602 (1944).

49. LINCOLN L. DAVIES ET AL., ENERGY LAW AND POLICY 293 (2d ed. 2018).

return the market—a market that, by definition, did not exist—would provide and when a rate of return was unjust and unreasonable to the captive consumer.[50]

While this determination was fraught with difficulty, the public utility commissions ultimately converged on a fairly standard formula for regulators to follow: utilities would be allowed to recover the costs of service from ratepayers, where the costs of service included the "rate base," or capital investments (minus depreciation), multiplied by the allowable "rate of return" on that investment (usually set around 10 percent but varying by local market conditions), plus basic operating expenses (think salaries for employees and the cost of fuel).[51] The thinking behind this formula was that it approximated the results of a competitive market, at least so long as utilities only made prudent investment decisions for capital assets like power plants and transmission and distribution lines. In some states, utilities were required to engage in integrated resource planning (IRP) to ensure that these investment decisions were prudent.[52] However, the key backstop was the rate hearing, where the utility would defend its request for a rate increase to cover a new investment in front of the public utility commission and rate payers themselves as intervenors.[53]

The regulatory compact prevailed without serious difficulties for about half of the twentieth century, balancing the monopoly power of vertically integrated utilities with the public interest, but it was not sustainable. While the grid was still developing and there were ever greater economies of scale to be realized in expansion, the ratemaking formula used by public commissions across the country facilitated major capital investment without resulting in exorbitant rate hikes to customers.[54]

50. *Hope Nat. Gas*, 320 U.S. at 605 ("Rates which enable the company to operate successfully, to maintain its financial integrity, to attract capital, and to compensate its investors for the risks assumed certainly cannot be condemned as invalid, even though they might produce only a meager return on the so-called 'fair value' rate base.").

51. JOEL B. EISEN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT 455–57 (4th ed. 2015); DAVIES ET AL., *supra* note 49, at 300–04.

52. Coley Girouard, *Understanding IRPs: How Utilities Plan for the Future*, ADVANCED ENERGY PERSPS. (Aug. 11, 2015, 4:59 PM), https://blog.aee.net/understanding-irps-how-utilities-plan-for-the-future [https://perma.cc/TCX9-JWS8].

53. EISEN ET AL., *supra* note 51, at 460; DAVIES ET AL., *supra* note 49, at 304–07.

54. Joseph P. Tomain, *Electricity Restructuring: A Case Study in Government Regulation*, 33 TULSA L.J. 827, 833 (1998).

The nation needed lots of transmission wires as utilities moved power plants to the outskirts of metropolitan areas,[55] and absolute demand for electricity grew steadily.[56] Eventually, though, the party ended. Starting in the 1970s, oil price shocks,[57] diminishing economies of scale,[58] cost overruns on nuclear power projects and subsequent attempts to pass those costs to rate payers,[59] and other factors drove retail prices of electricity up.[60]

On top of this, critics of cost-of-service regulation identified a potential flaw in the very idea of guaranteeing recovery on capital investments. The Averch-Johnson effect—the tendency for rate-regulated utilities to grow the rate base to maximize the return, whether or not specific investments made fiscal sense—suggested systemic failures by public utility commissions to monitor the prudence of investment decisions.[61] The modern theory of "regulatory capture," where regulation allegedly serves the interests of the very entities that are supposed to be regulated, emerged in large part to explain these failures.[62]

Eventually, cracks in the traditional regulatory model began to emerge. Most notably, Congress responded to rising retail prices by opening the door to non-utility generation in the Public Utility Regulatory Policies Act of 1978 (PURPA), which required utilities to purchase power from competitor generators at

55. PLATT, *supra* note 45, at 162–90.

56. Tomain, *supra* note 54, at 833.

57. Boyd, *supra* note 21, at 1658.

58. *Id.*

59. *See* Richard J. Pierce, Jr., *The Regulatory Treatment of Mistakes in Retrospect: Canceled Plants and Excess Capacity*, 132 U. PA. L. REV. 497 (1984).

60. Paul L. Joskow, *The Difficult Transition to Competitive Electricity Markets in the United States*, *in* ELECTRICITY DEREGULATION: CHOICES AND CHALLENGES, *supra* note 26, at 31, 34–35 ("Serious problems began to emerge during the 1970s and 1980s as fossil fuel prices rose, inflation and interest rates rose, nuclear power plant costs exploded . . . [and] real retail electricity prices rose significantly.").

61. *See* Shi-Ling Hsu, *Capital Rigidities, Latent Externalities*, 51 HOUS. L. REV. 719, 755–56 (2014) (defining the Averch-Johnson effect and noting that "[e]mpirical evidence for the Averch–Johnson effect is not unambiguous, but generally supportive").

62. William J. Novak, *A Revisionist History of Regulatory Capture*, *in* PREVENTING REGULATORY CAPTURE: SPECIAL INTEREST INFLUENCE AND HOW TO LIMIT IT 25 (Daniel Carpenter & David A. Moss eds., 2013). It is important to note that it is not necessarily the case that the cure is better than the disease when it comes to regulatory capture. Recent analyses of restructuring in the electricity sector find some evidence that decisions to restructure retail electricity markets are driven by incumbent firms who are well-positioned to profit from the competition. *See, e.g.*, J. Dean Craig, *Motivations for Market Restructuring: Evidence from U.S. Electricity Deregulation*, 60 ENERGY ECON. 162 (2016); *see also* Welton, *supra* note 14.

"avoided cost" rates, or the rate that a utility would have to pay to generate the electricity itself or purchase it from another utility.[63] This first experiment with breaking up vertical integration in electricity systems was not an unmitigated success,[64] but it did perhaps break down the previously widely held assumption that electricity business must be regulated as a vertically integrated natural monopoly in all respects.[65] These cracks in the regulatory compact would pave the way for more fundamental restructuring of the industry in the following decades.

B. *Restructuring: The Introduction of Competition*

Starting in the 1990s, policymakers at the state and federal level took the next logical steps and began restructuring the electricity sector.[66] The first step began by treating each subsector of the electricity utility business separately, rather than as a package of related services.[67] In some states, public utility commissions ordered incumbent utilities to divest themselves of their generation assets (i.e., their power plants), allowing the remaining distribution utilities to purchase electric power from the lowest-cost sources.[68] This move is widely referred to as "unbundling."[69] Generators would no longer pass the costs of their new plant on to rate payers with the public utility commission's blessing; instead, they would make decisions about whether to invest in a particular generation asset based on the prices they could charge on a wholesale market for electric power.[70]

63. Richard D. Cudahy, *PURPA: The Intersection of Competition and Regulatory Policy*, 16 ENERGY L.J. 419, 422 (1995).

64. Joskow, *supra* note 60, at 35 (arguing that it actually led to a rise in retail prices in states that too aggressively enforced PURPA).

65. Benjamin F. Hobbs & Shmuel S. Oren, *Three Waves of U.S. Reforms: Following the Path of Wholesale Electricity Market Restructuring*, IEEE POWER & ENERGY MAG., Jan.–Feb. 2019, at 73, 74.

66. *Id.*

67. Richard J. Pierce, Jr., *Antitrust Policy in the New Electricity Industry*, 17 ENERGY L.J. 29, 32 (1996) (discussing "functional unbundling," wherein utilities are required to "separate [their] transmission, distribution, and generation functions and to perform each function as if it were being performed by a separate firm").

68. Tomain, *supra* note 54, at 842.

69. *Id.* at 841 (describing Order 888, *supra* note 28, as involving "functional unbundling of a utility's vertically integrated electricity products").

70. *See* Joshua C. Macey & Jackson Salovaara, *Rate Regulation Redux*, 168 U. PA. L. REV. 1181, 1186–87 (2020). This presented a dilemma for regulators of how to deal with generation investments made before the shift to a market-based model, which are not guaranteed to recoup costs through market transactions—the so-

At the same time, policymakers realized that the transmission subsector likewise needed its own governance regime to work efficiently with the restructured generation subsector. Because owners of generation assets often no longer owned the transmission assets they needed to bring their energy to market, the risk that hold-out problems and bottlenecks would prevent prices from converging on a competitive equilibrium became tangible.[71] By refusing to deal, transmission owners could drive prices up, and because transmission lines (unlike generation) are more of a natural monopoly,[72] competition could not be relied on to supply new transmission lines to satisfy the need. The answer policymakers offered to this problem was similar to restructuring efforts in other sectors, such as the internet services sector: the network of transmission lines would be treated as a commons subject to open-access tariffs.[73] That is, transmission line owners were required to allow all generators to use the transmission lines on the same terms, conditions, and prices as the transmission owner's own generation.[74] But although previously proprietary transmission networks were restructured into an open-access network, the rates charged were still set through traditional cost-of-service ratemaking.[75]

Finally, distribution and metering were left largely untouched by the wave of restructuring. Local distribution utilities still purchase their power on the bulk or wholesale power market, where they already have every incentive to purchase power as cheaply as possible to satisfy the retail demand in their jurisdictional territory. Since distribution networks are the ultimate natural monopoly, there is little to be gained, and perhaps much to lose, by permitting multiple utilities to provide the service of delivering power to individual customers.[76]

called stranded cost problem. *Id.* It also relates to another problem—the missing money problem—wherein nonrenewable generators are increasing unable to recoup their costs due to price caps in wholesale markets and the falling clearing prices driven by an influx of renewables with low variable costs. *Id.*

71. Tomain, *supra* note 54, at 837–38.

72. Joseph P. Tomain, *The Persistence of Natural Monopoly*, 16 NAT. RES. & ENV'T 242, 242 (2002).

73. Order 888, *supra* note 28; Tomain, *supra* note 54, at 841–42.

74. Tomain, *supra* note 54, at 841–42.

75. *Id.*

76. There is one caveat to this generalization. In the 1990s, some states created so-called "retail choice" mechanisms to allow consumers to choose their generation provider. *See* WILSON GONZALEZ, RESTRUCTURED STATES, RETAIL COMPETITION, AND MARKET-BASED GENERATION RATES, at C-1 (2015),

In sum, restructuring partially reconfigured the relationship between regulators and utilities and relaxed assumptions that each subsector of the electricity business needed to be regulated as a single bundle of services, with each considered a natural monopoly. While these changes are sometimes referred to as "deregulation," that moniker is fundamentally misleading. What really happened was a trend toward unbundling of the generation, transmission, retail, and distribution components of electricity service.[77] Even where rate regulation was largely replaced by competition amongst firms, as it was in the power generation subsector, regulation retains its importance. Just as before, an "unreasonable" rate is an unlawful rate,[78] but instead of ensuring reasonableness of interstate wholesale rates through ex ante rate hearings, competition would ensure reasonableness.[79] In addition, regulation of the transmission subsector

https://www.raponline.org/wp-content/uploads/2016/05/appendix-c-smart-rate-design-2015-aug-31.pdf [https://perma.cc/34EM-F7R8]. The local utility in such jurisdictions still handled the distribution on its own distribution network (which was regulated under a cost-of-service framework), thus avoiding wasteful duplication, but the electricity itself could be from any number of different utilities or independent generators. *Id.* After problems with market manipulation drove the price of retail energy through the roof in California, many states abandoned their retail choice programs, none have since added retail choice, and only a handful of states (most notably, Texas) still operate retail choice programs. *See* David Schraub, *Renewing Electricity Competition*, 42 FLA. STATE U. L. REV. 937, 961–62 (2015). For all intents and purposes, the retail and distribution subsector is still regulated as it was before the wave of restructuring. *See* Joel B. Eisen, *The Environmental Responsibility of the Regionalizing Electric Utility Industry*, 15 DUKE ENV'T L. & POL'Y F. 295, 295–96 (2005).

77. Hobbs & Oren, *supra* note 65, at 74. *See generally* Tomain, *supra* note 54.

78. 16 U.S.C. § 824d(a).

79. *Electric Competition*, FERC, https://www.ferc.gov/industries-data/electric/power-sales-and-markets/electric-competition [https://perma.cc/R8UR-NCLK] (Aug. 6, 2020). In many ways, generators in restructured markets are more regulated than they were before, albeit through different methods. Jim Rossi & Hannah J. Wiseman, *Constrained Regulatory Exit in Energy Law*, 67 DUKE L.J. 1687 (2018). When FERC restructured interstate wholesale markets, its new method of oversight centered on ensuring that participating firms lacked market power, which could allow them to manipulate prices. *See* Market-Based Rates for Wholesale Sales of Electric Energy, Capacity and Ancillary Services by Public Utilities, 119 FERC ¶ 61,295 (June 21, 2007) [hereinafter Order 697]. The early experience with restructured electricity markets in California, where market manipulation by power marketers like Enron ran amok, made it clear to FERC that simply allowing competitor firms to trade on an open market without rigorous market power preclearance screens or rules against market manipulation presented serious risks for ratepayers. In turn, and with the steady prodding of courts, FERC developed elaborate premarket review mechanisms and prohibited market manipulation tactics. California *ex rel.* Lockyer v. FERC, 383 F.3d 1006 (9th Cir. 2004). For a comprehensive look at FERC's responses to market manipulation, see Boyd, *supra* note 13.

continues to be necessary, if not more necessary than ever before. The shift to markets for wholesale generation, while possible, is not as straightforward from an operational standpoint as it is with most other commodities. The transmission grid still must be balanced at a granular level in real time or there is risk of damage to the system or blackouts and brownouts, which can cost billions of dollars.[80] The need for a heavy-handed system operator is thus unavoidable. Integrating this heavy-handed operation with markets to the maximum extent possible requires carefully calibrated market-based tariffs and heavy computational artillery to ensure fine balancing while protecting consumers from price gouging. FERC, therefore, continues to regulate the transmission subsector, albeit with substantial delegation to quasi-governmental Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs).[81] Where they exist, RTOs and ISOs plan and operate the transmission system and sometimes design and run markets for wholesale electricity.[82]

One aspect of restructured markets goes to the heart of the problem discussed in Part II. In the traditional model, vertically integrated utilities either built their own transmission lines, connecting their power plants to distribution networks in their territories, or they contracted for transmission services with other utilities.[83] As a practical matter, it most often made sense to build transmission lines whenever there was generation opportunity, as utilities could obtain cost recovery plus a return on

80. Lauren Dunlap et al., *Electricity 101: Terms and Definitions*, RESOURCES FOR THE FUTURE (Mar. 3, 2020), https://media.rff.org/documents/Electricity_101.pdf [https://perma.cc/F9WB-SPTA] ("Grid operators (also known as transmission system operators) balance grid operations by ensuring that the amount of electricity put into the grid matches the amount of electricity used by consumers. They work with all of the utilities, generators, and retailers to ensure that the grid is balanced and reliable: too little power can cause blackouts, while too much can cause damage to equipment.").

81. *See* Order 2000, *supra* note 28.

82. *Id.*; *see also* Hannah J. Wiseman & Hari M. Osofsky, *Regional Energy Governance and U.S. Carbon Emissions*, 43 ECOLOGY L.Q. 143, 185–86 (2016) (describing the role and responsibilities of RTOs and ISOs in regional energy governance).

