Private Energy

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Energy is key to our modern lives. Until recently, energy was generated by centralized utilities. That, however, is changing. Fundamental shifts in the generation and consumption of electricity are underway. In the age of "distributed generation," when you and I can install solar panels on our roof and a battery in our garage, we are all part of the energy field. This Article argues that along with the blending of technological categories comes a shift in the legal categories as well. Energy law scholars have traditionally focused on the public law aspects of electricity production and consumption. This framework was indeed apt for the age of centralized energy. But in an era where electricity production is increasingly dispersed, looking at the energy field solely through the lens of public law misses the full picture. Focusing specifically on property law, the Article thus unearths the new property-energy connection that has emerged along with the rise of distributed generation. It then shows why policy-makers seeking to advance the adoption of distributed generation should pay attention, in addition to other things, to the underlying web of private law regimes.

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I. INTRODUCTION

The debate over energy policy is most commonly analyzed from a public law perspective, whereas private law is hardly part of the energy discourse. That, however, is changing. Due to fundamental shifts in the energy field, age-old private law doctrines are now circulating back into the spotlight as they regain importance in the energy sphere.

One of the most significant changes in recent times is the rise of distributed energy production. Whereas in the past, electricity would be produced at one central facility and then sent around to customers, today the modern grid increasingly incorporates distributed producers of a much smaller scale.[1] Trends such as the rise of "distributed generation," where energy is produced in close proximity to where it is consumed,[2] are thus profoundly changing energy dynamics. Solar panels on roofs, batteries in cars and in garages, "smart" meters that can run your dishwasher at the precise time of day when electricity is cheapest, and more, all make our energy field more dispersed in new ways. The result is that rather than a one-way push of electricity from the utility onto customers, the electric grid is becoming more like a dialogue or a discourse.

The trend toward dispersed energy will likely be amplified by the introduction of peer-to-peer trading. Just recently, in May 2018, a blockchain-based platform was launched on a university campus in Chicago.[3] This means that a digital platform (based on the blockchain

1. Shelley Welton, *Grasping for Energy Democracy*, 116 MICH. L. REV. 581, 600 (2018) ("Supply and demand once occupied neat sides of an electricity diagram, with large companies producing and transmitting electricity to be parceled out and delivered to those who demanded it. Now, every consumer can herself be an energy supplier as well, by putting solar panels on her roof.").

2. U.S. ENERGY INFO. ADMIN., MODELING DISTRIBUTED GENERATION IN THE BUILDINGS SECTOR 1 (Nov. 2017) [hereinafter EIA, DISTRIBUTED GENERATION IN BUILDINGS] ("Distributed and dispersed generation technologies produce electricity near the particular load they are intended to serve."); FED. ENERGY REG. COMMISSION, STAFF REPORT, DISTRIBUTED ENERGY RESOURCES: TECHNICAL CONSIDERATIONS FOR THE BULK POWER SYSTEM 8 (Feb. 2018) [hereinafter FERC, DISTRIBUTED ENERGY RESOURCES] ("A source or sink of power that is located on the distribution system, any subsystem thereof, or behind a customer meter."); Richard L. Revesz & Burcin Unel, *Managing the Future of the Electricity Grid: Distributed Generation and Net Metering*, 41 HARV. ENVTL. L. REV. 43, 43 (2017) (defining distributed generation).

3. *See* Mike Butcher, *Power Ledger Deploys First Blockchain-based P2P Energy Trading System in Chicago*, TECHCRUNCH (May 3, 2018), https://techcrunch.com/2018/05/03/power-ledger-deploys-first-blockchain-based-p2p-energy-trading-system-in-chicago/ ("Power Ledger's platform lets consumers buy and sell renewable energy directly between one another.").

technology which is itself inherently dispersed) allows individuals to buy and sell electricity directly among each other. Imagine a world in which you can, with a simple touch of a button on your phone, sell the electricity your solar panel produced to your neighbor.[4] The energy exchange between you and your neighbor will be direct, and will not rely on a centralized body for either the production of electricity or the exchange itself. That is inevitably the age of private energy.

Energy law scholarship, however, does not fully grasp the nuances of how private law plays an increasing role in our current energy dynamics. Most scholarly attention to date has engaged with the public law aspects of electricity. Scholarship has focused on questions of federal versus state jurisdiction and the contours of the authority given to the Federal Energy Regulatory Commission (FERC);[5] the division of power between local government and states in this regard;[6] competition in interstate electricity markets;[7] regulating public utilities;[8] assessing the effectiveness of public financing mechanisms for renewable energy production and decarbonization;[9] and evaluating the pricing of electricity whether through utilities[10] or through State policies such as

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4. *See* POWER LEDGER, POWER LEDGER WHITE PAPER 11 (2018), https://powerledger.io/media/Power-Ledger-Whitepaper-v8.pdf ("[Cryptocurrency is] digital currency in which mathematical encryption techniques and network consensus protocols are used to regulate the generation of units of currency and verify transactions (i.e. the transfer of funds), operating independently of a central bank. It can be used as a form of P2P digital money, purely relying on the blockchain ledger and verification through encryption algorithms, rather than a centrally controlled entity like a central bank."). In certain circumstances, utility wires will still be necessary to transport some of that electricity. However, that depends on specific details of each location and its infrastructure.

5. *See, e.g.,* Christopher J. Bateman & James T.B. Tripp, *Toward Greener FERC Regulation of the Power Industry*, 38 HARV. ENVTL. L. REV. 276 (2014); William Boyd & Ann E. Carlson, *Accidents of Federalism: Ratemaking and Policy Innovation in Public Utility Law*, 63 UCLA L. Rev. 810 (2016); Joel B. Eisen, *Dual Electricity Federalism Is Dead, but How Dead, and What Replaces It?*, 8 GEO. WASH. J. ENERGY & ENVTL. L. 3 (2017); Kate Konschnik & Ari Peskoe, *Minimizing Constitutional Risk: Crafting State Energy Policies that Can Withstand Constitutional Scrutiny,* HARV. ENVTL. L. PROGRAM POL'Y INITIATIVE (Nov. 17, 2014); Joe Margolies, Note, *Powerful Friends: EPSA, Hughes, and Cooperative Federalism for State Renewable Energy Policy*, 118 COLUM. L. REV. 1425 (2018); Felix Mormann, *Clean Energy Federalism*, 67 FLA. L. REV. 1621 (2015); Jim Rossi, *The Brave New Path of Energy Federalism*, 95 TEX. L. REV. 399 (2016); Ari Peskoe, *Easing Jurisdictional Tensions by Integrating Public Policy in Wholesale Electricity Markets*, 38 ENERGY L.J. 1 (2017).

6. *See* Shelley Welton, *Public Energy*, 92 N.Y.U. L. REV. 267 (2017).

7. *See, e.g.,* Jim Rossi & Hannah Jacobs Wiseman, *Constrained Regulatory Exit in Energy Law*, 67 DUKE L.J. 1687 (2018).

8. *See, e.g.,* Jim Rossi & Morgan Ricks, *Foreword: Revisiting the Public Utility*, 35 YALE J. ON REG. 711 (2018); K. Sabeel Rahman, *Infrastructural Regulation and the New Utilities*, 35 YALE J. ON REG. 911 (2018).

9. *See, e.g.,* Emily Hammond & Jim Rossi, *Stranded Costs and Grid Decarbonization*, 82 BROOK. L. REV. 645 (2017); Shelley Welton, *Electricity Markets and the Social Project of Decarbonization*, 118 COLUM. L. REV. 1067 (2018).

10. *See, e.g.,* Michael P. Vandenbergh & Jim Rossi, *Good for You, Bad for Us: The Financial Disincentive for Net Demand Reduction*, 65 VAND. L. REV. 1527 (2012).

net metering.[11] However, a full understanding of the role *private law* holds in the production and consumption of electricity has been lacking from the discourse.[12]

This Article begins to fill that gap by analyzing the rising significance of private law in the age of distributed generation. The term "private law," as used here, broadly refers to the disciplines of property law, contracts law, torts and remedies. However it can also be understood, more broadly, as a concept for dispersed management and decision-making. Within the domain of private law, this Article focuses specifically on property law.[13]

The Article's first aim is clarificatory. It suggests that a lack of clarity as to the role private law actually plays in energy policy stands as an impediment to our ability to effectively advance such policy. The Article thus offers an account of the ways in which property law plays an important, yet underappreciated, role throughout our energy system.

A quick primer is in order here. The "energy system" encompasses a variety of processes that occur until a watt of electricity reaches the socket now powering your laptop.[14] In brief, the first step is finding and extracting a primary energy resource, such as oil, gas, the sun, or the wind, from which electricity can be produced. At the second stage, the energy locked in these resources is converted into electric energy. This is known as the production or generation stage. The third step is consuming the electricity, which is what you do when you power up your laptop.

Traditionally, property entitlements were seen as playing a role only

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11. *See, e.g.,* Revesz & Unel, *supra* note 2; Lincoln L. Davies & Kristin Allen, *Feed-in Tariffs in Turmoil*, 116 W. VA. L. REV. 100 (2014).

12. On the resources side of energy, scholars have long acknowledged the importance of property entitlements, especially with regards to oil and gas rights. Gary Libecap's work on oil and gas rights is illustrative of this strand of scholarship. *See generally, e.g.,* GARY LIBECAP, CONTRACTING FOR PROPERTY RIGHTS (1989). More recently, the significance of property rights to renewable resources has also been highlighted. *See generally, e.g.,* Yael Lifshitz, *Gone with the Wind? The Potential Tragedy of the Common Wind*, 28 UCLA J. ENVTL. L. & POL'Y 435 (2010); Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change, Carbon Sequestration, and Property Rights*, 2010 U. ILL. L. REV. 363 (2010); Troy A. Rule, *Property Rights and Modern Energy*, 20 GEO. MASON L. REV. 804, 806-08 (2013); Michael Pappas, *Energy Versus Property*, 41 FLA. ST. U. L. Rev. 435, 483-86 (2014) (discussing how energy-related causes, for example renewable energy policies, have fared in takings cases). However, these accounts have not connected that discussion to the broader energy picture and how it relates more generally to private law tools in shaping policy in the way this Article does.

13. I imagine there is much interesting work to be done with regards to the energy-contracts connection, especially in the world of peer-to-peer trading we appear to be entering. I reserve that discussion for future work.