83. R. Ryan Staine, Note, *CREZ II, Coming Soon to a Windy Texas Plain Near You?: Encouraging the Texas Renewable Energy Industry Through Transmission Investment*, 93 TEX. L. REV. 521, 527 (2014) ("For most of its existence, the electric market in the United States was vertically integrated from the power-generation stage to the market stage. This format made transmission investment a relatively simple process: generally, a single company would build power lines to get its own power to customers.").

investment from ratepayers for any capital asset, transmission included. By contrast, in restructured markets, owners of generation often do not develop their own transmission.[84] While the availability of FERC-approved cost recovery for the transmission line still provides some incentive for *other* firms—standalone transmission utilities or merchant transmission companies—to build new transmission to support new generation,[85] this introduces new transaction costs. In discrete cases, it is not difficult for the pieces to align organically. In cases where a discrete new generation facility provides a definite value to the grid, transmission developers are likely to see opportunity as well. As long as the project is well-defined and limited in geographic scope, transaction costs may be manageable, and contractual agreements can fuse the two companies as if they were basically one vertically integrated firm on a project-by-project basis. However, as Part II of this Article argues, these ideal circumstances rarely facilitate coordinated investments in society-scale projects that could provide the groundwork for a clean energy transition.

II. LUMPINESS PROBLEMS IN THE ENERGY ECONOMY

This Part develops the core argument of this Article: the organization of the modern electricity sector artificially slices a lumpy good, dissolving the alignment of incentives necessary to make coordinated complementary investments in clean generation and transmission at societal scale. I start with a review of the law and economics of "lumpiness" before applying these concepts to the efforts to build out intermittent renewable energy generation and the infrastructure necessary to integrate that renewable energy seamlessly into the grid.

A. *The Concept of Lumpiness*

Most things we buy, sell, manufacture, and develop are pretty simple. They come in a unit that is valuable on its own

84. *Id.*

85. *See* Order 679, *supra* note 29, at para. 221 (creating a category of "Transcos" that are able to obtain a return on equity on their stand-alone transmission investments). Recent years have seen the rise of "merchant" transmission developers who essentially provide these services without acting as a public utility. *See* Shelley Welton, *Non-Transmission Alternatives*, 39 HARV. ENV'T L. REV. 458, 473 n.91 (2015).

and is susceptible to marginal pricing. To take a relatable example (for me, at least), a can of LaCroix sparkling water has a set value. Demand-side factors may affect this pricing—for instance, an exceedingly hot summer day may drive the price up,[86] or a scare that it contains harmful chemicals may drive the price down[87]—but the intrinsic value is invariant. A can of LaCroix is and always will be just a can of LaCroix. I do not need anything else to enjoy it if I have it. This is not the case for all commercial and social goods, though. Some are lumpy.

Lee Anne Fennell's work excavating the concept of lumpiness and showing its fundamental importance to property law, regulation, and public health provides a starting point. Fennell argues that lumpiness is essentially indivisibility.[88] Something of value can either acquire its value from assembly of component parts, or its value can be reduced because it cannot be divided into parts that a consumer wants;[89] for the purposes of this Article, the former is the more important manifestation of this phenomenon.[90] When something acquires value only upon assembly, it is lumpy in the sense that the good's consumers or users cannot get the value of the good without ensuring that the assembly is completed. A key concept for understanding this lumpiness is the production function, which charts the relationship between production of the good and value to consumers or to

86. Dana Olsen, *The LaCroix Effect: Public and Private Interest in Sparkling Water Is Bubbling Over*, PITCHBOOK (Aug. 17, 2018), https://pitchbook.com/news/articles/the-lacroix-effect-public-and-private-interest-in-sparkling-water-is-bubbling-over [https://perma.cc/CZM4-NUM2] (expressing a "feeling of inner peace that comes with that first sip of an ice-cold Passionfruit LaCroix on a hot summer day"—a feeling one presumably would pay a premium for).

87. Tiffany Kary, *La Croix, Nestle Among 7 Waters with Elevated PFAS in Study*, BLOOMBERG, https://www.bloomberg.com/news/articles/2020-09-24/lacroix-nestle-waters-have-elevated-pfas-consumer-reports-says [https://perma.cc/Q5Q5-PFBX] (Sep. 24, 2020, 11:08 AM).

88. FENNELL, *supra* note 20, at 11. In some ways, indivisibility is closely related to the concept of nonrivalry in the literature on collective-action problems. Nonrivalrous goods are those whose consumption by an individual doesn't exclude others from consuming the same good—that is, the good does not come in neatly divisible units that can be charged à la carte. *See* RUSSELL HARDIN, COLLECTIVE ACTION 17 (1982).

89. FENNELL, *supra* note 20.

90. Although, as I will suggest later, the ability to slice and disaggregate energy into different units would be another way to deliver value to the grid. Many of the reforms associated with demand-side management and distributed energy resources, including storage, can be understood as efforts to do just this. *Id.*

society.[91] When dealing with non-lumpy goods—that is, goods that are intrinsically valuable—the production function is going to be close to linear because the units demanded, in themselves, deliver the desired value. Production will be at the equilibrium point on the demand curve and the supply curve—the starting point for all marginal economics. Supply meets demand not only because overproducing or underproducing leaves the producer of the good uncompensated but also because the satisfaction of demand is the value that the whole enterprise seeks to achieve. Add one additional unit of demand, and one gets one additional unit of product.

But with lumpy goods, the production function is not linear. Scholars have identified what they call "pure step good[s]," which "deliver all of [their] utility in one large chunk or 'step'" that occurs at some point in an ongoing process of assembly.[92] Fennell derives analytical purchase from the simple but powerful example of a bridge: "Picture a bridge spanning a chasm. Removing one chunk of the span renders it worthless—indeed, it is no longer even a bridge."[93] Likewise, building even marginally "too much bridge" to cross the chasm is completely worthless. The demand for the good, by its very nature, is all or nothing. In practice, the non-linearity might be less extreme—it may be gradual, or exponential—but the lumpiness still has consequences for the application of marginal economic principles.[94] Thus, lumpiness can be understood as encompassing "severe discontinuities or non-linearities in the production function, whether or not those functions take a pure step form or intersperse segments of sharply increasing or decreasing returns with ranges exhibiting linearity."[95]

Of course, even as the bridge example is helpful in understanding the concept of the production function and the ways that this can exhibit non-linearity and discontinuities, it is misleadingly simple. As Fennell explains, the bridge example involves "relatively fungible inputs," which is to say that the issue is just whether the quantity of inputs meets a certain threshold

91. For a survey of production functions, see Pamela Oliver et al., *A Theory of the Critical Mass. I. Interdependence, Group Heterogeneity, and the Production of Collective Action*, 91 AM. J. SOCIO. 522, 527 fig.1 (1985).

92. FENNELL, *supra* note 20, at 13. *See generally* HARDIN, *supra* note 88.

93. FENNELL, *supra* note 20, at 8.

94. In the real world, it might be just as rare to find true linear goods. *Id.* at 14.

95. *Id.* at 15.

that delivers all of the good's utility.[96] When there is a vertically integrated firm that builds bridges, the lumpiness of the bridge is ordinarily not going to be an issue. The firm will usually ramp up or ramp down production as necessary to ensure that the right amount of bridge is supplied.

But lumpiness "may also refer to systems made up of heterogeneous elements, such as a machine that cannot operate without each and every one of its parts."[97] This kind of situation, with strong complementarities between heterogeneous component parts, greatly complicates things.[98] For one thing, if separate parties control unique and indispensable components, they might hold out when it comes time to contribute or perform.[99] This is a very real problem in many situations involving relationship-specific investments. It is less of a problem where there is at least some competition to supply the critical component (i.e., the component is not truly sui generis, like a one-of-a-kind piece of art), as a competitor firm could supply the component at a cheaper price as soon as the hold-out party attempted to renegotiate terms.[100] Likewise, hold-out problems can be greatly mitigated by entering into contracts whose terms can be enforced in court if there is a breach.[101] Still, useful aggregation of lumpy goods could be inhibited when competition is severely limited in the market for a particular component.[102]

96. *Id.*

97. *Id.*

98. As Fennell defines it, "Complementarity refers to the fact that certain goods and services produce more value when consumed in particular combinations. Right and left shoes are a standard example. Because most people have two feet of similar size and follow the social custom of shodding them identically, a pair of shoes typically delivers far more than twice as much value as a single shoe." *Id.* at 11. This form of the lumpiness problem closely resembles the idea of the "anticommons," where disaggregated ownership rights over property can inhibit socially optimal development of the property by creating an excess of veto opportunities. *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 622 (1998).

99. FENNELL, *supra* note 20, at 23 (describing the nature of hold-out problems); Scott Duke Kominers & E. Glen Weyl, *Holdout in the Assembly of Complements: A Problem for Market Design*, 102 AM. ECON. REV. 360 (2012).

100. Fennell, *supra* note 20, at 1987.

101. *See* Clayton P. Gillette, *Tacit Agreement and Relationship-Specific Investment*, 88 N.Y.U. L. REV. 128, 128 (2013) (arguing that default rules of contract law that permit consequential damages for breach of contract in certain circumstances help mitigate the risks of opportunistic or strategic hold-out in a relationship-specific investment context).

102. FENNELL, *supra* note 20, at 22 ("[W]hen monopoly power exists over some or all of the components, aggregation can become difficult. Land assembly is a

The problems with lumpy *social* or *public* goods,[103] like a clean electric power grid, run even deeper. It may be difficult to induce the heterogeneous holders of complementary components of a lumpy public good to agree to contribute in the first place when there is sufficient uncertainty as to whether the lumping of component parts will be achieved. This result flows intuitively from game-theoretic models of coordination. In the so-called Assurance, or Stag Hunt, Game, two individuals choose whether to cooperate in some enterprise with a large payoff, but they only receive that payoff if the other potential partner chooses to cooperate as well.[104] The setup of the game is represented in Table 1.[105]

special case of this general problem. Similar issues exist for products or creative works that depend on inputs to which others hold intellectual property rights.").

103. By "social" or "public" good, I mean only to invoke the basic notion that these are large-scale goods that benefit everyone in the general public. Legal economists use a more restrictive concept of public goods to try to understand why certain goods that are nonrival and nonexcludable (i.e., where freeriding is possible) might be underproduced. *See, e.g.*, Joshua A.T. Fairfield & Christoph Engel, *Privacy as a Public Good*, 65 DUKE L.J. 385, 421 (2015). For my purposes, a more general notion of public good as a thing that benefits society as a whole and must, therefore, be provided at a societal scale is sufficient.

104. The genre of Assurance Games traces back to a metaphorical story told by Jean-Jacques Rousseau where

> two hunters (the players) are faced with a dilemma of bagging either a stag or a hare. If one hunter chooses a stag, she or he would require the total cooperation of the other to succeed. Having discovered its path in the forest, the hunters can mutually cooperate in capturing the stag, which offers a bigger, tastier meal . . . . Plausible variations in the story appear at this point: In a few of them, the two hunters see a single hare running back and forth on the same path where they have laid out the stag trap. If they mutually defect (i.e., abandon a joint stag hunt), they divide the prize of that one hare, which may be tasty but substantially less filling as a meal. A more common version of the story tells of a pair of hares tempting the starving hunters, who each has an opportunity to take one hare for a meal.

Roger Lee Mendoza, *The Hare Question in Assurance Games: Practical Problems and Insights from Robotic Surgery*, 63 AM. ECON. 18, 19 (2018).

105. This representation of the game follows the standard setup, but it is borrowed directly from Julia Y. Lee, *Gaining Assurances*, 2012 WIS. L. REV. 1137, 1144 tbl.2 (2012).

Table 1: The Assurance/Stag Hunt Game

		Player 1	
		Hunt the Stag	Hunt the Hare
Player 2	Hunt the Stag	4,4	0,3
	Hunt the Hare	3,0	3,3

Note: The numbers in the table represent payoffs, with the number to the left of the comma in each quadrant representing the payoff to Player 2, and the number to the right of the comma in each quadrant representing the payoff to Player 1.

Each player must choose whether to hunt the more desirable stag or the less desirable (but still better than nothing) hare. Two assumptions are made: first, the pursuit of a stag only succeeds if both players choose to hunt the stag; and second, coordination is impossible, so neither player can be sure that the other will choose to hunt the stag.[106] Unlike the more well-known Prisoner's Dilemma Game, participants in the Assurance Game can converge on one of "two Nash equilibria, one risk-dominant and the other payoff-dominant."[107] If they yield to risk by hunting the hare, the players receive a payoff of three each, whereas if they both choose to cooperate to hunt the stag, they each receive a payoff of four. Since four is better than three, the best outcome for all is cooperation to hunt a stag, but in the absence of assurance, there is nothing irrational about choosing to hunt the hare. Which one they in fact converge on depends on individual assessments of uncertainty about the behavior of the other player,[108] and that is the case even though their interests are

106. *Id.* at 1144–45.

107. Sarah F. Brosnan et al., *Responses to the Assurance Game in Monkeys, Apes, and Humans Using Equivalent Procedures*, 108 PROC. NAT'L ACAD. SCIS. U.S. 3442, 3443 (2011). By contrast, in the Prisoner's Dilemma, there is only one Nash equilibrium: do not cooperate.

108. Amartya K. Sen, *Isolation, Assurance and the Social Rate of Discount*, 81 Q.J. ECON. 112, 122 (1967). While the experimental evidence from the Assurance Game suggests variables such as ingroup membership and trust influence decisions to choose to cooperate, see Fredrik Jansson & Kimmo Eriksson, *Cooperation and Shared Beliefs About Trust in the Assurance Game*, 10 PLOS ONE e0144191 (2015),

aligned and both would prefer the payoff-dominant strategy were they able to coordinate.[109] Behavioral experiments show that, despite the setup of the game, participants more often converge on the risk-dominant strategy—that is, they voluntarily choose not to pursue the maximum payoff that would be possible with cooperation.[110]

The risk that complementary components of a lumpy public good will not be provided is analogous to the risk that the stag hunt fails—that is, that one, but not the other, player chooses to not even attempt to achieve the lumpy public good. This is not a risk that investors can afford to ignore, especially if there are "hares" nearby. Depending on how severely one needs to discount the individual value of the components to account for the possible failure to complete the lumpy good, a firm may have much less or even no incentive to collaborate without assurances as to performance. And assurances as to performance, unlike assurances as to a particular agreed-upon price of performance, are not readily susceptible to enforceable contracts.[111] In these kinds of situations, each player has to make an educated guess as to whether the complementary components will in fact be supplied. Particularly when uncertainty is high, as in long-range, high-stakes investments in a lumpy infrastructural good that will only pay off if contingent contributions are made, it might be expected that cautious investors will choose the risk-

https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0144191&type=printable [https://perma.cc/FA93-36AB], I am not aware of studies that consider that strategic uncertainty may flow from long payoff periods, although it seems plausible that this could be a tipping point in choosing between strategies.

109. Lee, *supra* note 105, at 1138 (noting that in the Prisoner's Dilemma, each party is better off defecting, but in the Assurance, or Stag Hunt, Game, "there are no gains to be had from defecting: the best result is if everyone cooperates").

110. Brosnan et al., *supra* note 107, at 3445. Despite these tendencies, some scholarship suggests that the evolution of "social structure" is partially attributable to departures from this baseline, which begets greater trust and a virtuous cycle of cooperation within particular social networks or communities. *See, e.g.*, BRIAN SKYRMS, THE STAG HUNT AND THE EVOLUTION OF SOCIAL STRUCTURE 8–12 (2004). Social ties and group characteristics in the starting population largely determine which of the two equilibria emerges. *Id.*

111. Under standard contract law, specific performance is an exceptional equitable remedy, and courts rarely use it in cases involving commercial transactions. *See* Anthony T. Kronman, *Specific Performance*, 45 U. CHI. L. REV. 351, 354 (1978). And this, of course, would assume that there is a contract in the first place. Contracts are unlikely to be negotiable for large-scale societal coordination of renewable generation and facilitative infrastructure buildouts of the kind that this Article focuses on.

dominant strategy. Even worse, the probability that a necessary component may fail to materialize could be linked to these very considerations and become a self-fulfilling prophecy. For instance, the belief that a potential partner to a project may bow out because they believe you might bow out may induce you to not supply your contribution or even put it on the market. Ultimately, "second-order trust"—the belief that someone else trusts you to cooperate—is critical to maximum payoffs from the Assurance Game.[112] In repeat play, this kind of second-order trust can develop endogenously, but this evolution toward greater cooperation amidst uncertainty is a slow process.

B. *The Lumpy Clean Energy Transition*

The concept of lumpiness helps to identify the mechanisms that conspire to halt the transition to a decarbonized energy economy. For there to be any chance of achieving deep decarbonization goals, certain kinds of facilitative infrastructure need to be put in place.[113] A unique challenge for clean energy generation is the problem of variability, or intermittency.[114] Such renewable energy sources cannot produce energy on demand—they depend on meteorological conditions aligning at the moment energy demand must be satisfied, and we have yet to develop tools for forcing the sun to shine or the wind to blow when we want them to. Policy experts agree that achieving a predominantly renewable-based electric power system is a physical impossibility without finding technological ways to shift the generation from such sources over time or space.[115] While there are many tools for doing this, many of which are substitutes for one

112. Jansson & Eriksson, *supra* note 108.

113. Klass, *supra* note 17, at 531–34.

114. Severin Borenstein & James Bushnell, *The U.S. Electricity Industry After 20 Years of Restructuring*, 7 ANN. REV. ECON. 437, 455 (2015), https://www.annualreviews.org/doi/pdf/10.1146/annurev-economics-080614-115630 [https://perma.cc/GX7L-5G9X] ("The technical challenge stems primarily from the fact that production from [wind and solar] occurs intermittently and largely outside the control of the owner—when the wind blows or the sun shines. Because the physics requires that quantities supplied and demanded in an electrical grid must balance at all times for the system to be stable, and because storage is still quite expensive, the intermittency of wind and solar implies that either other flexible supply resources must be available to offset these fluctuations or demand must change in response."); *see also* Griffin & Puller, *supra* note 26, at 5–6 (discussing physical constraints that require real-time balancing of the grid).

115. ZEVIN ET AL., *supra* note 17, at 9.

another,[116] two of the most commonly cited technologies are high-voltage, interregional transmission lines[117] and grid-scale, long-duration energy storage.[118] Whichever technology is ultimately embraced, the bottom line is that the electric grid must be modernized and expanded to provide the flexibility to incorporate intermittent or variable sources of generation without losing reliable electric power.[119]

For both transmission and storage policy, regulators and experts have identified the persistence of so-called "chicken-or-egg problems," by which they mean that either the existence of more renewable resources could induce greater infrastructure development, or greater infrastructure development could induce greater development of renewables, but neither occurs because developers in either space would rather wait for the other to act first.[120] As a result, neither moves as quickly as it might with

116. Welton, *supra* note 85 (discussing "non-transmission alternatives," such as energy efficiency and demand response, which lower demand and therefore eliminate the need for new infrastructure).

117. Jenkins et al., *supra* note 5, at 2506 (summarizing studies suggesting renewable sources must be paired with some sort of "continent-scale expansion of transmission grids"); Trieu Mai et al., *Renewable Electricity Futures for the United States*, 5 IEEE TRANS. SUSTAINABLE ENERGY 372, 376 (2014) (finding that additional transmission, along with other "flexible" technologies, could make it possible to integrate up to 80 percent renewables on the electric grid). Whether storage or nationwide transmission are emphasized depends to some degree on which renewable generation takes hold, with solar-heavy models indicating a need for greater daily storage and wind-heavy models indicating a greater need for regional transmission buildout. *See* Matthew R. Shaner et al., *Geophysical Constraints on the Reliability of Solar and Wind Power in the United States*, 11 ENERGY & ENV'T SCI. 914, 919 (2018).

118. Maryam Arbabzadeh et al., *The Role of Energy Storage in Deep Decarbonization of Electricity Production*, 10 NATURE COMMC'NS 1, 2 (2019) (finding that the absence of storage greatly reduces the ability to achieve carbon dioxide reductions from deployment of renewable generation); Fernando J. de Sisternes et al., *The Value of Energy Storage in Decarbonizing the Electricity Sector*, 175 APPLIED ENERGY 368, 368 (2016) ("Electrical energy storage could play an important role in the deep decarbonization of the power sector by offering a new, carbon-free source of operational flexibility in the power system, improving the utilization of generation assets, and facilitating the integration of variable renewable energy sources (i.e., wind and solar power).").

119. Michael B. Gerrard, *Utility-Scale Renewable Generating Capacity*, *in* LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES, *supra* note 2, at 463, 487.

120. *See* Benjamin Fox, *The Offshore Grid: The Future of America's Offshore Wind Energy Potential*, 42 ECOLOGY L.Q. 651, 673 (2015).

As former Department of Energy official Susan Tierney notes:

> [I]n the current framework for transmission investment, wind development and transmission expansion suffers from a classic chicken-and-egg problem . . . . [T]ransmission companies typically have little

greater coordination between players or with the alignment of interests and capacity of single actors. This is lumpiness at work, stymying the clean energy transition. Sections II.B.1 and II.B.2 below look more closely at lumpiness dynamics, and their effects on incentives for investment, in the context of transmission and storage, respectively.

1. Modernized Transmission Grid

The pervasive electrification of our society and economy is only possible because of a modern marvel: the bulk electric transmission grid. The U.S. bulk electric grid, in particular, is often described as the "largest interconnected machine on Earth," with about 642,000 miles of high-voltage transmission lines sending power from utility-scale power plants dotting the continent to local distribution utilities in most every community, however remote.[121] Moreover, in a feat no less impressive, we have somehow managed to find ways to keep this system precisely balanced, despite frequent fluctuations in demand and a bewildering array of generators seeking to access the common network.

But as impressive as this machine is, experts agree that it needs modernization and expansion. In 2017, the American

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> interest in building transmission infrastructure in areas where there are no power plants or little power demand because of concerns about who will pay for their transmission investment. Similarly, there tends to be little interest in building renewable generating capacity in remote areas with little power demand and no transmission infrastructure to move power to load centers . . . . Each piece of potentially costly infrastructure—the wind project developments themselves, and the transmission projects to service them—wants the other to be developed first.

Id. (quoting SUSAN F. TIERNEY ET AL., ANALYSIS GRP., INC., STRATEGIC OPTIONS FOR INVESTMENT IN TRANSMISSION IN SUPPORT OF OFFSHORE WIND DEVELOPMENT IN MASSACHUSETTS 16–17 (2010)); Gary E. Marchant, *Complexity and Anticipatory Socio-Behavioral Assessment of Government Attempts to Induce Clean Technologies*, 61 UCLA L. REV. 1858, 1865 (2014) (discussing the rationale for California's zero-emission vehicle mandate and finding that a "classic chicken-and-egg problem" was at the center of it: "successful EV deployment required a significant investment in EV infrastructure such as public recharging stations from electric utilities and municipalities, not vehicle manufacturers," and "both industries wanted the other to go first").

121. Klass, *supra* note 17, at 527; Jennifer Weeks, *U.S. Electrical Grid Undergoes Massive Transition to Connect Renewables*, SCI. AM. (Apr. 28, 2010), https://www.scientificamerican.com/article/what-is-the-smart-grid [https://perma.cc/AVG4-NSV3].

Society of Civil Engineers gave the bulk transmission grid a D+ as part of its American Infrastructure Report Card, citing "aging equipment, capacity bottlenecks, and increased demand, as well as increasing storm and climate impacts" as threats to the integrity of the machine.[122] More importantly for this Article, the current bulk transmission grid is by all accounts insufficient for the integration of the massive amounts of variable renewable generation necessary to achieve deep decarbonization.[123] An inconvenient reality is that the regions with the greatest potential for development of variable renewable resources like wind and solar are located far from population centers.[124] Moreover, due to their dependency on meteorological conditions for operation, variable renewables must be able to serve customers far away, since the conditions where demand is located may not support dispatch of nearby renewable generation.[125] In the absence of a bulk transmission grid capable of meteorological and geographical arbitrage, the only real option is to continue to rely substantially on more nearby fossil fuel generation not subject to uncontrollable variation.

The problems with integrating variable renewables into the grid date back to the regulatory compact. The network of transmission lines we have today was largely built incrementally by an array of vertically integrated utilities serving their own monopoly territories' customers, rather than systemically by some central authority seeking to develop an optimized national grid (let alone one optimized for renewable integration).[126] As local utilities in the early days of electricity grew larger, they embraced the central station model, building coal power plants on the peripheries of population centers and dedicated

122. *Energy: 2017 Infrastructure Report Card*, AM. SOC'Y OF CIV. ENG'RS, https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Energy-Final.pdf [https://perma.cc/VR76-GGDT].

123. JOHN G. KASSAKIAN ET AL., MASS. INST. TECH., THE FUTURE OF THE ELECTRIC GRID: AN INTERDISCIPLINARY MIT STUDY, at xi (2011), https://energy.mit.edu/wp-content/uploads/2011/12/MITEI-The-Future-of-the-Electric-Grid.pdf [https://perma.cc/984R-VRWE] (explaining that variable renewable generation is not predictable or reliable enough on its own to satisfy all demand for electric power, at least with existing grid infrastructure).

124. *See* Alexandra B. Klass & Elizabeth J. Wilson, *Interstate Transmission Challenges for Renewable Energy: A Federalism Mismatch*, 65 VAND. L. REV. 1801, 1811 (2019).

125. *Id.*

126. K. K. DUVIVIER, ENERGY LAW BASICS 188 (2017).

transmission lines from those plants to customers.[127] Eventually, this disaggregated network of privately owned transmission lines grew large enough that it often made sense for different utility transmission owners to interconnect with others and pool power, but the utilities retained both ownership and operation of their own transmission lines.[128] Most of these cross-utility transactions involved contracting to "wheel" a specific amount of power from one utility to another, all across an interconnected set of grids.[129] Nevertheless, a National Power Survey conducted in 1964 by the Federal Power Commission (predecessor to FERC) found that

> the [utility] industry's pluralistic institutional structure inhibits the goal of coordinated operations, since "rivalries and controversies between segments of the industry [have] frequently resulted in economically meaningless boundaries for utility system planning and operation which undoubtedly cost the power consumers of this country millions of dollars every year in wasted opportunities for cost reduction."[130]

While restructuring aimed to reduce the network's balkanization by ordering that transmission systems be subject to open-access transmission tariffs, today the physical system largely looks the same as it did in the middle of the twentieth century. Indeed, 70 percent of transmission lines are over twenty-five years old, and many are much older than that.[131]

To be sure, in recent years, investment in new transmission lines has ticked up.[132] A 2018 Department of Energy study found that some 3,326 circuit miles of transmission lines over 100 kilovolts were under construction at the time, and three North American Electric Reliability Corporation (NERC)[133] regions

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127. PLATT, *supra* note 45.

128. James F. Fairman & John C. Scott, *Transmission, Power Pools, and Competition in the Electric Utility Industry*, 28 HASTINGS L.J. 1159, 1169–70 (1977).

129. *Id.* at 1165.

130. *Id.* at 1160.

131. *Major Utilities Continue to Increase Spending on U.S. Electric Distribution Systems*, U.S. ENERGY INFO. ADMIN. (Jul. 20, 2018), https://www.eia.gov/todayinenergy/detail.php?id=36675 [https://perma.cc/U94V-2QTN].

132. *Utilities Continue to Increase Spending on Transmission Infrastructure*, U.S. ENERGY INFO. ADMIN. (Feb. 9, 2018), https://www.eia.gov/todayinenergy/detail.php?id=34892 [https://perma.cc/8BS2-NF6Q].

133. NERC "is a not-for-profit international regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and

were planning to see an increase in transmission capacity of over 2 percent by 2027.[134] However, these investments are neither certain to materialize nor sufficient to pave the way for an "interstate highway for electrons."[135] Most proposed lines to date are geographically isolated and designed primarily to serve discrete markets with short-range, alternating current (AC) systems.[136] Few proposed lines are explicitly designed for the kind of high-voltage, direct current (DC), interregional transport that is more efficient for long-distance transmission.[137]

Existing legal scholarship has focused primarily on the ways that siting and permitting regimes are responsible for this stunted development of a national transmission grid,[138] and

security of the grid. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel." *About NERC*, N. AM. ELEC. RELIABILITY CORP., https://www.nerc.com/AboutNERC/Pages/default.aspx [https://perma.cc/9GYD-DG2A].

134. YINONG SUN ET AL., U.S. DEP'T OF ENERGY, 2018 RENEWABLE ENERGY GRID INTEGRATION DATA BOOK 87–89 (2020), https://www.nrel.gov/docs/fy20osti/74823.pdf [https://perma.cc/GN77-RPVK]. Of these three, the Northeast Power Coordinating Council planned the largest expansion (9.8 percent), the Western Electricity Coordinating Council planned the next largest expansion (4.1 percent), and the Midwest Reliability Organization was last (2.7 percent). The three other regions—ReliabilityFirst Council, the SERC Reliability Corporation (SERC), and the Texas Reliability Entity—were well under 2 percent, and most of that expansion was relatively low-voltage lines of 100 to 199 kilovolts, usually for shorter distances. *Id.*

135. Alex Nussbaum, *Cutting Pollution from U.S. Power Plants Cheaper than You Think*, BLOOMBERG (Jan. 25, 2016, 8:34 AM), https://www.bloomberg.com/news/articles/2016-01-25/cutting-pollution-from-u-s-power-plants-cheaper-than-you-think [https://perma.cc/2Y8S-HV3R].

136. AC, or alternating current, systems facilitate two-way transmission of electricity and easier voltage conversion, making them ideal for off-loading electricity to distribution systems at multiple substations. DC, or direct current, systems send power one way, and they are generally more efficient for long-range transfers of power with little need for off-loading to distribution systems along the way. *See* Klass, *supra* note 17, at 528.

137. SUN ET AL., *supra* note 134, at 87 ("Some interregional transmission projects are in a planning or conceptual phase and are expected to connect renewable energy resource areas (e.g., the Southwest for solar and the Midwest for wind) to load centers (e.g., in CAISO, MISO, the ReliabilityFirst NERC regional entity, and SERC service areas).").

138. *See, e.g.*, Alexandra B. Klass, *The Electric Grid at a Crossroads: A Regional Approach to Siting Transmission Lines*, 48 U.C. DAVIS L. REV. 1895, 1897 (2015) (describing the states' power over siting and permitting as "virtually complete" and noting the way that this balkanized system inhibits development of the kinds of regional grid updates that are needed); ZEVIN ET AL., *supra* note 17 (taking issue with the state-by-state approach necessary in the absence of federal preemption).

with good reason. Unlike interstate natural gas pipelines, which are permitted by FERC and which gain the power of eminent domain through FERC approval, interstate electric transmission lines must be approved on a state-by-state basis.[139] In practice, this has meant that proposed transmission projects have run into serious obstacles, including "not-in-my-backyard" (NIMBY) politics and hold-out problems.[140] One of the most famous of these episodes is memorialized in Russell Gold's book *Superpower*: Clean Line Energy Partners, a merchant transmission developer, attempted to connect massive windfarms in western Oklahoma to buyers of wholesale energy in the eastern United States.[141] Despite making significant progress, the project ultimately faltered under the pressure of siting politics.[142] While the Energy Policy Act of 2005 attempted to give the federal government greater ability to override state vetoes of necessary transmission projects,[143] these provisions have not proven useful in clearing a path. The most directly helpful provisions were narrowly construed to the point of nullification in a series of court decisions, and the remaining authorities have not been used by the Department of Energy.[144]

While these siting and permitting issues are clearly important limitations on the prospects of a modernized transmission grid, the problems really begin before that, with the functional separation of generation and transmission. Especially in regions with RTOs or ISOs, transmission is not usually built by the same utilities that own and operate generation. As noted above, in some of these regions, vertically integrated utilities have been unbundled such that separate firms (or at least

139. Klass & Wilson, *supra* note 124, at 1859 (noting that electric transmission, unlike natural gas pipelines, is regulated by the states).