14. *See* LINCOLN DAVIES, ET AL., ENERGY LAW AND POLICY 22 (2014) ("The energy system consists of both primary sources—coal, natural gas, oil, nuclear, renewables—and the secondary systems that use them, electricity and transportation."). The scientific term "energy" refers to "the ability to do work." *See What is Energy? Explained*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/index.cfm?page=about_home (last visited Mar. 25, 2018).

in the first step of resource extraction. Rights to primary energy resources, such as oil and gas, were typically framed as property entitlements.[15] Thus the extraction of traditional energy resources, in the United States, was largely dominated by property law.[16] The same property-driven dynamic continues to hold true today not only for traditional primary sources but for obtaining contemporary ones as well, such as wind energy.[17]

Yet the generation of electricity and its consumption, in contrast, were traditionally largely dominated by public law doctrines.[18] The utility, which was essentially the single player (or one of very few players) in a specific area, and the grid operator, were governed by state and federal authorities.[19] Under the centralized utility model, property entitlements thus played only a minor role in the production of electricity. This centralized mode of management was indeed apt for the age of centralized utilities.

Today, however, distributed modes of production are increasingly common. The paradigmatic and most readily understood example is a solar panel on one's roof. Distributed generation also includes other forms of producing electricity that take place onsite, in close proximity to where the electricity is consumed. These include, *inter alia*, on-site diesel generators, various mechanisms that re-use the runoff heat from natural gas-based heating and standalone generators that is otherwise wasted, and smaller-scale wind turbines.[20] Homeowners today also have multiple avenues for participating in our electric grid as *consumers* of electricity, even without directly generating "new" watts of electricity. For instance, they can install "smart" meters that decide when to run the home appliances at the precise moment when demand is lowest (and pricing accordingly); they can install batteries in their garage that store energy when it is cheap and re-sell it back into the grid when it is in high demand; or they can deliberately lower their electricity consumption at peak times and sell that non-use into the grid.[21]

Along with the blending of technological categories, the doctrinal

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15. "Mineral rights" are essentially property rights to underground minerals, including oil and gas reserves. There is a vast literature that analyzes the extent to which right-holders in this context will reach mutually beneficial agreements. *See, e.g.,* LIBECAP, *supra* note 12.

16. *See infra* Part II.A.

17. For an analysis of wind rights see Lifshitz, *Gone with the Wind? The Potential Tragedy of the Common Wind*, *supra* note 12. *See also* Yael Lifshitz, *Rethinking Original Ownership*, 66 U. TORONTO L.J. 515, 539-53 (2016).

18. *See infra* Part II.B.

19. *See, e.g.,* Rossi & Ricks, *supra* note 8, at 711-14.

20. *See* EIA, DISTRIBUTED GENERATION IN BUILDINGS, *supra* note 2, at 1, Table 1: Distributed generation technologies by sector; U.S. ENERGY INFO. ADMIN., DISTRIBUTED GENERATION AND COMBINED HEAT & POWER SYSTEM CHARACTERISTICS AND COSTS IN THE BUILDING SECTOR, 1-2 (Apr. 2017) (specifically for distributed small-scale wind).

21. *See infra* Part II.B.1.

and conceptual categories are blending as well. The most intuitive way to understand the new property-energy connection is the following: if you want to put a solar panel on your roof, it has to be *your* roof.[22] The same would be true, of course, if you were looking to install a battery in your garage or a smart-meter in your basement. Is it your roof or your basement? That is a property question. Now assume a policy-maker in a certain city wants to encourage adoption of rooftop solar panels. Will such policy succeed in fulfilling its goal? The extent to which solar panels are adopted depends, among other things, on whether or not the underlying property rights support such a move. That is the essence of the new property-energy connection.

Moreover, consider what happens in a city where many people rent their residences rather than own them. Do the property entitlements they hold support installing a solar panel on their roof? With over a third of Americans nation-wide living in rented residences,[23] the question becomes a pressing one.

Taken together, due to structural changes in both the production and the consumption of electricity, individuals can participate in the energy field in ways that were previously not available to them. However, these participatory mechanisms are supported by an underlying web of property law foundations that can act to either facilitate or inhibit the advancement of specific energy policies. The key contribution of this Article is, thus, in unearthing the new property-energy connection that emerged as a result of recent changes in the consumption and the production of electricity.

The Article analyzes the functions property entitlements serve under the new energy model. The first is providing access to locations at which energy-related activities need to take place. The locations in question can be extraction-related (where the drilling for oil occurs, or where the wind turbine is placed); production related (where the solar panel is installed); or consumption related (where the battery is installed). This location-specific and resource-specific dynamic raises the need for a management tool that accounts for the uniqueness of each location.

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22. "Your" roof, for this purpose, could include not only ownership but also leasing rights to the extent they provide the right-holder with the necessary authority (*see infra* Part II.B.2).

23. *See* DAVID FELDMAN ET. AL., SHARED SOLAR: CURRENT LANDSCAPE, MARKET POTENTIAL, AND THE IMPACT OF FEDERAL SECURITIES REGULATION 21 (Nat'l Renewable Energy Lab. Apr. 2015) ("[T]he percentage of renters in the U.S. housing market… has been around 35% since the 1970s . . . we assume the percentage of renters remains at 35% over the next decade."); Anthony Cilluffo, Abigail Geiger & Richard Fry, *More U.S. Households are Renting Than at Any Point in 50 Years*, PEW RESEARCH CENTER (Jul. 19, 2017), http://www.pewresearch.org/fact-tank/2017/07/19/more-u-s-households-are-renting-than-at-any-point-in-50-years/ (finding that, as of 2016, 36.6% of American households were renting their homes).

Property provides such a tool.[24]

Second, and more broadly, property enables distributed decision-making over resources.[25] Traditionally, as mentioned, this was true for oil, gas and coal, but today it also applies to wind, solar and even the electricity itself.[26] Think, for example, of peer-to-peer trading: one needs to establish some degree of authority and control over the electricity in order to be able to trade it. In other words, electricity itself needs to be subject to some kind of property regime in order to facilitate the trade. Property law is the conceptual category that allows us to control resources in a dispersed manner.

To be sure, the underlying property entitlements are not the only factor that determines whether one places a solar panel on the roof. Of course, financing the panels, the rate of return to the investment, the ability to sell back into the grid, and zoning restrictions—all play a part in the decision whether to install a solar panel or not. But, importantly, even if all these factors were favorable, one could not place a solar panel on a roof if the property entitlements did not support it. To illustrate, assume the finances of installing and operating a solar panel in your neighborhood were stellar and no zoning restrictions stood in the way. Could you put one atop your neighbor's roof? The answer, most likely, depends on the property entitlements you and your neighbor hold, and perhaps some kind of private agreement you may reach between the two of you. In any case, the point is that being able to finance the panels is not enough; you still have to put them somewhere, and whether or not you can do so depends to a large extent on property entitlements.[27]

Utility-scale production, of course, still holds an important role in grid operations and will likely continue to do so. While distributed generation has risen significantly in recent years and has potential to grow even further, at present it still represents a relatively small portion of overall electricity production.[28] The point is that although in terms of

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24. At least, real property; although intellectual property is also significant for energy operations, I leave that discussion for future work.

25. *See infra* Part III.B, discussing property as a mechanism for distributed management of resources.

26. In the consumption category, the resource in question is electricity. As a technical matter, the U.S. Energy Information Agency categorizes electricity as a "secondary" energy source, which means it is a source of energy that is produced from other (primary) energy sources. *Energy Explained: What are Secondary Energy Sources?,* U.S. ENERGY INFO. ADMIN, https://www.eia.gov/energyexplained/index.cfm?page=secondary_home (last visited Mar. 25, 2018).

27. I set aside for the moment zoning restrictions which might also impact one's ability to install a solar panel at a given location. In any case, as mentioned, even if zoning restrictions presented no restrictions, the location-specific property entitlements would still need to be secured.

28. In 2018, small-scale solar photovoltaic systems accounted for 30 billion kWh, whereas solar generation at the *utility-scale* level amounted to 67 billion kWh. U.S. ENERGY INFO.

kilowatts produced the centralized model is still the larger one, it is no longer the *only* one. The reality is that centralized and distributed producers will need to work together, both as a technological matter and as a policy one.

The analysis here is thus not meant to suggest that public law is no longer vital for energy management.[29] The analysis here aims to show that thinking of energy *solely* through the public law lens simply does not capture the full picture. Adding the lens of private law allows us to gain a richer and more nuanced understanding of the energy field. More broadly, it illustrates how the two perspectives, the centralized and the distributed, the public and the private, are entangled and how they can complement each other.

After setting out the new property-energy connection, the Article underscores its implications for current climate and energy debates. As an example of how the property-energy perspective can help us better understand the challenges of the modern grid, it focuses on a specific group of users: renters, that is, households or commercial enterprises that lease (rather than own) their dwellings. It shows how the scope of a typical landlord-tenant agreement prevents renters from participating in the distributed generation market. I call this the "renters' problem".

The renters' problem is a prevalent one. According to a recent study by the National Renewable Energy Laboratory (NREL), over a third of the housing market in the U.S. is dominated by renters.[30] Another group of consumers that has difficulties adopting distributed generation are those in multi-unit buildings. Given that property rights in the roof, basement, or other shared facilitates are often jointly held, consumers in multi-unit buildings face challenges with regards to aggregating the necessary property authority to carry out a project like installing a rooftop solar. Taken together, including the renters and the high-rise dwellers, NREL estimates that approximately thirty-seven percent of households in the United States are unable to host a solar PV system.[31]

The Article suggests that one way to overcome the renters' problem is by tweaking the landlord-tenant leases to include "distributed energy enabling" clauses. A second way is to embrace the lease-based model but create platforms for sharing distributed generation over time, much like sharing a car, an apartment, or a work-space. I call this "We-Solar."

ADMIN., *What is U.S. Electricity Generation by Energy Source?*, https://www.eia.gov/tools/faqs/faq.php?id=427&t=3 (last visited April 24, 2019). Notably, the overall utility-scale production (including all source of energy, both fossil-fuel based and renewables) in the U.S. in 2018 was 4,178 billion kWh. *Id.*

29. I fully agree with scholars who have suggested, for example, that "the future of the public utility remains a vibrant, evolving area of inquiry for law and economic regulation." Rossi & Ricks, *supra* note 8, at 714.

30. FELDMAN ET AL., *supra* note 23, at 21.

31. *Id.* at 22 ("[A]pproximately 37% of households are occupied by renters or by owners who live in buildings with four or more stories.").