140. DAVIES ET AL., *supra* note 49, at 650.

141. RUSSELL GOLD, SUPERPOWER: ONE MAN'S QUEST TO TRANSFORM AMERICAN ENERGY (2019).

142. *Id.*

143. Fox, *supra* note 120, at 681; ZEVIN ET AL., *supra* note 17.

144. *See* Piedmont Env't Council v. FERC, 558 F.3d 304, 314–15 (4th Cir. 2009) (rejecting an argument that FERC could permit a transition line in a national interest electric transmission corridor designated by the Department of Energy when a state denies an application); Cal. Wilderness Coal. v. U.S. Dep't of Energy, 631 F.3d 1072, 1085–90 (9th Cir. 2011) (holding that the Department of Energy failed to adequately consult with stakeholders in designating a national interest electric transmission corridor). *But see* ZEVIN ET AL., *supra* note 17 (arguing that these court cases do not foreclose most uses of these federal authorities, and that the Biden Administration should aggressively use these authorities to preempt state control over siting).

separate subsidiaries of a larger holding utility) own generation and transmission assets.[145] In such a setup, much of the transmission business falls to standalone transmission companies that do not have any relationship to generation at all. As FERC's restructuring efforts explicitly contemplated, the transmission development business is a self-sufficient island in the electric power industry, allowing it to be regulated as a natural monopoly while generation would be opened up to competition. Under this plan, standalone transmission companies' business model is based on rate regulation by FERC, whereas generators of electricity can compete in wholesale markets for energy.[146] Charges for using transmission lines must be just and reasonable,[147] and costs are allocated to users in proportion to the benefit they receive from the lines.[148] In theory, this guarantee of cost recovery for prudent transmission projects should be enough to incentivize adequate development of new transmission (not to mention upgrades to existing lines). Yet given the tight complementarities between generation and transmission—literally, the need to interconnect a new power plant to a transmission network capable of delivering power to consumers—the artificial boundaries between the two subsectors created by restructuring introduce substantial uncertainty about the sequencing of investments.[149]

145. Again, this is not the case in certain RTOs and ISOs, like MISO and SPP, where most states are still traditionally regulated, but it is largely true in others, like PJM, which cover mostly restructured states. *See supra* note 8 and accompanying text.

146. Order 679, *supra* note 29.

147. *Id.* at paras. 7–9.

148. Midwest ISO Transmission Owners v. FERC, 373 F.3d 1361, 1368 (D.C. Cir. 2004).

149. These miscoordinations manifest themselves in long queues for interconnection in some parts of the country for overeager renewable energy developers who built before the transmission necessary to bring the power to market was there. *See generally* JAY CASPARY ET AL., AMS. FOR A CLEAN ENERGY GRID, DISCONNECTED: THE NEED FOR A NEW GENERATOR INTERCONNECTION POLICY 4 (2021), https://cleanenergygrid.org/wp-content/uploads/2021/01/Disconnected-The-Need-for-a-New-Generator-Interconnection-Policy-1.pdf [https://perma.cc/FK6H-RT4W] ("America's system for planning and paying for the nation's transmission grid is causing a massive backlog and delay in the construction of new power projects. While locally produced electric power is gaining in popularity, most of the lowest cost new power production comes from projects which are located in rural areas and, thus, depend on new electricity lines to deliver power to the urban and suburban areas which use most of the nation's power. Project developers must apply for interconnection to the transmission network, and until the network capacity is expanded to accommodate the resources, the projects must wait in an 'interconnection queue.' At the end of 2019, 734 gigawatts of proposed generation were waiting in interconnection queues nationwide.").

And while this problem is essentially baked into the cake in restructured states, it remains a problem even in traditionally regulated states subject to an RTO or ISO. There, transmission planning under FERC Order 1000 is done by the RTO or ISO (with feedback from utilities), while the actual contracting and building is handled by incumbent utilities who lack the same bird's-eye vision or territorial reach to take on the risk of major interregional projects.[150]

Whatever the setup, transmission companies and utilities are unlikely to pursue transmission networks without a certain tie to actual generation. Even if they were, it is questionable whether FERC or a public utility commission would approve cost recovery since the cost of building transmission lines would not necessarily prove to be justly or reasonably incurred for the benefit of consumers—it would all depend on whether generation follows.

This setup pushes transmission companies and vertically integrated utilities to make sure bets—mostly local or regional lines tying together smaller-scale projects or improving existing networks—over transformative projects.[151] The kinds of interregional transmission projects that would permit development and integration of massive levels of wind and solar energy from the Great Plains and the Southwest into a national "supergrid" are far too speculative, and questions of cost-allocation across such an expanse too thorny, to support the proposal of many of these projects.[152] On the other side of the line, generators who would

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150. *See* Daniel Tait, *Records Reveal Entergy's Role in Stalling MISO Transmission Planning*, ENERGY & POL'Y INST. (Apr. 5, 2021), https://www.energyandpolicy.org/entergy-role-stalling-miso-transmission-planning [https://perma.cc/YJK7-UEXE] (showing how Entergy retained authority to derail transmission planning in MISO).

151. This phenomenon can be seen in the context of Order 1000, where despite FERC's mandate for competitive bidding for regional and interregional projects, most building since has avoided that process and focused on small-scale system upgrades. Order 1000, *supra* note 19; Herman K. Trabish, *With New Transmission Urgently Needed, FERC Chair Hints at a New Order 1000 Proceeding*, UTIL. DIVE (May 31, 2019), https://www.utilitydive.com/news/with-new-transmission-urgently-needed-ferc-chair-hints-at-a-new-order-1000/555586 [https://perma.cc/95QK-KBHL] ("Incumbents can claim exclusions [from competitive bidding for regional and interregional transmission lines] for 'supplemental' projects that are sited on their rights-of-way, use their infrastructure, are below the voltage threshold or are required for reliability within three years . . . . 'Many transmission builders made a conscious business decision not to build competitive generation and to focus on the regulated transmission business.'").

152. There are other causes—namely, costs of engaging in competitive bidding for interregional projects. *See* Trabish, *supra* note 151. This is just another

be ready to develop in these remote regions must also factor in the uncertainty about whether transmission companies will provide the necessary lines to interconnect and give these generators access to markets across the country.

It is a classic chicken-or-egg problem, and it largely stems from the fact that the value added by such a transformation is entirely contingent on coordination of complementary actions. The array of investors who must make these coordinated investment decisions must make them in an environment of substantial uncertainty about whether complementary investments will be made, and the Assurance Game tells us that many of the individual investors will often default to a risk-dominant strategy.[153] That is, investors will not make the investments they would if they were sure that the other complementary components of the lumpy social good will be developed.

2. Storage

Another possible technological solution to the challenge of integrating renewable generation into the grid is long-duration energy storage. Storage resources (such as chargeable batteries) and modernized transmission systems are, in some sense, substitutes for each other.[154] Each can be used to relax the physical constraints of a grid, which generally must be finely balanced in real time, making it possible to integrate variable renewable energy without crashing the grid. Whereas an interregional high-

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manifestation of the transaction costs that inheres in the bifurcation of generation planning and transmission planning.

153. *See* Uma Outka, *The Renewable Energy Footprint*, 30 STAN. ENV'T L.J. 241, 268–69 (2011) ("Still, one of the most cited barriers to new transmission is insufficient investment, which the complexity of siting regulation only exacerbates. This is not a new concern, but frustration with current law is intensifying, as a 'chicken-and-egg dilemma hinders the development' of remote renewable energy resources. The dilemma presents a critical planning problem: 'transmission developers are hesitant to build transmission to a region without certainty that a power plant will be built to use the line, just as wind and solar developers are hesitant to build a power plant without certainty that a transmission line will be built.'" (quoting CHI-JEN YANG, CLIMATE CHANGE PARTNERSHIP, ELECTRICAL TRANSMISSION: BARRIERS AND POLICY SOLUTIONS 4 (2009) and AM. WIND ENERGY ASS'N & SOLAR ENERGY INDUS. ASS'N, GREEN POWER SUPERHIGHWAYS 16 (2009)); *see also* Fred Bosselman, *The Future of Electricity Infrastructure*, 42 URB. LAW. 115, 123 (2010).

154. Dina Khastieva et al., *Value of Energy Storage for Transmission Investments*, 24 ENERGY STRATEGY REV. 94, 94 (2019) (reporting case studies showing that "energy storage investments complement transmission expansion and contribute to higher social welfare values"); Welton, *supra* note 85.

voltage transmission grid achieves this by facilitating geographical arbitrage of intermittent resources (for instance, allowing cloudy Seattle to be powered by solar power from the Southwest, or Atlanta to be powered by wind power from the Great Plains on a still and muggy southern day), storage provides this benefit by allowing for the temporal arbitrage of electrical power (that is, by allowing power generated at one point in time to be saved for ultimate consumption at a later time).[155] Storage can also help smooth natural variations in the load curve throughout the day by decoupling load from supply, improving the overall operation of the grid.[156]

Just a few years ago, it was possible to state that energy storage was not a cost-effective way of improving grid flexibility and integrating high levels of renewables into the grid.[157] Within the span of a few years, that conventional logic has been flipped on its head. The cost of many forms of energy storage, from pumped hydropower storage to a newer generation of lithium ion batteries, flow batteries, and compressed-air storage, is

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155. *See* Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies, 144 FERC ¶ 61,056, para. 172 (Jul. 18, 2013) [hereinafter Order 784] ("[P]roperty that is interconnected to the electrical grid and is designed to receive electrical energy, to store such electrical energy as another energy form, and to convert such energy back to electricity and deliver such electricity for sale, or to use such energy to provide reliability or economic benefits to the grid."); MADISON CONDON ET AL., INST. FOR POL'Y INTEGRITY, MANAGING THE FUTURE OF ENERGY STORAGE: IMPLICATIONS FOR GREENHOUSE GAS EMISSIONS 5 (2018) ("Energy storage is often presented as a solution to the challenges utilities around the country face due to a desire for a higher penetration of renewable energy resources. Wind or solar energy can be stored when there is excess demand and injected into the grid later when the supply is insufficient to meet the demand. Energy storage can also help with minute-to-minute smoothing that would be necessary when a cloud passes by, as well as larger smoothing needs when a large amount of wind energy is generated during off-peak demand hours.").

156. *See* THOMAS BOWEN ET AL., NAT'L RENEWABLE ENERGY LAB'Y, GRID-SCALE BATTERY STORAGE FREQUENTLY ASKED QUESTIONS 2 (2019), https://www.nrel.gov/docs/fy19osti/74426.pdf [https://perma.cc/LSL9-4TF5]; Giorgio Castagneto Gissey et al., *Value of Energy Storage Aggregation to the Electricity System*, 128 ENERGY POL'Y 685, 690–91 (2019) (finding that storage can reduce and stabilize energy prices); CONDON ET AL., *supra* note 155, at 4 ("[T]he ability of energy storage to smooth demand throughout the day enables generators to run at their optimal capacity over longer periods of time, increasing overall grid efficiency . . . . By partnering with storage resources, these generators can produce a continual level of output at a low cost, storing the unwanted power until demand increases later in the day.").

157. *See Utility-Scale Battery Storage Costs Decreased Nearly 70% Between 2015 and 2018*, U.S. ENERGY INFO. ADMIN. (Oct. 23, 2020), https://www.eia.gov/todayinenergy/detail.php?id=45596 [https://perma.cc/56U7-GWC8].

plummeting.[158] These changes in the cost of storage make it possible to imagine an entirely regionalized system of transmission that is nevertheless able to integrate extremely high levels of relatively local variable renewable resources—somewhere on the order of 70 to 90 percent renewables.[159] Already, battery storage is being installed in a distributed fashion with residential rooftop solar panels and paired with solar projects throughout the country, displacing the need for development of new natural gas peaker plants.[160]

However, it is not clear that these investments in storage capacity are, or are planned to be, the right kind of storage investments to help facilitate development of grid-scale renewable generation. For the most part, existing distributed storage projects (primarily lithium-ion batteries connected to rooftop solar panels) feature short-term storage designed mainly to improve the profitability of generation by allowing access to multiple new revenue streams, such as ancillary services or short-term energy arbitrage—what the industry refers to as "value stacking."[161]

158. Pippa Stevens, *The Battery Decade: How Energy Storage Could Revolutionize Industries in the Next 10 Years*, CNBC, https://www.cnbc.com/2019/12/30/battery-developments-in-the-last-decade-created-a-seismic-shift-that-will-play-out-in-the-next-10-years.html [https://perma.cc/R7KC-K592] (Dec. 30, 2019, 3:25 PM) (reporting that the price of lithium-ion batteries, in particular, fell by 85 percent in the 2010s).

159. *See* GOLDMAN SCHOOL OF PUBLIC POLICY, U.C. BERKELEY, 2035: THE REPORT 20 (2020), https://www.2035report.com/wp-content/uploads/2020/06/2035-Report.pdf [https://perma.cc/Y99P-T7QH] (describing modeling that found a grid with 150 GW of storage could run with between 90 percent and 70 percent renewables).

160. *See* Max Hall, *Solar-Plus-Storage Will Start to Make Big Inroads in the Year Ahead*, PV MAG. (Dec. 31, 2019), https://www.pv-magazine.com/2019/12/31/solar-plus-storage-will-start-to-make-big-inroads-in-the-year-ahead [https://perma.cc/ZM92-Y44E]. Much of the action is taking place in California, which has an aggressive energy storage mandate. *See* Bill Sweet, *California's First-in-Nation Energy Storage Mandate*, IEEE SPECTRUM (Oct. 25, 2013), https://spectrum.ieee.org/californias-firstinnation-energy-storage-mandate [https://perma.cc/P2AU-8LBN].

161. Paul Denholm, Nat'l Renewable Energy Lab'y, & Jennifer Leisch, U.S. Agency for Int'l Dev., Address at the Clean Energy Solutions Center Webinar: Greening the Grid: Utility-Scale Battery Storage 6 (Feb. 28, 2019), https://cleanenergysolutions.org/sites/default/files/documents/2019-02-28-transcript.pdf [https://perma.cc/D2KZ-TRJ8]. One of the unique aspects of storage is that it can provide many different services to the grid, including reliability-related services, lowering costs of all energy, encouraging more efficient production of energy, and decreasing emissions. *See* Amy L. Stein, *Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage*, 41 FLA. STATE UNIV. L. REV. 697, 710 (2014). In a concrete setting, investment in storage assets often depends on the ability to tap into markets for each of these potential services and turn those

Storage installations with four hours of duration or less are ideally suited to many of these available revenue streams within the existing energy markets, and the bulk of investment has understandably been in this short-duration market.[162] Much less concrete deployment of long-duration, grid-scale storage—the kind of supply-shifting installations that could facilitate much greater integration of variable renewable generation into the grid—has been achieved to date.[163] The latest reports suggest that the utility industry on the whole is becoming "less bullish on grid-scale storage" than it is on distributed applications, such as pairings with rooftop solar photovoltaic panels.[164] Utility Dive's 2020 "State of the Electric Utility" survey downgraded expectations for grid-scale storage, with 27 percent of participants expecting significant investments in grid-scale battery storage by their firm compared to 37 percent in 2018 and 34 percent in 2019.[165] In short, while the market for storage is expected to continue to grow into a sizeable $11.5 billion market business by 2026,[166] it is unclear just how much of this growth will come in

services into revenue for the owner without engaging in "double counting" services in a way that provides a windfall subsidy. *See* CONDON ET AL., *supra* note 155, at 15–17 (discussing the value stack and difficulties regulators face in setting rates for different services that storage provides).

162. Max Tuttman & Scott Litzelman, *Why Long-Duration Energy Storage Matters*, ARPA-E: BLOG (Apr. 1, 2020), https://arpa-e.energy.gov/?q=news-item/why-long-duration-energy-storage-matters [https://perma.cc/52JT-JF26] (noting that if the main purpose of storage is to access these short-term revenue streams, anything longer than four hours represents diminishing returns).

163. The only major grid-scale installment is the 100MW Tesla "Powerpack" battery in Australia, which has been hailed as a "total success." Caroline Delbert, *Elon Musk's Battery Farm is an Undeniable Success*, POPULAR MECHS. (Mar. 10, 2020), https://www.popularmechanics.com/science/a31350880/elon-musk-battery-farm [https://perma.cc/F4RR-WR58]. Other grid-scale projects have begun to come online in the United States but not nearly as quickly as the success of the Australia battery farm might have suggested would be optimal.

164. Kavya Balaraman, *Why Is the Utility Industry Less Bullish on Grid-Scale Storage?*, UTIL. DIVE (Feb. 13, 2020), https://www.utilitydive.com/news/safety-volatile-market-less-bullish-storage/572013 [https://perma.cc/D4DD-XPN5]. *See Solar-Plus-Storage 101*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY (Mar. 11, 2019), https://www.energy.gov/eere/solar/articles/solar-plus-storage-101 [https://perma.cc/5NXC-M6F9] (estimating that over 95 percent of storage systems operative in the United States are connected to rooftop solar PV systems); CONDON ET AL., *supra* note 155, at 16 (stating that behind-the-meter applications present one of the thorniest regulatory issues, because they are typically used for a wider array of services than grid-scale applications).

165. Balaraman, *supra* note 164.

166. WOOD MACKENZIE, U.S. ENERGY STORAGE MONITOR: Q4 2021 EXECUTIVE SUMMARY (2021), https://www.woodmac.com/research/products/power-and-renewables/us-energy-storage-monitor [https://perma.cc/5SCC-CQN8].

the form of grid-scale aqueous sulfur flow batteries or other long-duration technologies that are currently in demonstration.

This raises the question of why a technology that many envisioned as critical to a modernized bulk electrical system has become less appealing to investors over time, even as costs have continued to decline[167] and as regulatory barriers to participation in various grid services have been partially eliminated.[168] To put the point bluntly, "Rarely has such a crucial enterprise for the future of human civilization led to such little commercial success."[169] What gives?

The likely answer is the lumpiness of the investment and the difficulties of monetizing the full benefits of storage amidst uncertainty about the penetration of variable renewables on the grid. Though much depends on technological developments and their effects on the ultimate costs of energy storage,[170] one thing is absolutely clear: the cost-effectiveness of grid-scale storage is much higher with higher penetration of renewables on the

167. Prachi Patel, *How Inexpensive Must Energy Storage Be for Utilities to Switch to 100 Percent Renewables?*, IEEE SPECTRUM (Sept. 16, 2019), https://spectrum.ieee.org/energywise/energy/renewables/what-energy-storage-would-have-to-cost-for-a-renewable-grid [https://perma.cc/J74Q-YLV8] (noting that to get to 95 percent renewable penetration, estimates are that long-duration energy storage would need to cost $150/kWh, which is well within reach of many technologies in demonstration).

168. For a discussion of FERC's efforts in Order 841 to eliminate barriers to entry and encourage value stacking, see *infra* Part III. Some barriers undoubtedly still exist. In Texas, for instance, storage is seen as generation, which prevents transmission and distribution utilities from investing in it. *See* Julian Spector, *Why is the Texas Market So Tough for Energy Storage?*, GREENTECH MEDIA (Nov. 19, 2018), https://www.greentechmedia.com/articles/read/why-is-the-texas-market-so-tough-for-energy-storage [https://perma.cc/7DDS-UP4P] ("Texas power market deregulation separated competitive generation from regulated wires utilities. That implicates storage because it qualifies as generation in this market; that means it has to compete with gas generators, and wires utilities are not allowed to own it, lest their ownership undermine the bedrock of competitive markets."). For a more thorough discussion of the uncertainty about how to classify storage for regulatory purposes and how that affects investment in storage, see Stein, *supra* note 161.

169. Julian Spector, *The 5 Most Promising Long-Duration Storage Technologies Left Standing*, GREENTECH MEDIA (Mar. 31, 2020), https://www.greentechmedia.com/articles/read/most-promising-long-duration-storage-technologies-left-standing [https://perma.cc/H5L5-5EL2].

170. There are many challenges, but there is also much reason for optimism in that long-duration utility-scale storage will soon move from demonstration projects to deployable setups. *See* Julian Spector, *5 Tangible Advances for Long-Duration Energy Storage in 2019*, GREENTECH MEDIA (Dec. 30, 2019), https://www.greentechmedia.com/articles/read/5-tangible-advances-for-long-duration-energy-storage-in-2019 [https://perma.cc/8JHT-UBM9].

grid.[171] Long-duration, grid-scale storage is at best marginally valuable given the grid we currently have and the revenue streams that are currently available,[172] but it begins to look more and more valuable, from both a public and private perspective, once we crest the hill to a renewable-based system.[173] Such a renewable-dominated system creates enormous market value for technologies that can shift generated supply by days—indeed, it renders the variability problem with renewables nearly obsolete.

In sum, there are strong complementarities between renewable generation and storage that render the production function for grid-scale, long-duration storage non-linear: after the grid reaches a certain threshold of renewable generation, the value of this kind of storage increases at a faster rate than it did before, and vice versa for renewable generation itself. The problem is that a high penetration of renewables on the grid is also more valuable when there is sufficient long-duration grid-scale storage to facilitate low levels of curtailment of available renewable capacity.[174] If renewable generators have to shed capacity due to overinvestment in capacity that cannot be effectively delivered on the grid, that is wasteful and a deterrent to investment. Where long-duration grid-scale storage has begun to make

171. de Sisternes et al., *supra* note 118, at 378 ("[E]nergy storage can reduce generation costs by increasing the utilization of installed resources and enabling greater penetration of the lowest cost carbon-free resources."); *see* Paul Denholm & Maureen Hand, *Grid Flexibility and Storage Required to Achieve Very High Penetration of Variable Renewable Electricity*, 39 ENERGY POL'Y 1817 (2011); Denholm & Leisch, *supra* note 161, at 3 ("[A]s we increase renewable penetration the value of storage increases . . . .").

172. Spector, *supra* note 169 ("Plenty of options technically 'work.' The question is, do they work with an acceptable price point and development cycle, and can the businesses providing them stay afloat long enough to actually prove that? That last step has been hard for companies to fulfill, insofar as in previous years there were practically no places to actually sell this stuff."). Indeed, a recent paper on the economics of grid-scale storage suggests that, due to high investment costs, the consumer surplus (i.e., the societal benefit) of grid-scale storage is twice as large as the owner's short-term profits. Ömer Karaduman, *Economics of Grid-Scale Energy Storage in Wholesale Electricity Markets* 4 (Mass. Inst. of Tech. Ctr. for Energy & Env't Pol'y Rsch., Working Paper No. 2021-005, 2021), http://ceepr.mit.edu/files/papers/2021-005.pdf [https://perma.cc/JE5R-ASPF]. Even worse, some studies suggest that storage could lead to an increase of carbon dioxide emissions at low levels of renewable penetration, because the use of storage primarily for energy arbitrage encourages charging when cheap, dirty generation is the marginal price setter. *See* CONDON ET AL., *supra* note 155, at 9.

173. *See* Karaduman, *supra* note 172.

174. Arbabzadeh et al., *supra* note 118, at 2.

inroads, it is precisely in those places where fast-paced deployment of renewables has created a strong need for long-duration storage,[175] but that accidental progress in overcoming lumpiness simply cannot be counted on to move fast enough for energy decarbonization goals.

Given the functional similarities in the purposes of transmission and storage on the grid, it should come as no surprise that the lumpiness that suppresses interest from investors and grid operators in modernizing transmission also limits the deployment of storage. Were it absolutely certain that renewables were going to achieve 70 to 90 percent market share of generation in the United States within the next three decades, passing on a chance to corner the market of grid-scale storage now would look like a wasted opportunity, both for private investors and for society writ large. But in the real world, it is anything but certain that the United States will achieve this drastic transition of its generation portfolio. In fact, the probability that the country will achieve that degree of renewable penetration is itself directly affected by utilities' evaluations of whether they believe the energy storage infrastructure necessary to support that degree of renewable penetration will exist.[176] The problem of lumpiness, and the chicken-or-egg dilemmas it presents for the energy sector, rears its ugly head again.

175. Spector, *supra* note 169 ("That's finally starting to change, thanks to two connected trends. First, wind and solar are now competing very effectively for capacity additions in the U.S. and other developed countries. The proliferation of these resources creates its own push for long-duration storage in places with high concentrations of wind and solar farms. A particularly appealing early market is in remote or island grids, where renewables-plus-storage already outcompete imported diesel fuel on price. Second, spurred by this success, many utility companies, states, and nations are upping their targets for clean energy. Once a jurisdiction officially commits to 100 percent carbon-free power, it has to start thinking in earnest about how to replace the gas plants that currently provide the flexible counterpart to renewables' ups and downs. These policies typically give prime billing to the clean energy sources, but they just as well could be considered market-creation tools for the long-duration storage asset class.").

176. Worse, it appears that there is a "non-monotonic relation between returns for renewables and energy storage investment. For moderate levels of renewable power, storage reduces renewable generators' revenue; however, for high levels of renewable power, storage increases renewable generators' revenue." Karaduman, *supra* note 172, at 46.

III. OVERCOMING UNCERTAINTY IN THE ENERGY TRANSITION

As Part II showed, several necessary transformations for decarbonizing the electric grid can be understood as lumpy social goods, meaning that achievement of them will require the assembly of complementary components before the value of any component is realized. For variable renewable generation to make major inroads on the electric grid, it must be coupled with massive buildouts of a national high-voltage transmission network and/or grid-scale, long-duration energy storage. In both cases, the lumpiness of the social good manifests as a chicken-or-egg dilemma: investment in one component is stifled by a wait-and-see dynamic.[177] We are chasing hares rather than stags.[178]

Policymakers have recognized these complementarities and have attempted to facilitate greater investment. As I show in Section III.A, policymakers have attempted to facilitate interregional planning, foster greater competition for transmission and storage, and subsidize discrete projects through incentive rates. In Section III.B, I argue that these efforts are insufficient. While these policies attempt to compensate for the lack of cross-subsector incentives for coordinated investment, they are not sufficiently aggressive to deal with the full extent of the lumpiness problem detailed in previous parts of this Article. In Section III.C, I outline what would amount to a much more proactive method to deal with lumpiness dynamics through "holistic" planning,[179] and I urge policymakers to take at least some of these steps to hasten the transformation of the sector.

A. *Existing Policies for Promoting Transmission Development and Grid-Scale Storage*

Policymakers are well aware of the need for lumpy investment in the energy transmission, although they may not currently use the terminology.[180] This Section reviews the tentative

177. For a helpful overview of this dynamic as it has played out in transmission proposals, see Robert H. Schulte & Fredric C. Fletcher, *Why the Vision of Interregional Electric Transmission Development in FERC Order 1000 Is Not Happening*, 33 ELEC. J. 1 (2020).

178. *See supra* notes 104–110 and accompanying text.

179. CASPARY ET AL., *supra* note 149, at 24.

180. One of the central purposes of this Article is to provide a language for describing the problem. *Cf.* James Baldwin, *As Much Truth as One Can Bear*, N.Y.

steps that policymakers have taken to try to facilitate investment in transmission and storage and stoke complementary investment in renewable generation.

1. Transmission

Policymakers have been fairly active in trying to address the need for new transmission networks, not only to integrate greater volumes of renewable generation but also to improve overall reliability of the system.[181] A key moment was the 2005 Energy Policy Act.[182] The Act contained several strategies for promoting a buildout of transmission lines.

First, addressing concerns that interstate transmission line development—particularly, multi-state, high-voltage DC transmission lines—was being undermined by NIMBYism in crossover states, the Energy Policy Act gave the federal government greater siting and eminent domain authority. Traditionally, states have possessed the authority to site transmission, but particularly with these multi-state projects where the benefits to local residents were minimal, state public utility commissions were able to exercise this authority to block transmission development that would benefit other regions.[183] Section 1221 of the Energy Policy Act empowered the Department of Energy to designate national interest electric transmission corridors (NIETCs) in regions of the bulk power grid plagued by congestion, and then gave FERC authority to override state siting

TIMES, Jan. 14, 1962 (§ 7), at 1, 38, https://timesmachine.nytimes.com/timesmachine/1962/01/14/118438007.html [https://perma.cc/LL7S-HZ8Q] ("Not everything that is faced can be changed; but nothing can be changed until it is faced.").

181. While FERC and RTOs/ISOs have "always tried to be neutral, with no discrimination or preference to any particular resource" in its transmission policies, it has a long history of pushing transmission investments for purposes of improving general reliability of the electric power system. CASPARY ET AL., *supra* note 149, at 27. *See* Robert Walton, *PJM Approves $1B in Transmission Upgrades*, UTIL. DIVE (Oct. 19, 2017), https://www.utilitydive.com/news/pjm-approves-1b-in-transmission-upgrades/507661 [https://perma.cc/CX2D-WT6R] (describing a PJM-approved transmission upgrade designed to improve reliability and market efficiency).

182. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005).

183. Klass, *supra* note 138, at 1916–18 (discussing the state siting paradigm and noting that the "problem with individual states determining whether there is a 'need' for an interstate transmission line or whether the line is a public use is that a single state legislature, public utility commission, or court will necessarily focus on the need of the citizens of its own state" and ignore regional or national benefits).

decisions that obstructed development of lines in that area.[184] While advocates for grid modernization had high hopes for this provision, federal courts' interpretations of the Section left it more or less dormant.[185] Less heralded, but similarly motivated, was Section 1222 of the Energy Policy Act, which allowed certain federal power marketing administrations the authority to partner with the Department of Energy to build new transmission lines (or upgrade existing ones) and avoid state siting regimes.[186] Section 1222 was nearly used for the first time in the infamous Clean Line Energy Partners plan to build the Plains & Eastern Clean Line transmission project, but ultimately the Department of Energy ended the partnership, throwing the project into limbo.[187]

Second, the Energy Policy Act of 2005 authorized FERC to offer incentives to would-be transmission developers to build projects designed to reduce congestion. Section 1241 of the Act called for FERC to develop "incentive-based (including performance-based) rates" and to ensure a "return on equity that attracts new investment in transmission facilities."[188] In turn, FERC issued Order 679,[189] which did in fact establish "a number of incentive rate treatments, including return on equity (ROE) adders to compensate for risks and challenges faced by a specific project, for forming a transmission-only company, or for joining a regional transmission organization or independent system operator."[190] In addition, Order 679 took some modest steps to reduce risks altogether, "allowing the use of hypothetical capital structures and inclusion of 100% of prudently incurred costs of abandoned plant in rate base."[191] Over the first decade of this program, FERC received over one hundred rate filings for new

184. 16 U.S.C. § 824p.