Lastly, the Article underscores some broader implications for energy law and policy under the new property-energy connection. When so many property holders are involved, a new group of stakeholders emerges in energy law and policy. This new interest-group of property holders may seek to advance and protect its interests through public action (for instance, protesting a change to zoning that would make it harder to install solar arrays), or alternatively, through property-based litigation, by invoking claims such as trespass and nuisance.

The Article makes three scholarly contributions. First, it unearths the significance of property entitlements throughout the entire "energy cycle," including electricity generation and consumption. It offers an analytical analysis of the functions property plays in this regard, from access to specific locations to a distributed governance system. Second, the Article contributes to ongoing debates regarding energy and climate policy, and the ways in which private law tools can be used to advance such policy. Third, more broadly, by calling attention to the significance of property law in facilitating and shaping public policy, the Article contributes to the conceptual discussion regarding the relationship between these supposedly separate domains and the ways in which they interact.

The Article proceeds as follows. Part II underscores the property-energy connection, and the ways in which property underlies key energy decisions throughout the energy cycle. Part III analyzes the functional role property entitlements play in this regard. Part IV draws out the implications for current energy and climate debates. Part V offers concluding remarks.

II. THE NEW PROPERTY-ENERGY CONNECTION

In order to understand how property runs throughout the energy cycle, a brief primer is in order. The energy system (also sometimes referred to as the "energy cycle"), can be divided, roughly, into three stages. How does a watt of electricity reach your socket? The first stage is obtaining a primary energy resource. These include oil, gas, coal, wind, sun rays, biothermal and hydropower. At the second stage, these primary resources are then converted into electric energy, and transmitted through the grid. Lastly, the electric energy is consumed, which is what happens when you plug in your laptop or smart-phone.

The following discussion shows how property entitlements play an important role throughout the energy cycle, from obtaining the resources through generation and consumption of electricity.

A. *Property in Primary Energy Resources*

Primary energy resources are ones from which we produce usable energy such as electricity to turn on the lights at home.[32] (Energy resources can also be converted into motion-energy in the case of transportation, although for the sake of simplicity let us leave that aside). Some primary energy resources are nonrenewable, such as coal, oil or natural gas. Others are renewable, such as wind, solar, geothermal, biomass and hydropower from flowing water.[33] Each primary resource, whether renewable or not, has a certain type of energy "locked" within it, which can eventually be converted into electric energy.[34]

From a legal standpoint, obtaining the entitlements to these primary energy resources is the first step toward converting them into electricity. The rights to these resources have typically been framed as property entitlements. Consider for instance traditional rights to oil and gas. Based on the historic notion of *ad coelum* in the Anglo-American legal tradition, "mineral rights" are essentially property rights to minerals that underlie the land, including oil and gas reserves.[35] Thus, the resource side of the energy cycle, to a large extent, has always been dominated by a property-type discourse and governed by a property strategy. The same property-driven dynamic continues to hold true for other contemporary resources, such as wind energy or solar rights.[36]

What does it mean that resources are governed by a property strategy? To understand, consider the following: the issue of hydraulic fracturing ("fracking") has drawn much scholarly and policy attention over the past years.[37] Federal and State policies that pertain to drilling speak to aspects such as the practices developers must adhere to when drilling, for example with regards to waste discharge or safety. But they do not directly cap the *quantity* of gas extracted from the ground.[38]

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32. FED. ENERGY REG. COMMISSION, ENERGY PRIMER: A HANDBOOK OF ENERGY MARKET BASICS, 1 (2015) [hereinafter FERC, ENERGY PRIMER] ("A primary energy source is an energy source that can be consumed directly or converted into something else, like electricity.").

33. *See What is Energy? Explained*, U.S. ENERGY INFO. ADMIN https://www.eia.gov/energyexplained/index.cfm?page=about_home (last visited Mar. 25, 2018). The division into renewable and non-renewable resources also "also aligns well with resources that are less and more carbon-intensive." DAVIES ET AL., *supra* note 14, at 99.

34. *See* FERC, ENERGY PRIMER, *supra* note 32, at 1.

35. *See, e.g.,* Thomas W. Merrill, *Four Questions About Fracking*, 63 CAS. W. RES. L. REV. 971, 977 (2013). There is a vast literature that analyzes the extent to which right-holders in this context will reach mutually beneficial agreements. Gary Libecap's work on contracting among landowners toward control of oil and gas reserves is an illustrative example of this strand of literature. *See* LIBECAP, *supra* note 12.

36. *See generally*, Sara C. Bronin, *Solar Rights*, 89 B. U. L. REV. 1217 (2009); Sara C. Bronin, *Modern Lights*, 80 U. COLO. L. REV. 881 (2009); Alexandra B. Klass, *Property Rights on the New Frontier: Climate Change, Natural Resource Development, and Renewable Energy*, 38 ECOLOGY L.Q. 63, 95-102 (2011); Lifshitz, *Gone With the Wind*, *supra* note 12, at 539-53 (analyzing property rights in wind).

37. *See, e.g.,* Merrill, *supra* note 35, at 977 (discussing the importance of mineral rights—as property rights—to the recent "fracking revolution").

38. These policies can affect the economics of drilling, and in so doing impact the amount

Rather, the quantity is ultimately driven primarily by the extent to which developers have gathered the mineral rights they need in order to drill[39] (and on the economics of drilling at a given point in time). Importantly, the question of how much natural gas is extracted is determined by a set of dispersed decisions, relating to the entitlements in the mineral resources.

The same, again, is true for other primary energy resources such as wind energy. Just like a developer seeking to drill an oil and gas reserve, a developer seeking to set up a large-scale wind farm will need to collect the relevant "wind rights" from multiple (often dozens) of right-holders.[40] Whether or not she succeeds in doing so depends, again, on an aggregation of multiple dispersed decisions, rather than (just) a centralized one.

In addition to property in the energy resources themselves, property rights to the land are also significant. Since extraction has to occur at a specific location, at least under current technologies,[41] those who control that particular location also partake in the decision when and where to extract the resource.[42] The significance of the rights to land is especially relevant to distributed generation, as the discussion below illustrates.

In sum, on the resource side of the energy system, scholars and policy-makers have long acknowledged the importance of property entitlements with regards to traditional primary resources such as oil and gas, and more recently the significance of property to renewable resources has also been underscored. Even the more contemporary accounts, however, have been limited to the resource side of energy, and have not connected the property discourse to the broader energy picture,

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which will be extracted. For example, the Federal Energy Regulatory Commission (FERC) oversees the Liquified Natural Gas (LNG) terminals, which impacts the economic viability of extraction. But importantly, FERC does not regulate directly the quantity or the location of extraction.

39. This is true whether drilling takes place over private lands—in which case mineral rights are secured from private right-holders—or over public lands, in which case rights-of-way are obtained from the relevant state or federal agency. In any case, the mineral rights are an entitlement to extract a certain portion of the resource.

40. *See* Lifshitz, *Rethinking Original Ownership*, *supra* note 17, at 543 (developers seeking to set up a utility-scale wind farm need to obtain permissions from owners of land underlying the wind currents. To do so they enter into "wind leases" and "wind easements" with multiple landowners).

41. Future technologies that could change the importance of land in this regard include airborne solar panels and "floating" wind turbines ("airborne wind energy systems"). Although they too would require a point of tethering to the ground, it will presumably be a smaller land impact, at least when considered on a watt-per-acres basis.

42. To clarify, mineral rights are often initially tied to ownership of land, although over time they may be severed from the landownership. Even when mineral rights are severed from the landownership, energy operations still depend on access to the surface of the earth, and in that sense, entitlements in the crust of the earth (regardless of the entitlements to what lies below and above it) are significant to our ability to harness energy resources.

to shifts in the generation and consumption of electricity, and to how the discourse relates more generally to private law tools in shaping policy.

B. *Property in the Generation and Consumption of Electricity*

As opposed to the resource category, in the production stage—in which primary resources are converted to electricity—property entitlements were traditionally seen as playing only a minor role. Most energy law scholarship to date has focused on the public law aspects of the electricity system. Scholarly attention has centered on issues such as federalism in energy regulation and the contours of the authority given to the Federal Energy Regulatory Commission (FERC);[43] competition in interstate electricity markets;[44] state and federal financing mechanisms for renewable energy production and for decarbonization;[45] and price setting for electricity by regulated utilities[46] or through state policies such as net metering.[47]

This scholarly focus on public law was indeed apt for the age of centralized generation of electricity. Under the centralized model, property entitlements played only a minor role in the production of electricity. Of course, the central generator presumably had to have some entitlements to the piece of land on which its generation plants were built, some entitlements to the equipment and so on. But the key issues on which production turned, and on which scholars' and policy-makers' attention was focused, were not the property entitlements. A full understanding of the role private law holds in the production and consumption of electricity has therefore been lacking from the discourse.[48]

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43. *See, e.g.*, Bateman & Tripp, *Toward Greener FERC Regulation of the Power Industry*, *supra* note 5; Boyd & Carlson, *Accidents of Federalism: Ratemaking and Policy Innovation in Public Utility Law*, *supra* note 5; Eisen, *Dual Electricity Federalism Is Dead, but How Dead, and What Replaces It?*, *supra* note 5; Mormann, *Clean Energy Federalism*, *supra* note 5; Rossi, *The Brave New Path of Energy Federalism*, *supra* note 5; Peskoe, *Easing Jurisdictional Tensions by Integrating Public Policy in Wholesale Electricity Markets*, *supra* note 5; Margolies, Note: *Powerful Friends: EPSA, Hughes, and Cooperative Federalism for State Renewable Energy Policy*, *supra* note 5; Konschnik & Peskoe, *Minimizing Constitutional Risk: Crafting State Energy Policies that Can Withstand Constitutional Scrutiny, supra* note 5.

44. *See, e.g.*, Rossi & Wiseman, *Constrained Regulatory Exit in Energy Law*, *supra* note 7.

45. *See, e.g.*, Hammond & Rossi, *Stranded Costs and Grid Decarbonization*, *supra* note 9; Welton, *Electricity Markets and the Social Project of Decarbonization*, *supra* note 9.

46. *See, e.g.*, William Boyd, *Just Price, Public Utility, and the Long History of Economic Regulation in America*, 35 YALE J. ON REG. 721 (2018); Vandenbergh & Rossi, *Good for You, Bad for Us*, *supra* note 10.