185. *See* ZEVIN ET AL., *supra* note 17.

186. 42 U.S.C. § 16421. For details of this program, see Request for Proposals for New or Upgraded Transmission Line Projects Under Section 1222 of the Energy Policy Act of 2005, 75 Fed. Reg. 32,940 (June 10, 2010).

187. *See* Robert Walton, *DOE Terminates Partnership with Clean Line Energy Partners*, UTIL. DIVE (Mar. 26, 2018), https://www.utilitydive.com/news/doe-terminates-partnership-with-clean-line-energy-partners [https://perma.cc/MRT9-DDWB].

188. 16 U.S.C. § 824s(a), (b)(2).

189. Order 679, *supra* note 29, at para. 42.

190. *FERC Seeks Ideas on How to Improve Transmission Incentives Policy*, T&D WORLD (Mar. 27, 2019), https://www.tdworld.com/transmission-reliability/article/20972396/ferc-seeks-ideas-on-how-to-improve-transmission-incentives-policy [https://perma.cc/TC5Y-ZQUT].

191. *Id.*

transmission proposals and supported over $53 billion in new transmission projects[192]—an encouraging, but by no means sufficient,[193] addition to the nation's transmission infrastructure. FERC understands as much, having recently opened up a new Notice of Inquiry into ways to modernize Order 679 to further spur investment in transmission projects.[194]

Finally, in a series of orders inspired by the larger push in the Energy Policy Act of 2005 to bolster transmission grids, FERC sought to encourage cooperation and planning for regional or national grid improvements that benefit the system as a whole but may only have indirect or limited benefits for particular utilities and generators who use the lines. Under a principle known as "cost causation," FERC has long labored under an inability to approve transmission rates that recover costs from system users who do not derive any benefit from a transmission project.[195] In Order 890, FERC attempted to encourage utility planning as a means of realizing shared benefits in transmission projects and avoiding cost-allocation fights.[196] Then, in 2011, FERC issued Order 1000, which extended the mandate for cooperation and planning to organizations and states.[197] It also required these planning processes to consider transmission needs based on "public policy requirements" (e.g., compliance with state renewable portfolio standards, among other items) and regional and interregional needs for transmission capacity.[198] Again, FERC hoped that the planning processes would

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192. Kent Knutson, *Before FERC Order 1000 There Was Order 679 – $53bn and Counting*, T&D WORLD (June 8, 2017), https://www.tdworld.com/overhead-transmission/article/20969754/before-ferc-order-1000-there-was-order-679-53bn-and-counting [https://perma.cc/6PSZ-PJGD].

193. Glick & Christiansen, *supra* note 15, at 35 ("The Commission's success in using these incentive frameworks to develop long-distance, high-voltage transmission facilities is debatable.").

194. Electric Transmission Incentives Policy Under Section 219 of the Federal Power Act, 86 Fed. Reg. 21,972 (proposed April 26, 2021) (to be codified at 28 C.F.R. pt. 35).

195. Ill. Com. Comm'n v. FERC, 576 F.3d 470, 480 (7th Cir. 2009) (Cudahy, J., concurring in part and dissenting in part) ("Cost causation requires that 'approved rates reflect to some degree the costs actually caused by the customer who must pay them.'" (citing Midwest ISO Transmission Owners v. FERC, 373 F.3d 1361, 1368 (D.C. Cir. 2004)).

196. *See* Klass & Wilson, *supra* note 124, at 1823.

197. *Id.*

198. *Id.* at 1823–24; Shelley Welton & Michael B. Gerrard, *FERC Order 1000 as a New Tool for Promoting Energy Efficiency and Demand Response*, 42 ENV'T L. REP. NEWS & ANALYSIS 11025, 11025–26 (2012) (noting that Order 890, along with Order 888, "created a major restructuring of transmission operations, opening

"create additional authority to spread transmission costs regionally, which will facilitate regional transmission lines to expand the reliability of the transmission grid generally and increase capacity for renewable energy specifically."[199] Critics have suggested that these planning orders have not helped overcome barriers to new transmission development enough to justify the costs of planning.[200] Indeed, there has been almost no uptake of interregional transmission under Order 1000.[201]

One reason that Order 1000 may not have had much success is that almost all new transmission projects have avoided competitive regional planning processes. As energy law scholar Ari Peskoe notes, transmission has historically been built by investor-owned utilities with a monopoly franchise over a local territory.[202] Jealously guarding this territory, these utilities have acted as a syndicate, or cartel, to co-opt regional planning

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transmission access to a broader range of market participants and leading to the establishment of more effective transmission planning").

199. Klass & Wilson, *supra* note 124, at 1825; Welton & Gerrard, *supra* note 198, at 11026 (noting that Order 1000 responded to the fact that FERC's "existing orders regarding transmission did not provide regional planners adequate direction as to how to consider" reforms targeted at the "generation mix and future transmission needs").

200. *See* AMS. FOR A CLEAN ENERGY GRID, PLANNING FOR THE FUTURE: FERC'S OPPORTUNITY TO SPUR MORE COST-EFFECTIVE TRANSMISSION INFRASTRUCTURE 8 (2021), https://cleanenergygrid.org/wp-content/uploads/2021/01/ACEG_Planning-for-the-Future1.pdf [https://perma.cc/C437-39RG] ("For all of the best efforts of the Commission and regional planning authorities, the current set of transmission regulations have resulted in inadequate levels of infrastructure that have burdened the interconnection process with the task of planning new network facilities—a task that should instead take place in the planning process. Further, existing regulations have created a system that disproportionately yields projects that address only local needs, that address reliability without more broadly assessing other benefits, or that simply replace old retiring transmission assets with the same type and design despite the potential for larger projects to more cost effectively meet the same needs."); *see also* Herman K. Trabish, *Has FERC's Landmark Transmission Planning Effort Made Transmission Building Harder?*, UTIL. DIVE (Jul. 17, 2018), https://www.utilitydive.com/news/has-fercs-landmark-transmission-planning-effort-made-transmission-building/527807 [https://perma.cc/6MY5-FJGW]; Knutson, *supra* note 192.

201. FERC, REPORT ON BARRIERS AND OPPORTUNITIES FOR HIGH VOLTAGE TRANSMISSION: A REPORT TO THE COMMITTEES ON APPROPRIATIONS OF BOTH HOUSES OF CONGRESS PURSUANT TO THE 2020 FURTHER CONSOLIDATED APPROPRIATIONS ACT 27–28 (2020) (noting that some have suggested that "development of interregional transmission facilities, which often could include high voltage transmission, continues to be an area of challenge" and that "there are various limitations in the current interregional transmission coordination processes that limit the effectiveness of those Order No. 1000 reforms"). *See generally* Schulte & Fletcher, *supra* note 177.

202. Peskoe, *supra* note 19, at 42.

processes and prevent new entrants from taking on larger interregional transmission projects.[203] Order 1000, thus, also contained some features designed to fight cartelization in transmission development. Most notably, it required incumbent utilities to forgo rights of first refusal for any project approved by a regional plan—meaning that such utilities would not automatically have the rights to actually build transmission within their service territory and would have to allow competitors to bid on the projects.[204] However, FERC also exempted projects within a utility's service territory that were paid for entirely by the utility's ratepayers.[205] In practice, almost all transmission projects since Order 1000 have been built using this loophole to avoid competition and retain the right of first refusal.[206]

2. Storage

Less policy has been made around energy storage than about transmission, despite the fact that "large-scale deployment of these assets, and the development of successful business models to support them, is heavily reliant on policy, regulation, and market design."[207] FERC's only major foray into this space came in 2018 in Order 841.[208] This order attempted to make it easier for storage assets to find value streams and compete on an even playing field with conventional generation assets in wholesale power markets.[209] Issues about how to classify storage services have dogged the industry, as market rules and utility regulations adhere to definitions of generation, transmission, and distribution services that were crafted before the Swiss Army knife of storage scrambled traditional categories.[210] In response to concerns that existing RTO and ISO governing tariffs were making it difficult for energy storage assets to offer services on regional wholesale energy, capacity, and ancillary services markets, FERC ordered the grid operators to establish new rules

203. *See id.* at 55–56.
204. *See id.* at 53–54.
205. *See id.* at 54.
206. *Id.* at 56.
207. Apurba Sakti et al., *Review of Wholesale Markets and Regulations for Advanced Energy Storage Services in the United States: Current Status and Path Forward*, 120 ENERGY POL'Y 569, 569 (2018).
208. Order 841, *supra* note 18.
209. Glick & Christiansen, *supra* note 15, at 16 n.68.
210. *See* Stein, *supra* note 161.

that did not discriminate against storage assets.[211] Clearing up these barriers to entry made it possible for several states to engage in a blunt-force approach to encouraging storage asset development—one analogous to the state renewable portfolio standards that have substantially greened the generation mix.[212] California and New York have led a small group of states in mandating specific targets for the development of in-state storage capacity.[213] Order 841, to the extent that regional grid operators complied with it, ensures that these large levels of storage will at least have access to an interstate market capable of partially remunerating developers.[214]

While Order 841 was thus a critical first step for paving the way for markets developed for conventional generation to integrate large levels of storage, experts believe that more work will have to be done (potentially by FERC, but also perhaps by states) to allow storage assets to value stack services at the transmission and distribution level and be properly incentivized to do so.[215] Utilities have generally been reticent in their integrated resource planning processes to fully invest in storage, seeing doubts about whether storage assets will be used in all the ways that are useful in generation, transmission, and distribution.[216] While FERC has occasionally treated storage facilities as a transmission asset and allowed cost recovery for those

211. *See* Order 841, *supra* note 18, at para. 51.

212. *See* Sean Baur, *Going Beyond Order 841 to More Meaningful FERC Storage Policy*, UTIL. DIVE (Sept. 1, 2020), https://www.utilitydive.com/news/going-beyond-order-841-to-more-meaningful-ferc-storage-policy/584129 [https://perma.cc/YM73-C6BF].

213. Sakti et al., *supra* note 207, at 576 (noting that California set a target of 1.325GW of storage capacity, and New York set a target of 1.5GW).

214. Although there was some doubt about whether Order 841 was within FERC's jurisdiction, the D.C. Circuit in *NARUC v. FERC* upheld Order 841, holding that provisions of the Order banning states from preventing storage located on local distribution systems from participating in competitive wholesale markets did not violate the Federal Power Act's division of authority between the federal and state governments. Nat'l Ass'n of Regul. Util. Comm'rs v. FERC, 964 F.3d 1177 (D.C. Cir. 2020).

215. Sakti et al., *supra* note 207, at 578; Baur, *supra* note 212.

216. AL COOKE ET AL., U.S. DEP'T OF ENERGY, ENERGY STORAGE IN INTEGRATED RESOURCE PLANS (2019). For an overview of mandates, targets, and goals imposed by states to do a better job of integrating storage into planning, see Jason Burwen, *Energy Storage Goals, Targets, Mandates: What's the Difference?*, ENERGY STORAGE ASS'N: THE ESA BLOG (Apr. 24, 2020), https://energystorage.org/energy-storage-goals-targets-and-mandates-whats-the-difference [https://perma.cc/6M8B-HW4J].

services,[217] it has not developed a clear policy encouraging grid-scale storage planning, as it has with traditional transmission lines in Order 1000. Thus, "[w]hat role storage will ultimately play in the transmission mix is, for the time being, very much an open question."[218]

B. *The Root Cause of Past Failures*

The slow progress in transmission and storage development speaks to a persistent failure of policymakers to recognize the degree to which uncertainty about the production of lumpy social goods is built into the way the restructured electric power sector is designed. As Part I explained, recent decades saw substantial change in the way that the energy sector is organized, with a general unbundling of previously vertically integrated electric utilities providing generation, transmission, and distribution services into separate subsectors each operating at arm's length from each other, and each regulated in different ways. This unbundling was necessary to allow for competition in the wholesale of electric power because the transmission and distribution services necessary to bring energy from generation to consumer gave utilities too much market power and allowed them to favor their own local generation.[219] From the standpoint of trying to eliminate barriers to competition in power generation and open up regional markets, the uncertainty created by the unbundling of energy services is a feature, not a bug.

While these regulatory reforms made sense and delivered enormous benefit to ratepayers, I argue below in Section III.B.1 that the lumpiness problems detailed in previous Parts put pressure on this seemingly innocuous regulatory design choice and require more proactive policies to address the coordination problems that unbundling creates. The key problem with lumpiness is the costs of coordination, or what economists call "transaction costs."[220] The Assurance/Stag Hunt Game dynamics that arise

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217. W. Grid Dev., LLC, 130 FERC ¶ 61,056, at paras. 43–45 (Jan. 21, 2010).

218. Glick & Christiansen, *supra* note 15, at 36.

219. Griffin & Puller, *supra* note 26, at 10 ("The preceding discussion of how a market for power generation might function suggests that power-generating firms should operate independently of firms that own the transmission network. Otherwise, monopolistic abuses may arise with a vertically integrated firm having no incentive to eliminate transmission bottlenecks.").

220. For a classic statement and analysis of transaction costs in the law and economics literature, see Guido Calabresi, *Transaction Costs, Resource Allocation*

from lumpy social goods can be overcome only to the extent that coordination is permissible and possible—that is, to the extent that the transaction costs, which prevent avoidance of a key premise of the Game (the inability to mutually decide to pursue the Stag), are low enough.

As Section III.A showed, more than a decade of tepid attempts to encourage regional coordination across subsectors gives little indication that the substantial transaction costs necessary to achieve lumpy investment in the unbundled electric power sector are being appropriately mitigated. I therefore argue in Section III.B.2 that the challenge for policymakers is to find more effective ways of coordinating investment.

1. Unbundling's Hidden Costs

Energy economists have long been aware that transaction costs potentially complicate the case for unbundling,[221] and beyond that, an array of "soft-costs" emerges in actual investment behavior in the renewable energy space.[222] Simply put, if we relax the unrealistic assumption that coordination for lumpy goods is frictionless and enforcement of coordinated commitments costless, then it is "not at all surprising that regulated firms evolved as vertically integrated firms."[223] Allowing utilities to organize as vertically integrated firms "may reduce transaction costs because within a firm, incentives are mutually aligned, and

and Liability Rules — A Comment, 11 J.L. & ECON. 67, 68 n.5 (1968) ("By transaction costs, I have in mind costs like those of getting large numbers of people together to bargain, and costs of excluding free loaders."); *see also* Pierre Schlag, *The Problem of Transaction Costs*, 62 S. CAL. L. REV. 1661, 1672–76 (1989) (deconstructing the concept of transaction costs and showing that it "remains something of a black hole").

221. Paul L. Joskow, *Electricity Sector Restructuring and Competition: A Transactions-Cost Perspective*, *in* THE ECONOMICS OF CONTRACTS: THEORIES AND APPLICATIONS 503 (Eric Brousseau & Jean-Michel Glachant eds., 2002); Aurelio Fetz & Massimo Filippini, *Economies of Vertical Integration in the Swiss Electricity Sector*, 32 ENERGY ECON. 1325 (2010); Monica L. Greer, *A Test of Vertical Economies for Non-Vertically Integrated Firms: The Case of Rural Electric Cooperatives*, 30 ENERGY ECON. 679 (2008). Much of the concern has to do with lumpiness in much more granular transactional circumstances—specifically, accounting for the costs of transacting around "long-lived, transaction-specific assets," such as a new power plant and a transmission line built just for the purpose of connecting that plant to the grid. Griffin & Puller, *supra* note 26, at 10. But, the same language and framework applies (and actually applies with much greater force) around the societal-scale lumpiness problems in the energy transition.

222. Mormann, *supra* note 15, at 704–10.

223. Griffin & Puller, *supra* note 26, at 11.

various sharing rules between the generation and transmission divisions can be resolved at lower costs."[224] For instance, a vertically integrated firm that owns power generation and needs to bring that power to market can decide to build the transmission itself, and if it does so, the costs of coordination are next to nothing. Hence, a lumpy good that only acquires the bulk of its value once assembly is completed can be valued appropriately at the outset rather than discounted by whatever uncertainty might exist in a free market transaction with separate entities.[225]

In today's electric power sector, separate generators and transmission builders must incur the costs of bargaining and coordinating amidst tremendous uncertainty. This is especially likely to deter investment when the thing being bargained over is not a specific transaction or project (which can be subjected to contract terms enforceable in court), but rather a social good that does not lend itself to legal enforcement (like coordinating massive, interregional and national investments in complementary technologies to decarbonize the energy sector). Operating on this larger scale, there are many more variables to account for and, therefore, more uncertainty.[226]

For instance, it might not be immediately clear who the relevant parties are when pursuing a project of national scope. Few firms can afford to operate on a truly national scale,[227] so the coordination dilemma inevitably entails working with a diffuse group of many partners at the expense of greatly exacerbated transaction costs. Furthermore, the nature of the bargain is inherently more open-ended: Will the precise combination of complementary technologies be transmission heavy or storage heavy? What combination of collaborators are the right ones to transact with in the first place? In addition, the longer time frame necessary to complete major complementary investments introduces substantial and unwieldy uncertainty. What effective remedy will I have if I uphold my end of a lumpy investment in renewable generation, but my collaborators hold out on me and

224. *Id.* at 10–11.

225. Of course, traditionally, investor-owned utilities operated on a local scale, tethered to a monopoly territory. *See* Peskoe, *supra* note 19. Within this limited territory, a vertically integrated utility faces few if any lumpiness problems. A hypothetical vertically integrated provider operating at a regional or national scale would not face any lumpiness problems either, although such actors have not ever existed.

226. *See* Schulte & Fletcher, *supra* note 177.

227. *See id.* at 4–5.

either fail to perform or attempt to exercise hold-up power and renegotiate the terms of use?

In small-scale individual transactions, these problems can often be solved by entering into long-term contracts that can be enforced in court. Accordingly, there does not seem to be much lost by unbundling deeply related components of the electric utility business and imposing the cost of coordination on firms in each subsector. Perhaps that is part of why these small-scale individual projects are quite common, even today.[228] But at a societal scale, there is no analog to a contract, or at least none sufficiently enforceable to resolve the dilemma. There is no social contract for the energy transition.

To put it another way, an overlooked root cause of the problem is the fact that regulators' policies have opened up regional generation competition by unbundling generation from the transmission building business but have not taken adequate steps to create a forum for coordination of generation and transmission at the same regional or interregional scale. The tepid steps that FERC took in Order 1000 have not stoked regional or interregional transmission development.[229] Descriptively, the transmission business has shied away from these processes and exploited loopholes to avoid competition, but functionally, this is a manifestation of great uncertainty and high transaction costs for coordination with competitive generation.[230] We have to ask

228. CASPARY ET AL., *supra* note 149, at 21 ("While current transmission investment numbers are relatively high by historical standards, the majority of recent transmission investments have been small local projects, as demonstrated by Brattle: '[A]bout one-half of the approximately $70 billion of aggregate transmission investments by FERC-jurisdictional transmission owners in ISO/RTO regions are approved outside the regional planning processes or with limited ISO/RTO stakeholder engagement.'" (quoting JOHANNES P. PFEIFENBERGER ET AL., COST SAVINGS OFFERED BY COMPETITION IN ELECTRIC TRANSMISSION: EXPERIENCE TO DATE AND THE POTENTIAL FOR ADDITIONAL CUSTOMER VALUE 4 (2019)).

229. *See supra* Part II.

230. It could be that it also represents anticompetitive behavior: major investor-owned utilities want to avoid competition in order to maintain a position of advantage, both in the generation market and in the transmission development business. *See* Peskoe, *supra* note 19. This "public choice" explanation of the same lack of investment is plausible, but like all public choice accounts of regulation, it suffers from a lack of falsifiability and excessive cynicism. *See* STEVEN P. CROLEY, REGULATION AND PUBLIC INTERESTS: THE POSSIBILITY OF GOOD REGULATORY GOVERNMENT (2008). My account of lumpiness dynamics posits a more benign motivation for the same behavior, and the reader can decide which account better describes reality. In any event, there is no reason to think that a strategy responding to concerns about anticompetitive behavior cannot be paired with a strategy

why transmission developers continue to double down on local projects, and the lumpiness characteristics of the social goal provide an answer.

2. The Need for Greater Expressive Support of Nationwide Coordination

One solution to the root problem—perhaps the most direct solution—would be to reduce transaction and coordination costs for interregional projects altogether by eliminating the functional separation of the generation and transmission subsectors and nationalizing the bundled electric power sector. This idea is not without its supporters.[231] But while municipalization and state takeovers of utilities are having a moment,[232] I assume that, for now, reforms must work within the existing private-utility-dominated framework. Another solution is doing the same "re-bundling" but preserving privately owned utilities. The problem here is that no investor-owned utility operates on a sufficiently interregional scale to support this enterprise, and the balkanized geographical distribution of existing utilities in practice means that re-bundling would accomplish nothing when it comes to addressing lumpiness dynamics.[233] I therefore assume that this is a nonstarter as well.

With these assumptions, the way forward on decarbonization of the electric grid involves preserving the benefits of competitive generation while making concomitant changes to supercharge cross-subsector planning and coordination of needed facilitative infrastructure. To achieve this balance, policymakers must engage in "expressive" approaches, which will provide the kind of certainty for cross-subsector coordination that can overcome transaction costs. Expressive approaches seek to harness

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addressing the need for more robust planning than FERC has required to date. These can, and should be, complementary reforms.

231. *See* Kate Aronoff, *Nationalizing the Power Industry Isn't Radical*, NEW REPUBLIC (Mar. 2, 2020), https://newrepublic.com/article/156713/nationalizing-power-industry-isnt-radical [https://perma.cc/4AA7-PEUK].

232. *See* Welton, *supra* note 45; Lilli Ambort, *Spreading Like Wildfire: An Interest in Making Electric Power Public*, INST. FOR LOC. SELF-RELIANCE (Mar. 5, 2020), https://ilsr.org/municipalization-electric-utilities-update-2020 [https://perma.cc/3HWY-PMLS]; Taryn Luna, *It's Time for California to Take Over PG&E, State Lawmaker Says*, L.A. TIMES (Feb. 3, 2020, 6:05 AM), https://www.latimes.com/california/story/2020-02-03/its-time-for-california-to-take-over-pg-e-state-lawmaker-proposes [https://perma.cc/LRT3-SNLD].

233. *See* Peskoe, *supra* note 19.

"law's expressive function" by offering rules that "by their mere expression can serve as 'focal point[s] around which individuals can coordinate their behavior.'"[234] The literature on expressive commitments provides much evidence that merely signaling commitment to provision of a social good—like decarbonization—can reduce transaction costs enough to spur significant investment.[235] With governmental expression of support, one would expect more investment, but the critical question is whether the expression of support for the project of decarbonization is explicit enough to induce the most transformative investments.

To some extent, the FERC policies detailed above in Section III.A attempt to express this kind of support, but they are tepid expressions. For instance, Order 1000, while expressing support for regional and interregional transmission planning through a requirement for parties to meet and produce plans, left the permissibility of considerations of social or public policy (i.e., considerations about what kinds of interregional transmission would be necessary to integrate renewable generation) ambiguous in the regional planning context and unrecognized in the interregional planning process. FERC's proposal that regional transmission planning processes consider "public policy requirements" generated many comments either resisting clearly stated policy goals or arguing that neither FERC nor the transmission planners should be involved in the determination of policy.[236] In its final Order, FERC largely acceded to these demands to water down the public policies requirement. Transmission operators would have to engage in planning, but the goals were left almost completely unspecified and were left to stakeholders to flesh out (stakeholders who, of course, operate in the silo of the transmission subsector).[237] On the interregional side, even this vague aspiration to use planning to achieve undefined public policy goals was conspicuously absent.[238] This left it fundamentally unclear

234. *See* Lee, *supra* note 105, at 1139 (quoting Richard H. McAdams, *A Focal Point Theory of Expressive Law*, 86 VA. L. REV. 1649, 1651 (2000)); *accord* Robert B. Ahdieh, *Law's Signal: A Cueing Theory of Law in Market Transition*, 77 S. CAL. L. REV. 215, 259–61 (2004); Cass R. Sunstein, *On the Expressive Function of Law*, 5 E. EUR. CONST. REV. 66 (1996); Robert Cooter, *Expressive Law and Economics*, 27 J. LEGAL STUD. 585 (1998).

235. Ahdieh, *supra* note 234.

236. Order 1000, *supra* note 19, at paras. 169–202.

237. *Id.* at paras. 206–207.

238. *Id.* at para. 401.

to what degree the Order contemplated the planning of transmission lines optimized to incentivize renewable development rather than to enhance the operational efficiency and resilience of the grid. Not surprisingly, these planning processes have yielded no serious interregional or regional transmission upgrades explicitly designed to solve the chicken-or-egg dynamic holding back investment in renewable generation corridors. Much stronger expressions of support—ideally, ones that explicitly recognize the lumpiness dynamics that inhibit investment in this space—will be necessary to overcome the very serious barriers to coordination of such projects detailed in this Article. The next Section details two such expressions of support.

C. *Two Paths Forward*

There are many ways that FERC could improve on its current approach to encouraging the development of facilitative infrastructure, including simply making the development of interregional transmission grids capable of incentivizing renewable development an explicit public policy goal in its planning orders. However, the need to take swift action in the face of the impending climate crisis suggests that bolder changes may be necessary to achieve the lumpy social good of decarbonization as quickly as possible. In this Section, I offer two reforms befitting the urgency of the challenge that policymakers face: first, an enhanced mechanism, a National Renewable Energy Development Zone, for paired generation and transmission planning; and second, incentive rates for transmission and storage infrastructure. Each addresses the coordination problem head on—one by integrating generation and transmission planning, and the other by offsetting the costs of uncertainty that transmission and storage developers must labor under.

1. A National Renewable Energy Development Zone

First, following the example of several states and grid operators who have successfully experimented with the "renewable energy development zones" concept,[239] Congress could authorize

239. *See generally* NATHAN LEE ET AL., NAT'L RENEWABLE ENERGY LAB'Y, RENEWABLE ENERGY ZONE (REZ) TRANSMISSION PLANNING PROCESS: A GUIDEBOOK FOR PRACTITIONERS (2017), https://www.usaid.gov/sites/default/files/documents/1865/69043.pdf [https://perma.cc/8X6G-3WSC].

FERC to designate a National Renewable Energy Development Zone. Under this proposal, FERC would assume from the states the power to approve new generation projects and transmission projects and plan them together.

These renewable energy development zones projects share an implicit recognition of the problems of lumpiness. Such programs integrate generation and transmission planning so that there is greater certainty that complementary investments will be made. For instance, in Texas, the state government passed legislation creating the Competitive Renewable Energy Zone (CREZ) project, which aimed to develop Texas's vast wind power resources in the western part of the state.[240] Before CREZ, there were not enough transmission lines to this part of the state from population centers to induce all possible development of these resources.[241] Wind farms that were built tended to cluster around existing transmission lines, even when the meteorological conditions were not as good as in other, more remote areas. Moreover, congestion on the few transmission lines that existed caused even these wind farms to curtail their production of energy.[242] Texas needed more transmission to set the stage for better development of wind resources. CREZ solved this chicken-or-egg problem by identifying zones where there were ample untapped wind resources, interest from potential generation developers, and the ability to cost-effectively develop transmission connecting them to the grid.[243] Once zones were designated, the state brought stakeholders and policy analysts together to hash out a plan to spend $6.7 billion building transmission lines capable of delivering large amounts of power from West Texas to population centers, all to be recovered from ratepayers throughout the state.[244] Like in Order 1000, CREZ used competition bidding for lines—in all, seventy-two new lines bid by incumbent utilities and new entrants were permitted.[245] But unlike in

240. Klass & Wilson, *supra* note 124, at 1845 ("When the Texas legislature established its RPS goal in 2005, it also addressed transmission constraints by creating a process for the Texas Public Utilities Commission ('TPUC') to plan transmission facilities in advance of renewable energy–generation facilities.").

241. Staine, *supra* note 83, at 531.

242. *Id.*

243. *Id.*; *see also* JEFF BILLO, ELEC. RELIABILITY COUNCIL OF TEX., THE TEXAS COMPETITIVE RENEWABLE ENERGY ZONE PROCESS (2017), https://cleanenergysolutions.org/sites/default/files/documents/jeff-billo_webinar-ercot-crez-process.pdf [https://perma.cc/22XR-VV5E].

244. Staine, *supra* note 83, at 531.

245. FERC, *supra* note 201, at 36.

Order 1000, the explicit coordination between generation development and transmission development actually encouraged bids. The difference between standalone transmission planning, as Order 1000 encourages, and coordinated generation *and* transmission planning makes a large difference. When the planner has the authority to approve both projects simultaneously, uncertainty is virtually eliminated.

If the experiences of Texas and other jurisdictions are any guide,[246] the result of a *national* renewable energy zone would be lightning-fast development of both renewable generation and transmission and storage necessary to move the energy produced through time and space to where it is needed. In Texas, CREZ helped drive integration of more than 19 gigawatts of wind generation and reduced wind curtailment from 17 percent to 0.5 percent in less than a decade. [247] CREZ is frequently cited as an almost unabashed success.[248] Likewise, other areas have experienced a fair amount of success using the concept of development zones. Possible pilot projects to draw on include California's Renewable Energy Transmission Initiative (RETI),[249] MISO's Multi-Value Project (MVP),[250] and the SPP's Priority

246. Of course, there may be other factors that contributed to Texas's success in the CREZ program, including the abundance of wind resources in the panhandle and a renewable portfolio standard, but CREZ undoubtedly "stimulated significant transmission development" and, therefore, supported these other policies. Felix Mormann et al., *A Tale of Three Markets: Comparing the Renewable Energy Experiences of California, Texas, and Germany*, 35 STAN. ENV'T L.J. 55, 91–92 (2016). These other factors may not be present throughout the United States—for instance, as of this writing, there is no national renewable portfolio standard, although, that may be coming. *See* Andreas Karelas, *Clean Electricity Standard Should Be a No Brainer Amid Extreme Climate Impacts*, THE HILL (Jul. 19, 2021, 4:30 PM), https://thehill.com/opinion/energy-environment/563739-clean-electricity-standard-should-be-a-no-brainer-amid-extreme [https://perma.cc/3X37-U6MS] (discussing talks to implement a national clean electricity standard); Lincoln L. Davies, *Power Forward: The Argument for a National RPS*, 42 CONN. L. REV. 1339 (2010) (arguing for such a standard).