47. *See, e.g.*, Davies & Allen, *Feed-in Tariffs in Turmoil*, *supra* note 11; Revesz & Unel, *Managing the Future of the Electricity Grid*, *supra* note 2, at 43.

48. Although a recent proposal to implement "energy exactions" as a way of dealing with the impacts of new local energy-related developments begins to use the property language, *see* Jim Rossi & Christopher Serkin, *Energy Exactions*, 104 CORNELL L. REV. (forthcoming 2019),

1. *Recent shifts in electricity generation and consumption*

Fundamental changes in the structure of electricity generation are underway as distributed modes of production are becoming increasingly common.[49] "Distributed generation" refers, broadly, to electricity that is produced in close proximity to where it is consumed.[50] Distributed generation could be employed for self-use (thus offsetting consumer demand for electricity from the central grid), and could also be used for feeding back electricity into the grid.[51]

The paradigmatic example of a distributed generation system is a solar panel on one's roof. The most common solar-to-electricity technology is photovoltaic (PV) cells.[52] The PV cells collect solar photons from the sunlight. Once the photons are absorbed in the cells, they transfer their energy to electrons. Those electrons, in turn, are pulled by an internal electric field toward an electrode, which results in an electric current.[53] PV cells are then linked together into PV modules, or panels.[54] Combining multiple PV cells into panels also makes the

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it does not take on the broader perspective of how adding a property (or private law) lens can produce a more nuanced understanding of our modern grid.

49. Historically, decentralized power production actually predated the centralized model. Until the end of the 19th century, most power production was local. The first central power generating station was only opened by Thomas Edison in 1882. In over a century since then, however, the production of electricity followed a centralized model. *See* Sharon B. Jacobs, *The Energy Prosumer*, 43 ECOLOGY L.Q. 519, 528 (2016) (discussing the history of distributed and central generation). The discussion here sets aside, for the time being, the shifts that occurred in the energy sector about two decades ago from vertical integration to open transmission. *See* DAVIES ET AL., *supra* note 14, at 45.

50. U.S. ENERGY INFO. ADMIN., MODELING DISTRIBUTED GENERATION IN THE BUILDINGS SECTOR 1 (Nov. 2017), https://www.eia.gov/outlooks/aeo/nems/2017/buildings/pdf/moddistribg.pdf ("Distributed and dispersed generation technologies produce electricity near the particular load they are intended to serve."); U.S. ENERGY INFO. ADMIN., DISTRIBUTED GENERATION SYSTEM CHARACTERISTICS AND COSTS IN THE BUILDING SECTOR, 1 (August 2013).

51. FERC, DISTRIBUTED ENERGY RESOURCES, *supra* note 2, at 7 ("[D]epending on their size and configuration, distributed energy generation resources could partially or completely offset consumer electrical demand. They could also feed surplus energy back into the distribution system or . . . the transmission system.").

52. *See* MASSACHUSETTS INSTITUTE OF TECHNOLOGY ENERGY INITIATIVE, THE FUTURE OF SOLAR ENERGY 19 (2015) [hereinafter MIT, FUTURE OF SOLAR] ("Solar PV is the leading solar electric technology today, constituting 98% of global solar generation capacity in 2013."). The other solar-to-electricity technology is known as concentrated solar power (CSP); the two technologies differ with regards to their conversion methods: "PV cells convert sunlight directly into electricity, whereas CSP technologies convert sunlight first to heat and then to electricity." *Id*. In addition to distributed solar, recent years have also seen a growth in distributed wind energy production. *See generally* U.S. DEP'T OF ENERGY, 2016 DISTRIBUTED WIND MARKET REPORT (Aug. 2017); NAT'L RENEWABLE ENERGY LAB., ASSESSMENT OF THE ECONOMIC POTENTIAL OF DISTRIBUTED WIND IN COLORADO, MINNESOTA, AND NEW YORK (2018).

53. *See* MIT, FUTURE OF SOLAR, *supra* note 52, at 21.

54. *Id.* ("A typical silicon (Si) PV module consists of a glass sheet for mechanical support and protection . . . 60 to 96 individual 6-inch-square (15-cm-square) solar cells, each capable of producing 4–5 watts under peak illumination (Wp) . . . and an aluminum frame for mounting. Common module dimensions are 1 meter by 1.5 meters by 4 centimeters, and peak power ratings

technology highly modular. One advantage of this modularity is that it does not (significantly) reduce its efficiency as scale is reduced.[55] This enables the technology to be employed at a smaller, distributed, scale.[56]

Distributed solar in the U.S. more than doubled between 2014 and 2017.[57] Distributed solar also accounted for 12 percent of new additions to electric capacity in 2017.[58] Even though the growth rate of the solar industry has slowed down since 2017,[59] the adoption of solar is expected to continue due to cost reductions. The cost of solar power has fallen rapidly in recent years,[60] and is expected to continue dropping.[61] According to one projection, by 2040 the cost of solar PV will drop by two-thirds.[62] By that time, as a result of declining costs, solar is

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range from 260 W to 320 W."); VARUN SIVARAM, TAMING THE SUN: INNOVATIONS TO HARNESS SOLAR ENERGY AND POWER THE PLANET 46-47 (2018).

55. *See* MIT, FUTURE OF SOLAR, *supra* note 55, at 21 ("PV cells enable generation at any scale: A 10-square-meter (m2) PV array is in theory no less efficient per unit area than a 10-squarekilometer (km2) array. This contrasts with other generation pathways, such as thermal generators or wind turbines, which lose efficiency with reduced scale."). However, the cost per-watt produced may differ with scale; due to economies of scale, generally, "the larger the solar installation, the lower the cost per watt." SIVARAM, *supra* note 54, at 48.

56. For a residential solar PV system, an additional component is necessary. PV solar panels convert the sunlight into direct current (DC), but our grids run on alternating current (AC), so an inverter is needed to convert the current from DC to AC. SIVARAM, *supra* note 57, at 46.

57. *See* U.S. Energy Info. Admin., *Electricity Data Browser*, (Apr. 3, 2018), https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=vtvv&geo=g&sec=g&linechart=ELEC.GEN.DPV-US-99.A&columnchart=ELEC.GEN.DPV-US-99.A&map=ELEC.GEN.ALL-US-99.A&freq=A&chartindexed=0&ctype=linechart&ltype=pin&columnendpoints=1&columnvalues=0&rtype=s&maptype=0&rse=0&pin= (demonstrating that the net generation of small-scale solar PV increased from 11,233 thousand MWh in 2014, to 24,139 thousand MWh in 2017).

58. FERC, DISTRIBUTED ENERGY RESOURCES, *supra* note 2, at 3; *see also* Mark Muro & Devashree Saha, *Rooftop Solar: Net Metering is a Net Benefit*, BROOKINGS INSTITUTION (May 23, 2016), https://www.brookings.edu/research/rooftop-solar-net-metering-is-a-net-benefit/# ("Residential solar installations surged by 66 percent between 2014 and 2015 helping to ensure that solar accounted for 30 percent of all new U.S. electric generating capacity.").

59. Institute for Energy Research, *U.S. Solar Installations Down in 2017*, INST. FOR ENERGY RESEARCH (Mar. 21, 2018), https://www.instituteforenergyresearch.org/renewable/solar/u-s-solar-installations-2017; Nichola Groom, *U.S. Solar Forecast Ratcheted Down as Tariffs Weigh*, REUTERS (March 15, 2018), https://www.reuters.com/article/us-usa-solar/u-s-solar-forecast-ratcheted-down-as-tariffs-weigh-idUSKCN1GR0C5. Note the data on this point do not distinguish between utility-scale solar and distributed solar. The data refer to the solar industry as a whole.

60. *See* SIVARAM, *supra* note 54, at 49. The cost of installing solar has plunged since 2010 by over seventy percent. Solar Energy Indus. Ass'n, *Solar Industry Research Data* (Mar. 29, 2018), https://www.seia.org/solar-industry-research-data.

61. *See* SIVARAM, *supra* note 54, at 49 (explaining that part of the drop in cost of solar energy has occurred because "installers and developers around the world have gained experience and devised clever ways to install solar more cheaply. As solar becomes more widespread, these trends should continue to drive down the installed cost of solar"); U.S. ENERGY INFO. ADMIN., DISTRIBUTED GENERATION AND COMBINED HEAT & POWER SYSTEM CHARACTERISTICS AND COSTS IN THE BUILDING SECTOR, Table 1: Efficiency and Capital Cost Assumptions for Selected Years (Apr. 2017).

62. *See* BLOOMBERG NEW ENERGY FINANCE, NEW ENERGY OUTLOOK 2017, 2 (2017) (predicting that "the levelized cost of new electricity from solar PV drops by 66% by 2040").

projected to supply 17 percent of global electricity generation.[63] In certain regions the penetration rate of distributed generation is even higher, as in California.[64]

Distributed generation is not limited, however, to renewable energies.[65] Another form of distributed generation is combined heat and power. Such mechanisms, essentially, reuse the heat that is otherwise wasted from on-site generation, such as a natural gas-fired turbine or engine. The run-off heat in a combined power system is typically used for heating water or heating spaces. These systems are more common in commercial and industrial sectors.[66]

Distributed generation holds many benefits for the individual producer. A homeowner or business-owner can offset their electricity bills and their overall costs. It offers, in addition, the benefits of individual resilience in the face of outages. Distributed generation is also advantageous to the grid as a whole. To the extent distributed generation replaces "dirtier" production sources it provides significant benefits from reductions of both local air pollution and greenhouse gas emissions.[67] It also provides, regardless, increased resilience.[68] From a grid, or system-wide, perspective, the benefits of distributed energy generation can be understood as the difference between investing in a single share and diversifying one's investment portfolio. In the latter case, the risk is spread across a range of shares such that the potential fall of any single share does not threaten the entire investment. The same is true for the grid: if the generation capacity is centered at very few

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63. SIVARAM, *supra* note 54, at 51. Of the newly installed capacity, 30 percent will come from distributed solar, while the remaining 70 percent will come from utility-scale solar installations. *Id*., at 52.

64. *See* FERC, DISTRIBUTED ENERGY RESOURCES, *supra* note 2, at 5. On the potential and expected growth of solar PV, *see* NAT'L RENEWABLE ENERGY LAB., RENEWABLE ELECTRICITY FUTURES STUDY, xxix (2012) (predicting that renewables can potentially, in combination with storage solutions, supply 80% of the U.S. electricity in 2050). *See generally* U.S. ENERGY INFO. ADMIN, ANN. ENERGY OUTLOOK 2018 (Feb. 6, 2018).