247. BILLO, *supra* note 243. Texas is now the nation's leading wind generation state, with 24 gigawatts of installed capacity. POWERING TEXAS, TEXAS: AMERICA'S LEADER IN WIND ENERGY 3 (2019), https://poweringtexas.com/wp-content/uploads/2019/02/Powering-Texas-R15.pdf [https://perma.cc/VUL5-XG5W].

248. *See* LEE ET AL., *supra* note 239, at 15.

249. Klass & Wilson, *supra* note 124, at 1838.

250. Sam Gomberg, *New Transmission Projects Will Unleash Midwestern Wind Power—And Save Billions*, UNION OF CONCERNED SCIENTISTS: THE EQUATION (Dec. 8, 2017), https://blog.ucsusa.org/sam-gomberg/midwest-transmission-wind-power [https://perma.cc/2SCN-GTSJ] (predicting that, when finished, MVP transmission improvements will lead to "significant" additions of wind generation to the MISO system).

Projects.[251] The reason these projects often succeed in inducing investments in renewable-optimized transmission is easy to grasp using the framework of lumpiness: these programs reconstruct some of the coordination that used to occur with vertically integrated firms building both generation and transmission. With uncertainty about contingent complementary investments allayed, investors in both wind generation and transmission were able to move forward quickly.

Texas's success with CREZ is probably partly attributable to its unique situation as the only state that is largely coterminous with its grid operator's jurisdictional boundaries.[252] This situation makes it easier for Texas to do something like CREZ because the state public utility commission and the grid operator, ERCOT, together have all the authority needed to quickly approve generation and transmission according to the CREZ plans. In other regions, it would be more difficult to eliminate much of the uncertainty, because individual states, who historically have controlled approval of new generation, may not cooperate with even the best-laid plans.[253] Were Congress to take up the idea and develop a National Renewable Energy Development Zone encompassing territory in different states across the Plains and Southwest, it would either need to gain assurances from states that they would cooperate with the national plan or preempt state authority over electricity generation.[254] Since moderately pro-climate majorities control Congress and the White House for the time being, now would be an ideal time to break through the balkanization in a direct way and preempt states' traditional control over generation within the region. While this would be a significant change to the usual order of things under our energy federalism[255] and would be politically fraught,[256] it is past time to be taking direct action to coordinate

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251. *Priority Projects*, SW. POWER POOL, https://www.spp.org/engineering/transmission-planning/priority-projects [https://perma.cc/EK6B-CG84].

252. Klass & Wilson, *supra* note 124, at 1843.

253. This may partially explain why other renewable energy zone projects, like RETI and MVP, have not seen quite the level of success that Texas saw. *Id.* at 1844.

254. *See id.* at 1814 (noting that states retain primary authority over transmission line siting, and criticizing this as inefficient, given the federal interest in transmission lines).

255. Hari M. Osofsky & Hannah J. Wiseman, *Dynamic Energy Federalism*, 72 MD. L. REV. 773 (2013) (describing the "fragmented" federalist framework governing energy law in the United States).

256. It is easy to imagine Senator Joe Manchin and other centrist Democrats viewing the assumption of power from the states by the federal government as a

a national climate policy, and the National Renewable Energy Development Zone concept could be a key part of that effort. If Congress takes up the task, as it could do under unified Democratic control, it would do well to consider the idea.

2. Incentive Rates to Offset Uncertainty in Transmission and Storage Projects

Alternatively, or in concert with the National Renewable Energy Zone, Congress or FERC could take steps to offset the pecuniary disincentives created by uncertainty surrounding facilitative infrastructure development.

To some extent, Congress and FERC have already taken steps in this direction, as discussed above. In the Energy Policy Act of 2005, Congress added Section 219 to the Federal Power Act, tasking FERC with developing incentive rates for the development of transmission.[257] FERC in turn issued Order 679 to detail what the precise incentives would be,[258] and it has recently proposed to revisit these incentives.[259] The idea behind

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step too far and using their veto-gate authority to force fewer sweeping reforms. This is a real concern with the National Renewable Energy Development Zone idea, but part of the reason for highlighting lumpiness is to make plain that less sweeping reforms are not likely to move the ball on renewable integration, despite these politicians' desires to have it both ways. Another potential political hurdle is review in the courts, which have shifted to the right in recent years. It is possible that even an attempt by Congress to implement a National Renewable Energy Development Zone would meet the same fate as the NIETCs did in the courts. *See* sources cited *supra* note 144. However, cases like *Piedmont Env't Council v. FERC*, 558 F.3d 304 (4th Cir. 2009) were based on a textualist reading of an ambiguity in the NIETC statute, so these problems could be avoided by careful statutory drafting.

257. 16 U.S.C. § 824s. However, Section 219 does not explicitly recognize the facilitation of renewable generation development as a public policy goal—instead, it centers on reliability and congestion concerns. *See id.* ("Not later than 1 year after August 8, 2005, the Commission shall establish, by rule, incentive-based (including performance-based) rate treatments for the transmission of electric energy in interstate commerce by public utilities for the purpose of benefitting consumers by ensuring reliability and reducing the cost of delivered power by reducing transmission congestion.").

258. Order 679, *supra* note 29; Knutson, *supra* note 192.

259. *See* Electric Transmission Incentives Policy Under Section 219 of the Federal Power Act, 85 Fed. Reg. 18,784 (proposed Apr. 2, 2020) (to be codified at 18 C.F.R. pt. 35). The proposal, however, marks a retreat from incentive rates for projects beyond those encouraging reliability or congestion relief (citing concerns about a giveaway to transmission companies and a desire to more closely align policy with the statutory mandate), *id.* at 18,785, when, if anything, FERC should be recalibrating its incentives to encourage the kinds of interregional transmission lines that are too risky for transmission companies to develop but would help facilitate the development of renewable generation facilities in remote areas.

things like a Return on Equity (ROE) adder is to offset costs that might deter investment. On the storage side, FERC Order 841 did give storage owners more of a green light to treat storage as a generation resource and bid into wholesale energy markets.[260] This framework partially sidesteps the problem of coordination by providing new revenue streams for storage connected to the grid. Not surprisingly, these opportunities for storage have led to a renaissance of paired solar and storage projects.[261]

These efforts are helpful because they partially alleviate the costs of uncertainty, but there is more that could be done to promote projects on the scale needed. Going forward, Congress or FERC could make a major difference by reforming the process of cost allocation to explicitly express a commitment to fund national-scale projects[262]—both high-voltage interregional transmission lines and grid-scale, long-duration storage proposed for use as a substitute for transmission—and backing that commitment up with rate recovery from a much broader set of users.[263] Under Order 1000, regional grid operators submit compliance filings laying out a cost-allocation methodology.[264] The methodology of these compliance filings has not ventured far beyond the traditional mandate of cost causation, which says that only those who directly use transmission should be responsible for paying for it.[265] A broader form of cost allocation—society wide, or at least interregional—would better reflect the national benefits that would be provided by interregional transmission.[266] The

260. Order 841, *supra* note 18, at para. 148.

261. *See supra* notes 208–215 and accompanying text.

262. AMS. FOR A CLEAN ENERGY GRID, TRANSMISSION POLICIES FOR THE NEXT ADMINISTRATION AND CONGRESS (2020), https://cleanenergygrid.org/wp-content/uploads/2020/10/ACEG-Policy-Recommendations-2.pdf [https://perma.cc/C6R5-6R7G].

263. *Id.*

264. Nicholas Adrian McTyre, *FERC's Order No. 1000 from a Historical Perspective: Restructuring and Reorganization of Electric Transmission Markets from 1996 Until Present*, J. ENERGY & ENV'T L. 51 (2015) (noting the importance of compliance process for shaping the actual impact of Order 1000).

265. *See id.* at 55, 57 (noting that PJM and ISO-New England "generally maintained its existing cost allocation methodologies"). At most, grid operators seem to have embraced regional cost allocation, specifically for public policy projects like MVP, *id.* at 56, but have not tackled the interregional cost allocation question. *Id.* at 58.

266. AMS. FOR A CLEAN ENERGY GRID, *supra* note 200, at 12 (arguing for reforms to planning processes that merge the cost allocation challenge with a consideration and recognition of the "broad benefits that are created by large regional and interregional transmission infrastructure"); Klass & Wilson, *supra* note 124, at 1870 ("[In] parts of Europe, regulators have adjusted cost-allocation structures so

courts have interpreted the cost-causation principle as a gloss on the Federal Power Act,[267] so Congress may need to act to clarify that spreading costs across a broader set of users who get indirect, if not direct, benefits from the existence of lines still help finance those lines.[268]

Additionally, while Order 679 took steps in the right direction, "spurr[ing] the construction of a tremendous number of projects that likely wouldn't have been built without the financial guarantees" provided by the Order,[269] Congress and/or FERC could and should build on it. First, Congress could amend Section 219 of the Federal Power Act to make it clear that incentive rates should be offered to transmission developers when they pursue projects that integrate renewables for the purposes of decarbonizing the electric grid, not just when they improve existing operations. Currently, FERC has proposed to take a step back from Order 679 to better align its incentives program to the statutory text, which emphasizes reliability and alleviation of congestion.[270] These are no doubt important statutory objectives, but FERC's apparent belief that it cannot adopt an incentive scheme tailored to the project of integrating renewable generation into the grid through new transmission greatly limits the impact of this program. Congress should clarify that promotion of renewables is an acceptable basis for an incentive rate program. Second, given the apparent success of Order 679 in spurring new transmission so far—especially when compared to the meager success of Order 1000—FERC should consider even more robust incentive rates, especially for interregional projects that will facilitate interconnection of new generation. A revamped Order 679 with explicit and significant support for

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that the costs of new transmission are generally 'socialized' on a 'postage-stamp' basis, particularly for renewable energy-based projects"). This is more or less the position of the American Wind Energy Association, which has argued that the "single largest obstacle to building transmission" is the lack of a cost-allocation methodology that spreads the cost of large public infrastructure projects among the broader public. AM. WIND ENERGY ASS'N, GRID VISION: THE ELECTRIC HIGHWAY TO A 21st CENTURY ECONOMY 75 (2019).

267. *See* K N Energy, Inc. v. FERC, 968 F.2d 1295, 1300 (D.C. Cir. 1992) (gleaning the cost-causation principle from the Natural Gas Act's "just and reasonable" requirement, which is interpreted the same way as the "just and reasonable" requirement in the Federal Power Act); *see also* Ill. Com. Comm'n v. FERC, 576 F.3d 470, 480 (7th Cir. 2009) (Cudahy, J., dissenting).

268. AMS. FOR A CLEAN ENERGY GRID, *supra* note 262.

269. Knutson, *supra* note 192.

270. *See supra* notes 257–259 and accompanying text.

projects that take on the significant risks associated with lumpy infrastructure investments would be a powerful tool for paving the way for progress.[271]

Likewise, a more advanced storage policy would allow storage resources not only to participate in energy markets as generators, as Order 841 allowed,[272] but also to recover the same incentive rates as transmission when they operate more like transmission by shifting load over time. That is, if grid-scale storage is being used as a substitute for the kinds of massive load-shifting services that interregional transmission would otherwise provide, the owners of those resources should be subsidized in the same way that transmission companies are. As Shelley Welton has argued, a variety of technologies and services are essentially substitutes for new transmission.[273]

Storage resources have so far befuddled regulators, including FERC, who want to treat resources as generation, transmission, or distribution only.[274] This regulatory rigidity prevents holistic thinking about how to optimize the integration of remote intermittent renewable generation into the grid. While storage is still at a nascent stage of technological development, falling costs and improving technology suggest that grid-scale storage could play a major role in overcoming lumpy barriers to renewable integration.[275] Again, perhaps with new authorization from Congress, FERC should incorporate grid-scale storage projects into its incentive rate program for transmission, treating storage as a potential substitute for new lines. Or perhaps with storage the potential uses are so varied[276] that it is best to take a use-agnostic approach for the time being and simply mandate regional or national planning processes, much like state-level integrated resource planning or Order 1000 for interregional

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271. Of course, much like a group splitting a tab at an expensive restaurant, increasing the payout for transmission projects without reforming the cost allocation process to recognize the interregional or national benefits of a supergrid could just make already heated fights over cost allocation that much more difficult to resolve. I thank Rob Gramlich for making this point and emphasizing the primacy of cost allocation reforms.

272. *See* Order 841, *supra* note 18; Baur, *supra* note 212.

273. Welton, *supra* note 85.

274. *See* Stein, *supra* note 161, at 702.

275. *Utility-Scale Battery Storage Costs Decreased Nearly 70% Between 2015 and 2018*, *supra* note 157.

276. Stein, *supra* note 161.

transmission projects, which would allow relevant players to coordinate an approach.[277]

CONCLUSION

This Article has offered a different perspective on the problems that frustrate siting the facilitative infrastructure that policy experts agree are necessary to realize a clean energy transition. To be sure, there are many reforms, such as using existing authorities or new authorities to preempt state siting vetoes and to exercise eminent domain authority to site lines. But even the most streamlined process will not work if incentives are not aligned and risks mitigated. This Article points to dynamics of lumpiness as an important drag on investment in both high-voltage, interregional transmission lines and grid-scale, long-duration storage—both of which will be necessary for the integration of renewables at levels sufficient to decarbonize the grid. Policymakers may have only a year or two to get it right when it comes to setting a national climate policy, and putting in place policies that help provide the lumpy social good of a clean electric grid should be a top priority.

Beyond these practical payoffs, the Article's use of the concept of lumpiness highlights some systemic weaknesses in restructured electric markets. While restructuring has disrupted the industry in many positive ways, it has heightened the need for coordinated investments in areas where there are strong complementarities between services and infrastructures. Policymakers would do well to pay more attention to these areas and make sure that they are adequately addressing the roadblocks to coordinated investments that are so needed as the nation and the world respond to the threat of climate change and the imperative of deep decarbonization of the electricity sector.

There are larger takeaways as well. Markets have delivered substantial value in the energy system, but we too often think of them as a form of autopilot that will carry us to our final destination more efficiently than hands-on management by policymakers ever could.[278] There is some truth to this: major debates continue about the degree to which various technologies should be subsidized by policies set at various levels of government,

277. *See supra* note 216 and accompanying text.
278. Kaswan, *supra* note 15, at 485–86.

given the potential for distortions that reflect political power rather than economic efficiency. And there should be no mistaking that, in the short term, markets are likely to deliver large amounts of renewable power generation as costs plummet. But there are also important limitations to the market model—limitations that inhere in electricity's physical nature and that must be solved by pairing production with transmission and distribution in one seamless "lump" that consumers experience when they turn on the lights. Our current market-based system for determining the portfolio of electric generation, in effect and necessarily, brackets each of the components of the energy system. But that bracketing obscures the fact that the "social project of decarbonization"[279] inevitably requires holistic, lumpy investment at each level of the energy system. The failure to reckon with the pressure that lumpiness in clean energy puts on the market construct holds society back from taking necessary steps to stave off climate disaster.

279. Shelley Welton, *Electricity Markets and the Social Project of Decarbonization*, 118 COLUM. L. REV. 1067, 1096 (2018) (elaborating on the concept of the "social project of decarbonization," which entails much more than "just a technical challenge" and that "implicate[s] choices and values that extend far beyond what technologies are available at what costs").