65. Although for certain purposes, some do hold a narrower definition of distributed generation that includes only renewable resources. *See, e.g.*, CAL. PUB. UTIL. CODE § 769 (a) (2015).

66. *See* U.S. ENERGY INFO. ADMIN., MODELING DISTRIBUTED GENERATION IN THE BUILDINGS SECTOR 1 (Nov. 2017); U.S. ENERGY INFO. ADMIN., DISTRIBUTED GENERATION AND COMBINED HEAT & POWER SYSTEM CHARACTERISTICS AND COSTS IN THE BUILDING SECTOR 2-38 (Apr. 2017).

67. *See* JEFFREY SHRADER, BURCIN UNEL & AVI ZEVIN, VALUING POLLUTION REDUCTIONS: HOW TO MONETIZE GREENHOUSE GAS AND LOCAL AIR POLLUTANT REDUCTIONS FROM DISTRIBUTED ENERGY RESOURCES, 1 (Institute for Policy Integrity Mar. 2018), https://policyintegrity.org/publications/detail/valuing-pollution-reductions.

68. "Resilience" in this context refers to the ability to endure and recuperate from fluctuations, changes and major disruptive events, either man made or natural. *See* Justin Gundlach, *Microgrids and Resilience to Climate-Driven Impacts on Public Health*, 18 HOUS. J. HEALTH L. & POL'Y 1 (2018) ("[R]esilience—the capacity to withstand and recover from disruption, and to improve that capacity vis-à-vis future events.").

locations, the threat to each one of them—weather related or otherwise—can bring down significant parts of the grid. Recall, for example, the blackout that engulfed lower Manhattan in the wake of Hurricane Sandy. The loss of power was due to a flood at a single substation along the east river, which led to loss of power to millions of people and to a commercial shutdown of lower Manhattan. If, however, the generation is spread across multiple producers and locations, the threat to each one of them is reduced, hence providing the grid as a whole with increased resilience.

Distributed generation also faces significant challenges. A first challenge relates to financing distributed generation systems.[69] Second, access to existing transmission infrastructure is often essential for realizing the full value of distributed generation. Access to this infrastructure, which is typically centrally controlled (not distributed), may not be necessary for self-consumption, but to the extent users want to sell back into the grid they will need (at least) access to the transmission infrastructure.

Third, from a grid-wide perspective, grid operators now need to deal with novel challenges to grid reliability.[70] "Reliability" in this context

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69. More recently, an increasingly popular mechanism for financing distributed generation has been "third-party owners" (TPOs). These are "private companies that provide either solar electricity or equipment to generate it to building owners or tenants, typically with little or no upfront costs." David Darling & Cara Marcy, *About 30% of Distributed Solar Capacity is Owned by Third Parties*, U.S. ENERGY INFO. ADMIN (Dec. 7, 2016), https://www.eia.gov/todayinenergy/detail.php?id=29052. One key advantage of TPOs is their ability to "take advantage of more tax incentives than homeowners can typically realize, ultimately reducing the up-front costs of a photovoltaic (PV) system." Office of Energy Efficiency & Renewable Energy, *Renewable Energy: Distributed Generation Policies and Programs*, U.S. DEP'T OF ENERGY (last visited Jul. 27, 2018), https://www.energy.gov/eere/slsc/renewable-energy-distributed-generation-policies-and-programs. It is important for our purposes, however, to carefully note what "ownership" is involved. Third-party companies, will typically own the hardware, the solar panel itself. They will be due some form of payment for the "lease" they offer, but that does not mean they own the electricity produced through the solar panel. Nor do they own the roof on which the panel is placed. Third-party financing has been declining in the residential solar sector. For example, "[i]n 2013, 72% of residential systems installed in California were third-party owned, compared with 32% in 2017"; however third-party financing mechanisms have been on the rise among commercial users ("Nationwide, in 2017 57% of all installed non-residential capacity was third-party owned, topping the previous high of 43% set in 2016"). Solar Energy Industry Ass'n, *Third-Party Solar Financing*, https://www.seia.org/initiatives/third-party-solar-financing (last visited 7 May, 2019).

70. *See generally* NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION, DISTRIBUTED ENERGY RESOURCES: CONNECTION MODELING AND RELIABILITY CONSIDERATIONS (Feb. 2017) (surveying the ways in which increasingly incorporating distributed resources into the grid presents reliability challenges for grid managers). For instance, "[t]oday, the effect of aggregated [distributed energy resources] is not fully represented in . . . models and operating tools. This could result in unanticipated power flows and increased demand forecast errors. An unexpected loss of aggregated [distributed energy resources] could also cause frequency and voltage instability at sufficient [distributed energy resource] penetrations. Variable output from [distributed energy resources] can contribute to ramping and system balancing challenges for system operators . . . ." *Id*., at vi.

refers to the ability of the grid to provide a continuous supply of electricity. One challenge in this regard stems from the fact that renewables (which make up most of the distributed generation) are intermittent and available only during certain periods of the day. The second challenge to grid operations stems from the mere fact that electricity comes from an aggregate of numerous sources rather than very few central utilities. However, as technology improves, smart metering and data collection are also expected to improve, making grid operations and managing distributed generation smoother and easier. Partly as a response to these challenges, along with the rise of distributed generation, aggregation mechanisms have risen too. Aggregators essentially pool together distributed (often, smaller) producers, which enables them to participate in the wholesale market for electricity, rather than just the retail side.[71]

In addition to shifts in the production of electricity, recent times have brought changes to the *consumption* of electricity. Homeowners today have multiple avenues for participating in our electric grid, as consumers, even without directly producing "new" watts of electricity.

Homeowners can, for example, install batteries that store electricity. As an example, think of the batteries one can install in a garage or basement. The Powerwall, Tesla's home battery, is one of the better-known examples of such batteries. It is relatively compact, can hold up to roughly 13 kWh, and can either be wall-mounted or attached to the floor, indoors or outdoors.[72] Homeowners can later use the stored electricity for themselves or they can sell it back into the grid.[73]

The lack of efficient storage solutions for the electricity itself (as opposed to traditional primary energy resources, such as oil, that can be put in a barrel), has been a defining characteristic of the electric grid for

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71. *See* Romany Webb, *Integrating Distributed Energy Resources into Wholesale Markets: What FERC Can Learn from the California ISOs Experience*, SABIN CTR. FOR CLIMATE CHANGE L. CLIMATE L. BLOG (Feb. 16, 2018), http://blogs.law.columbia.edu/climatechange/2018/02/16/integrating-distributed-energy-resources-into-wholesale-markets-what-ferc-can-learn-from-the-california-isos-experience/ (discussing the issues that arise with regards to wholesale market participation of distributed energy resources, including the fact that "[c]urrent wholesale market rules, which were developed with conventional generators in mind, often impose participation requirements that DERs cannot meet, such as minimum size thresholds. FERC is, therefore, considering requiring ISO/RTOs to allow DERs to participate on an aggregated basis").

72 *See* Tesla, *Powerwall*, https://www.tesla.com/powerwall (last visited Jul. 26, 2018). Relatedly, vehicle-to-grid technologies might also integrate electric vehicles and their storage capacity into the grid. *See* Jacobs, *The Energy Prosumer*, *supra* note 49, at 530-31.

73 Although, to date, not all jurisdictions support re-selling of electricity to the same extent. A recent FERC order stipulated that "each RTO and ISO to revise its tariff to establish a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets." U.S. Federal Energy Reg. Comm., *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators* (Feb. 15, 2018), https://www.ferc.gov/whats-new/comm-meet/2018/021518/E-1.pdf.

decades. If electricity cannot be stored, supply and demand of electricity have to be precisely balanced at every moment.[74] Thus one of the key developments in recent times is the ability to store electric energy in distributed batteries that are spread across the grid and draw from those batteries at times of need.[75]

Storage solutions are also significant in enabling more widespread penetration of renewable energies. The sun and wind are intermittent, and subject to fluctuations over time. Absent an ability to store the electricity produced from renewables, their usefulness to our electric consumption is inevitably limited. To illustrate, while the sun shines during the day, peak electric consumption is typically between five and nine in the evening. If a portion of the electricity produced during the day from a solar panel is not used immediately on-site, absent an ability to store it, it will be wasted. Moreover, since we cannot rely on the solar panel to power our homes at peak times, we need to turn to other, probably non-renewable, resources. Thus, having solutions for storing electricity dramatically impact the ability to usefully employ renewables.

Distributed storage is indeed increasingly combined with distributed generation.[76] The illustrative example here is a solar panel on a residential roof which produces electricity when the sunlight is available and stores the excess electricity that is not used by the household in a battery installed at home. That stored electricity can either be used later by the same household, or, can be sold back into the grid.

Another avenue through which homeowners can partake in the electric grid is by participating in "demand-response" programs. These entail, essentially, a deliberate reduction in demand for electricity in response to price signals.[77] These signals could be, for instance, time-based rates. Often the response is facilitated by various "smart" meters. These, essentially, decide when to run the home appliances or adjust the

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74 Jacobs, *The Energy Prosumer*, *supra* note 49, at 529.

75 *See* MADISON CONDON, RICHARD L. REVESZ & BURCIN UNEL, MANAGING THE FUTURE OF ENERGY STORAGE, i (2018), https://policyintegrity.org/files/publications/Managing_the_Future_of_Energy_Storage.pdf; Amy Stein, *Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage*, 41 FLA. ST. U. L. REV. 697, 700 (2014).

76. *See* FERC, DISTRIBUTED ENERGY RESOURCES, *supra* note 2, at 7-8 (noting that although the term "distributed energy resource" most commonly refers to dispersed production of electricity, it "has evolved to include not only generation resources, but also energy storage, energy efficiency and demand response resources").

77. *See* Office of Elec., *Demand Response*, U.S. DEP'T OF ENERGY, https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid/demand-response (last visited Apr. 5, 2018) [hereinafter DOE, *Demand Response*] ("Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives.").

air conditioners or heaters at the precise moment when demand is highest (and pricing accordingly).[78] In addition to providing benefits to the homeowners, smart meters and demand-response programs can also provide important services to the grid, allowing system planners and operators to control supply and demand of electricity, manage peaks and promote grid reliability over time.[79]

To some extent, the traditional categories of production and consumption are being merged together today. Scholars have even termed the active energy participants "Prosumers", to suggest they are both producers and consumers of electricity.[80] Especially in the case of renewables, not only are the categories of production and consumption blending together, but in fact, the resource side is added into the mix. Think again of the homeowner with a rooftop solar panel: in this case, the homeowner is simultaneously involved in all three categories of the energy system: first, obtaining the resource (solar rays); second, producing the electricity (via solar panel); and third, consuming it.

The next step toward an even more dispersed energy system is the rise of peer-to-peer trading of energy. The idea is that individual generators could trade their electricity directly. Although the technology is only in its infancy, digital platforms could make peer-to-peer trading easier, quicker, and altogether more plausible for users.[81] Imagine if you could sell your surplus electricity from your solar panel to your neighbor, via a simple finger swipe on your phone. In fact, a successful pilot program of this sort has been running in Western Australia and

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78. *See id.* ("Smart customer systems such as in-home displays or home-area-networks can make it easier for consumers to change their behavior and reduce peak period consumption from information on their power consumption and costs."). "[Demand response] also includes direct load control programs which provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills." *Id. See also, generally,* Bruce R. Huber, *Demand Response and Market Power*, 100 IOWA L. REV. BULLETIN 81 (2015); Sharon B. Jacobs, *Bypassing Federalism and the Administrative Law of Negawatts*, 100 IOWA L. REV. 885 (2015).

79. *See* U.S. DEP'T OF ENERGY, DEMAND RESPONSE AND ENERGY STORAGE INTEGRATION STUDY 1 (Mar. 2016); DOE, *Demand Response*, *supra* note 77.

80. *See generally* Jacobs, *The Energy Prosumer*, *supra* note 49; Welton, *Grasping for Energy Democracy*, *supra* note 1, at 600 ("[t]his consumer-supplier breakdown threatens many of the basic tenets of electricity grid design and regulatory structure, by transforming the previously passive 'ratepayer' into an active 'participant' in the system"); INT'L ENERGY AGENCY, RESIDENTIAL PROSUMERS – DRIVERS AND POLICY OPTIONS (June 2014), http://iea-retd.org/wp-content/uploads/2014/06/RE-PROSUMERS_IEA-RETD_2014.pdf.

81. *See* David Spence, *Blockchain and Electricity Trading: In Praise of Regulatory Skepticism*, SABIN CTR. FOR CLIMATE CHANGE L. CLIMATE L. BLOG (Feb. 21, 2018), http://blogs.law.columbia.edu/climatechange/2018/02/21/blockchain-and-electricity-trading-in-praise-of-regulatory-skepticism/ ("The Brooklyn Microgrid is an ongoing experiment in blockchain-based local electricity trading, and the State's 'Reforming Energy Vision' program promises to actively promote P2P [peer-to-peer] electricity trading in New York.").

Auckland, New Zealand since 2016,[82] and the first commercial deployment of a blockchain-based system for peer-to-peer energy trading was recently launched in the U.S. on a university campus in Chicago.[83] This will inevitably be the age of private energy.

2. *Property entitlements in distributed generation and consumption*

How, then, do these shifts in the generation and consumption of electricity relate to property? In the age of distributed generation, property entitlements play an increasingly important role in the generation and consumption stages due, precisely, to their inherently dispersed nature and the dispersed decision-making involved.

An intuitive way to understand the new property-energy connection is through the following example: if you want to put a solar panel on your roof, it has to be *your* roof. The same is true for a battery in your garage, and a smart-meter in your home. When a policy-maker wants to encourage adoption of rooftop solar, the extent to which it is indeed adopted depends, among other things, on whether or not the underlying property rights support such a move. That is the essence of the property-energy connection.

To further illustrate the pull of the problem, assume you are currently renting the residence you live in. Could you install a roof-top solar panel? Would you, even if you could? These two questions are essentially property questions. The first, relates to the scope of authority you have in the residence in question. In property terms, the question is whether your landlord has transferred to you the relevant authorizations with regards to the use of the residence in question. Do you have authorization to access the roof, install on it and perhaps alter the electric wiring of the building? The second question (would you invest in a solar panel assuming you could) relates to the duration of the property right. If the duration of the right is too short, it would not warrant the investment in permanent (or not so easily transferable) infrastructure like a solar panel or battery.[84]

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82. *See* POWER LEDGER, *supra* note 4, at 24.

83. *See* Butcher, *supra* note 3 ("Power Ledger's platform lets consumers buy and sell renewable energy directly between one another, using a blockchain platform, and will enable Northwestern University to trade clean energy both on-campus and between campuses with no hardware, software or subscription fees, by using pre-existing meters. . . On-campus P2P trading will be followed by connection to external peers across multi-campus universities, museums, laboratories and more."). In addition to facilitating peer-to-peer trading, blockchain-based technology may also prove to be useful in aggregating and managing the information generated by all the smart-meters and distributed generators at the grid's edge. As an example, see the technology proposed by Solara, https://solara.io/.

84. What would be "too short" in this context depends of course on how long it would take you to return your investment on the roof-top solar. Generally speaking, the longer the return

To be sure, the distinction does not have to be purely a doctrinal one. The typical distinction, at least in Anglo-American legal traditions, is between a perpetual entitlement and a time-limited entitlement. The former, is what people associate with "full" ownership, and in doctrinal terms when applied to land is known as "fee simple."[85] The latter type of entitlement, which is time-limited, is what we most intuitively think of as renting or leasing.[86]

Ownership provides the holder with both the managerial authority over the asset and the possessory interest in it. Leasing typically provides the holder with only the possessory interest, leaving the residual managerial authority with the owner. A lease is thus a way of splitting the managerial authority and the possessory interest.[87] There are many ways the owner and lessee can decide to split the interests between them. The lease can vary in its scope, both in terms of the authority it allocates to the lessee and in terms of its duration.

Returning to the rooftop solar example, you do not necessarily have to have a fee simple in your residence in order to be able to install a solar panel or battery. You could, for example, have an expansive long-term lease, which allows you to invest in and install distributed energy.[88] However, for ease of exposition, the doctrinal categories can be used as proxies for the functional equivalent of long-term entitlements (i.e. full ownership or fee simple) and short-term entitlements or time-limited use-rights (i.e. lease).

The focus, then, as a functional matter, is on whether and to what extent do the underlying property entitlements facilitate the adoption of distributed energy mechanisms?

A key issue in this regard, is the *duration* of the entitlement.[89] A time-limited entitlement could have many advantages. Many of the "renting-economy enterprises," including Airbnb, Uber, WeWork and so on, illustrate the potential of time-limited entitlements. By allowing

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period, the longer the property right has to be to fit it.

85. *See* THOMAS W. MERRILL & HENRY E. SMITH, PROPERTY PRINCIPLES AND POLICIES, 508-09 (3rd. ed. 2016).

86. *Id.* at 643-46.

87. *Id.* at 641-42. As Merrill and Smith point out, leasing is not the only way of splitting the managerial authority and the possessory interests. *Id.* at 641.

88. As an example, both in China and in Israel long-term leases (e.g. ninety-nine years) are the most prevalent form of holding land. Katrina M. Wyman, *In Defense of The Fee Simple*, 93 NOTRE DAME L. REV. 1, 8 (2017).

89. We can imagine an issue with the scope of the entitlement, regardless of its duration, which can also impact the ability to adopt distributed generation. For instance, if you have perpetual (non-time-limited) right to only a very tiny piece of earth, your ability to place a solar panel might be hindered not by the duration of the right but by its scope. I set aside these considerations for the time being and reserve the discussion for future work. I also set aside the question of chattels for now—although in the future you might be able to fully participate in the distributed energy system with little more than your cell-phone and a pocket side battery.

each user access to the resource for only a limited amount of time, the resource is put to better use and thus maximizes its value.[90] Leasing also acts as a risk-shifting mechanism and as a financing mechanism, which again maximizes its utility.[91]

The issue is tailoring the duration of the entitlement to the use, such that it best fits its purpose.[92] In a simplistic world, we would fashion each right for the ideal amount of time it is used for each specific use. For example, when you visit a city for a weekend, you need an entitlement that allows you only a temporary use of a residence, whereas when you live in a city you probably need use rights for a longer period of time. The difficulty is that many resources have more than one use and we often cannot tailor the duration of the right to each segment.

The issue with regards to distributed energy is thus one of duration because time-limited entitlements modify the investment you are willing to put into your home. If the entitlement is too short (in relation to the return on the investment), the investment that is necessary on the part of the individuals would not be feasible.[93]

Another question that arises with renters is the *scope* of the entitlement with regards to permitted activities or areas of use within the residence. Assume again that you are leasing the house or apartment you currently live in. Based on your agreement with your landlord, could you install a solar panel on the roof? In property law terms, the question is whether the landlord has transferred to you the entitlements to access the roof, install objects on it, alter the electric wiring in the residence, and so on.

Moreover, in order to fully reap the benefits of increased grid resilience, it is not enough for only one individual to adopt a solar panel or a smart-meter, but rather many individuals need to do so simultaneously. What happens, however, in a city where many of the residents are renters, that is, hold time-restricted property entitlements?

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90. *See* Rashmi Dyal-Chand, *Regulating Sharing: The Sharing Economy as an Alternative Capitalist System*, 90 TUL. L. REV. 241, 256-59 (2015) (providing a thorough analysis of the benefits of sharing economy enterprises both on the demand side and the supply side); more broadly, the concept of the sharing economy has been the subject of a rich body of literature. *See generally, e.g.,* Yochai Benkler, *Sharing Nicely: On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production*, 114 YALE L.J. 273 (Nov. 2004); Nestor M. Davidson & John Infranca, *The Place of the Sharing Economy*, *in* CAMBRIDGE HANDBOOK ON THE LAW OF THE SHARING ECONOMY 205 (Nestor M. Davidson, Michele Finck & John J. Infranca, eds., 2017; Shelly Kreiczer-Levy, *Share, Own, Access*, 36 YALE L. & POL'Y REV. 155 (2017); Michéle Finck & Sofia Ranchordás, *Sharing and the City*, 49 VAND. J. TRANSNAT'L L. 1299 (2016); Kellen Zale, *Sharing Property*, 87 U. COLO. L. REV. 501 (2016).

91. *See* MERRILL & SMITH, *supra* note 85, at 641-42.

92. That is, at least on a utilitarian account.

93. Property scholars have recently revisited the issue of perpetual holdings and fee simple. *See generally, e.g.,* Lee Anne Fennell, *Fee Simple Obsolete*, 91 N.Y.U. L. REV. 1457 (2016); Wyman, *supra* note 88.

The share of households in the United States that rent their residences has been rising in the last decade and is currently higher than at any point in the last five decades.[94] In cities such as Chicago, IL,[95] and Tucson, AZ,[96] for example, thirty-two percent of the residential units are renter-occupied. In Seattle[97] and Las Vegas[98] the share of renters is thirty-six and thirty-seven percent, respectively. In New York City, over fifty percent of residents are renters.[99]

Thus, the challenges in this regard stem from the fact that distributed generation is tied to residency or occupancy, and the latter is increasingly restricted in different ways, including the duration of the right (short-term rather than long-term) and its scope (whether roof access if part of the leasing agreement).

The underlying property entitlements are, of course, not the only factor that determines whether one places a solar panel on the roof. Financing the panels, the rate of return to the investment, the ability to sell back into the grid, and zoning restrictions all play a significant part in the decision whether to install a solar panel or not.[100] But, importantly,

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94. *See* Anthony Cilluffo, Abigail Geiger & Richard Fry, *More U.S. Households are Renting Than at Any Point in 50 Years,* PEW RESEARCH CENTER: FACTTANK, (Jul. 19, 2017), http://www.pewresearch.org/fact-tank/2017/07/19/more-u-s-households-are-renting-than-at-any-point-in-50-years/. According to the same analysis, "rental rates have also increased among some groups that have traditionally been *less* likely to rent, including whites and middle-aged adults." *Id.*

95. U.S. CENSUS BUREAU, AMERICAN HOUSING SURVEY FACTSHEETS: 2013 HOUSING PROFILE: CHICAGO, IL 1 (2015), https://www2.census.gov/programs-surveys/ahs/ 2013/factsheets/ahs13-5_Chicago.pdf#.

96. U.S. CENSUS BUREAU, AMERICAN HOUSING SURVEY FACTSHEETS: 2013 HOUSING PROFILE: TUCSON, AZ 1 (2015), https://www2.census.gov/programs-surveys/ahs/2013/factsheets/ahs13-25_Tucson.pdf?#.

97. U.S. CENSUS BUREAU, AMERICAN HOUSING SURVEY FACTSHEETS: 2013 HOUSING PROFILE: SEATTLE-TACOMA-EVERETT, WA, U.S. CENSUS BUREAU 1 (2015), https://www2.census.gov/programs-surveys/ahs/2013/factsheets/ahs13-23_Seattle.pdf?#.

98. U.S. CENSUS BUREAU, AMERICAN HOUSING SURVEY FACTSHEETS: 2013 HOUSING PROFILE: LAS VEGAS-PARADISE, NV 1 (2015), https://www2.census.gov/programs-surveys/ahs/2013/factsheets/ahs13-10_LasVegas.pdf?#.

99. U.S. CENSUS BUREAU, AMERICAN HOUSING SURVEY FACTSHEETS: 2013 HOUSING PROFILE: NEW YORK CITY, NY 1 (2015), https://www2.census.gov/programs-surveys/ahs/2013/factsheets/ahs13-15_NYC.pdf?#. Other reports suggest the rate of renters in New York City could be as high as sixty-eight percent (as of 2016). *See, e.g.,* STATE OF NEW YORK CITY'S HOUSING AND NEIGHBORHOODS IN 2017, NYU FURMAN CENTER 22 (2017), http://furmancenter.org/files/sotc/SOC_2017_Full_2018-08-01.pdf.

100. In brief, three main policies support the adoption of solar power: first, mandates that require utilities to purchase and use a certain portion of their energy from renewable resources, including solar; second, by providing subsidies of various sorts (e.g. tax credits) to the construction and installation of solar panels; third, by pricing the electricity that is produced from renewables, most notably by "net metering" (also known as "feed-in tariffs"). *See* SIVARAM, *supra* note 54, at 50. For a review of the range of incentives that are employed to encourage adoption of solar power (and other renewables), see U.S. Dep't of Energy & N.C. Clean Energy Tech. Ctr., *Database of State Incentives for Renewables & Efficiency*, DSIRE USA, http://www.dsireusa.org; OPENEI, https://openei.org/wiki/Main_Page (last visited April 28, 2019) (a "wiki"-type database which focuses on renewables and on energy efficiency); NAT'L

even if all these factors were favorable, one could not place a solar panel on a roof if the property entitlements did not support it. Being able to finance the panels is not enough; you still have to put them somewhere, and whether or not you can do so depends to a large extent on the property entitlements.[101]

To be sure, the analysis here is not meant to suggest that public law is no longer important in the management of our energy system. Support for distributed energy, from local government, to state and federal,[102] as well as the future of the public utilities[103] still present intriguing scholarly questions and continue to be crucial to the advancement of the distributed trend. The analysis here does show, however, that thinking about energy management *solely* through the lens of public law fails to capture the nuances of our modern energy operations. Adding the private law lens complements the analysis by enriching our understanding of the factors that act to either facilitate or inhibit the development of the modern grid.

III. PROPERTY AS A STRATEGY FOR DISTRIBUTED MANAGEMENT

A. *Enabling Location-Specific Activities*

The move toward a distributed energy model has made energy operations more location specific. Under the centralized model, we cared only about the location of the few power plants. For the sake of grid operation, it did not truly matter whether you consumed a watt of electricity or your next-door neighbor did.[104] The location of the consumption was essentially insignificant, and the location of the centralized production was only significant in very few locations.

Now however, in order for a distributed grid to operate, many more

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RENEWABLE ENERGY LAB., THE OPEN PV PROJECT, https://openpv.nrel.gov/ (last visited April 28, 2019).

101. I set aside for the moment zoning restrictions which might also impact one's ability to install a solar panel at a given location. In any case, as mentioned, even if zoning restrictions presented no restrictions, the location-specific property entitlements would still need to be secured.

102. As an example, for a review of the suite of policies California has to support "Distributed Energy Resources," defined to include "distribution-connected distributed generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies," see CAL. PUB. UTIL. COMM'N, CALIFORNIA'S DISTRIBUTED ENERGY RESOURCES ACTION PLAN: ALIGNING VISION AND ACTION, app. A (May 3, 2017); for a broad review of renewable policies, both distributed and non-distributed (utility-scale), see Lincoln L. Davies, *Eulogizing Renewable Energy Policy*, 33 J. LAND USE & ENVTL. L. 309 (2018).

103. As mentioned, I would agree that "the future of the public utility remains a vibrant, evolving area of inquiry for law and economic regulation." Rossi & Ricks, *supra* note 8, at 714.

104. There could be changes in the levels of consumption between you and the hypothetical person with whom you switched homes, in which case—holding all other things constant—the overall consumption of the grid would slightly shift. Although we can assume for the sake of discussion here that these differences between similarly situated residents are negligible, and might, for the sake of simplicity, use the average household electricity consumption.

locations become significant. Whereas before it did not matter exactly where your home is located, what entitlements you have in your roof, and what direction your roof faces, all these are now increasingly significant to the overall grid operations. The result is that we need a tool to manage the multiple dispersed location specific aspects of energy.

On the resource side, another interesting move has happened. Location was always a key factor in *extracting* primary resources. The exact location of an oil reserve, the prime spot to drill a well, the specific locations of coal reserves and the mines that follow are all examples of location-specific activities. Perhaps that is one reason why property has played a role in governing the extraction of these traditional energy resources for over a century now.

However, diversifying the type of primary energy resources—namely introducing more renewables into the mix—has also further increased the importance of location-specific activities. With non-renewable energy resources, such as oil and coal, extracting the primary resources need not take place at the same location where converting those resources into electric energy occurs, and in fact the two are often separate. With renewable resources, however, that is not the case.[105] Extracting the wind and converting the kinetic energy within it into electric energy must (at least under current technologies) occur at the exact same spot. The same is true for capturing the sun rays and converting them into electric energy. As a result, the necessary coupling of extraction and generation makes the specific location all the more important.

Interestingly, notice that in the case of renewables, the locality can be both a significant advantage (the sun shines pretty much everywhere)[106] and a constraint (the solar rays need to be both collected and converted to electricity at the exact same location).[107]

The move toward distributed generation and the introduction of renewable resources into the energy mix have thus both increased the importance of location specific activities. In a world where location matters, we need a tool for governing local spots on earth and access to local resources.[108] Property law provides such a tool.

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105. The exception is perhaps biofuels of different sorts, for which the conversion process can happen anywhere.

106. Of course, some places enjoy more sunny days than others. But generally speaking, there are very few places that do not have *any* solar potential at all.

107. *See* FELDMAN ET AL., *supra* note 23, at v ("Fundamentally, these [shared solar] models remove the need for a spatial one-to-one mapping between distributed solar arrays and the energy consumers who receive their electricity or monetary benefits.").

108. This aspect of property—as enabling location specific activities—ties in nicely with the idea of a specific "thing" at the center of the property entitlement, a concept which has been the subject of scholarly attention. *See, e.g.,* Katrina Wyman, *The New Essentialism in Property*,

B. *Distributed Resource Management*

Property is essentially a strategy for delegating authority to multiple agents, each of whom gets authority over a particular resource. This view of property as a strategy for distributed management of resources has been embraced by scholars from Morris Cohen in a famous essay from the Legal Realist era;[109] to leading contemporary property scholars such as Thomas Merrill and Henry Smith.[110]

In its most simplified form, the idea can be put as follows: if there are multiple resources in a given area, a policy-maker can choose how to manage them, either by appointing a single central agent (or agency) to oversee all of the resources, or alternatively, by allocating control over different resources to multiple agents. While the former is roughly akin to public law, the latter is broadly akin to property. In that sense, property is a strategy for distributed (as opposed to centralized) management of resources. Seen from this perspective, it is only natural that a shift toward distributed energy is also a shift toward a more property-oriented strategy.

Of course, in reality, the division between central and dispersed is never as clean or as simple as this hypothetical example suggests. Many resources are managed by some kind of mixture of the two strategies. In fact, that is precisely the point this Article makes with regards to electricity generation and consumption: that we currently witness a mixture of both strategies.

Interestingly, similar arguments are invoked in the property scholarship and the distributed energy literature. For example, the

9 J. LEGAL ANALYSIS 183 (2017) (offering a comprehensive analysis of "thing" element in the recent property scholarship); Henry Smith, *Property as the Law of Things*, 125 HARV. L. REV. 1691 (2012). The "thing" at the heart of the property relationships is not an amorphous one, but rather a specific asset. Anna di Robilant & Talha Syed, *The Fundamental Building Blocks of Social Relations Regarding Resources: Hohfeld in Europe and Beyond*, *in* THE LEGACY OF WESLEY HOHFELD: EDITED MAJOR WORKS, SELECT PERSONAL PAPERS, AND ORIGINAL COMMENTARIES (Shyamkrishna Balganesh, Ted Sichelman & Henry E. Smith, eds., 2018) (arguing that property is "resource-specific"). Thus, at least in the cases where the "thing" at the center of the property entitlement is a physical one, it often is location specific. This location can shift perhaps, in the case of movable resources, but it still remains specific. Your home is located on a very specific spot on earth; your barrel of oil, was extracted from a particular spot; the apple in your fridge, was not only grown at a specific location but it is in a specific spot now—your fridge.

109. Morris R. Cohen, *Property and Sovereignty*, 13 CORNELL L. REV. 8 (1927).

110. Thomas W. Merrill, *Private Property and Public Rights*, *in* RESEARCH HANDBOOK ON THE ECONOMICS OF PROPERTY LAW 75, 75 (Kenneth Ayotte & Henry E. Smith eds., 2011) ("[P]roperty can be viewed as a delegation of authority from society to particular individuals to exercise 'sovereign' authority over particular resources."); MERRILL & SMITH, *supra* note 85, at 173 ("[P]roperty can be seen as a system that delegates managerial authority over resources to private individuals who act as gatekeepers."); Thomas Merrill, *The Property Strategy*, 160 U. PA. L. REV. 2061, 2063 (2012) ("[T]he property strategy is one of decentralized control over resources. Specific resources are assigned to designated persons who have unique prerogatives in dealing with the resource relative to all other persons in the relevant normative community.").

institution of property is said to "facilitate[] the full realization of personal goals and aspirations."[111] This theme of personal realization and independence echoes in the literature on distributed generation as well.[112] The property strategy is also said to "diffuse power—although not perfectly, of course," due to its dispersion of authority among multiple agents rather than concentrating that power in the hands of few.[113] The same idea echoes in the literature on distributed energy with regards to resilience: the idea, as mentioned, is that dispersing the production of electricity among multiple users and locations increases the overall grid resilience by empowering individual generators.[114]

The concerns expressed with regards to these two dispersed systems also resonate similarly. Dispersing control over resources among multiple agents also means that sometimes problems of aggregation will arise. In property scholarship this relates, for example, to aggregating permissions to pass through multiple parcels of land with regards to highways, subway tunnels, navigable airways, communication cables, or natural resources like water reserves or habitats.[115] With regards to distributed energy, issues of aggregation arise in grid management. The concern in the context of energy is that grid operators who need to provide a steady and reliable supply of electricity to various locations will have trouble predicting and accounting for the dispersion of numerous individual producers.[116]

IV. IMPLICATIONS FOR CURRENT ENERGY AND CLIMATE DEBATES

Armed with a richer understanding of the role property law plays in the era of distributed energy, we can now turn to its implications for current energy and climate debates. Gaining a more nuanced understanding of the factors that can either facilitate or inhibit the adoption of certain policies can be helpful in evaluating existing policies

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111. *See* Merrill, *The Property Strategy*, *supra* note 110, at 2088. As Merrill notes, Margaret Jane Radin is one of the strongest proponents of this approach. *See generally, e.g.*, Margaret Jane Radin, *Property and Personhood*, 34 STAN. L. REV. 957 (1982). Hanoch Dagan argues that property law (and more generally private law) is, and should be, autonomy enhancing. *See generally* Hanoch Dagan, *Autonomy and Pluralism in Private Law* (January 1, 2019), in OXFORD HANDBOOK OF THE NEW PRIVATE LAW (Andrew Gold et al., eds., forthcoming 2019), available at https://ssrn.com/abstract=3308688; HANOCH DAGAN, A LIBERAL THEORY OF PROPERTY (forthcoming 2020).

112. *See generally e.g.*, Jon Wellinghoff & Steven Weissman, *The Right to Self-Generate as a Grid-Connected Customer*, 36 ENERGY L. J. 305 (2015); Jacobs, *supra* note 49.

113. *See* Merrill, *The Property Strategy*, *supra* note 110, at 2087.

114. *See supra* note 68 and accompanying text (discussing grid resilience).

115. *See* Robert Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1382 (1993) (discussing how the problems of aggregation could impair mobility if travelers had to bargain with every individual right-holder along the way); Yael R. Lifshitz, *Horizontal Property* (on file with author) (providing an overview of problems of aggregation in different context and how their shared spatial features).

116. *See supra* note 70 and accompanying text (discussing aggregation in the context of distributed generation).

as well as in crafting future ones. Adding the private law lens is thus helpful both in identifying problems that had otherwise not been identified, and in offering a new, private law-based set of solutions.

As an example of such a property-oriented analysis, the following section will focus on the "renters' problem" in distributed energy. After identifying the problem with the scope of the property rights, it will then offer a range of possible solutions. The first is mandating upgrades to building codes, such that all (or all new) buildings will have distributed energy facilities, regardless of who inhabits them and for how long. The second pertains to tweaking the landlord-tenant lease such that it can enable distributed energy. The third is creating platforms for sharing distributed energy, a sort of "We-Solar," much like the sharing of rides, apartments, and work-spaces. The fourth is facilitating peer-to-peer trading of energy.

Finally, Part IV.B will then suggest how private-law-based litigation could open new avenues for shaping energy and climate policy.

A. *Overcoming the Renters' Problem*

Recall that as a precondition for adopting distributed generation and smart consumption, one needs decision-making authority over a specific location (e.g. rooftop), over a timespan that would encourage investment in lasting infrastructure. One needs, in other words, the right property rights.

The most immediate problem arises with renters. Under a typical lease, where the tenants pay the energy costs, the tenants should be incentivized to invest in distributed and smart energy solutions. However, tenants typically lack the authority to access the facilities that are necessary for distributed and smart energy installations. Tenants also typically do not have the time horizon necessary to return their investment in installations such as rooftop solar.

Landlords, on the other hand, have the necessary authority and the investment horizon, but lack incentives to invest in such energy shifts when under the lease agreement they are not paying the energy costs. The professional literature calls this the "split incentive" problem.[117] I find the term "misaligned" better captures the reality in which the landlord has the *authority* to invest, but is not *incentivized* to do so; and the tenant has an *incentive* to invest for the sake of reducing energy costs, but neither the appropriate *authority*, nor a strong incentive to do so, given the limited duration of the lease. Either way, for ease of

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117. *See* U.S. DEP'T OF ENERGY, PROMOTING SOLAR PV ON LEASED BUILDINGS GUIDE: BENEFITS, BARRIERS, AND STRATEGIES 22 (Oct. 2015) [hereinafter DOE, PV ON LEASED BUILDINGS].

exposition, I will use the term "renters' problem" to describe the situation.

The term "split" is, however, relevant to the understanding of the property entitlements. Recall that a lease is a way of splitting the residual managerial authority over an asset from the possessory interest in it.[118] The renters' problem in the context of distributed energy serves as a nice illustration of this split: the landlord has the authority to determine what kind of installations would go on the roof, and would benefit in the long-run from the improvements on the buildings, precisely because she retains the residual managerial authority. The tenant, would benefit from the possession of the rooftop panel or basement battery, precisely because she is the one currently holding the possessory interest and thus is the one who is shouldering the ongoing electricity bills.

The renters' problem is widespread. Again, over a third of the housing market in the U.S. is dominated by renters. This figure has been fairly constant since the 1970s.[119] A similar trend is apparent in London[120] and in other cities world-wide.[121] In addition to renters, dwellers of multi-unit buildings also face property challenges to installing distributed energy systems. If the rooftop or basement are jointly held (which is typically the case in multi-unit buildings), then the tenants will need to aggregate permissions from all the right-holders in the building in order to carry out a distributed energy project. The result is that thirty-seven percent of residents in the U.S. can't participate in distributed energy.[122]

What can be done to address these challenges, increase the participation in distributed and smart energy systems and facilitate future areas of growth such as peer-to-peer energy trading? The

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118. *See* MERRILL & SMITH, *supra* note 85, at 642.

119. *See* FELDMAN ET AL., *supra* note 23, at 21 ("the percentage of renters in the U.S. housing market was roughly 50% between 1920–1940 and has been around 35% since the 1970s . . . we assume the percentage of renters remains at 35% over the next decade").

120. *See* Feargus O'Sullivan, *In London, Renters Now Outnumber Homeowners*, CITYLAB (Feb. 25, 2016), https://www.citylab.com/equity/2016/02/londons-renters-now-outnumber-homeowners/470946/ Moreover, the percentage of renters is expected to further increase: Isabelle Fraser, *Generation Rent: London to Become a City of Renters by 2025*, THE TELEGRAPH (Feb. 16, 2016) https://www.telegraph.co.uk/finance/property/property-market/ 12157946/Generation-Rent-London-to-become-a-city-of-renters-by-2025.html ("London will become a city of renters, with just 40pc owning their own home in 2025, according to new research from PwC.").

121. MICHAEL CARLINER & ELLEN MARYA, THE HARVARD JOINT CENTER FOR HOUSING STUDIES, RENTAL HOUSING: AN INTERNATIONAL COMPARISON, 2-3 (Sept. 2016), https://www.jchs.harvard.edu/sites/default/files/brief_international_housing_carliner_marya.pdf (surveying the percentage of renters in 12 countries: US, Canada, Austria, Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom).

122. *See* FELDMAN ET AL., *supra* note 23, at 23 Figure 5 (showing that 30 percent of residents are renters in buildings that have less than four stories; 4 percent are renters in buildings that have more than 4 stories; and an additional 3 percent of residents live in owner-occupied but are in buildings that have more than 4 stories).

following sections outline a few potential ideas.

1. *Mandating upgrades*

If all buildings had built-in solar panels and storage batteries, everyone could participate in the distributed energy market fully. One way to go about bringing that vision to life is setting a mandate for building that includes such infrastructure. California recently passed exactly such a mandate. Starting in 2020, all new residential buildings (over a certain size) will be required to have solar panels installed.[123]

2. *Distributed energy enabling leases*

Recall that from a property standpoint, renters' authority and ability to engage in distributed production and smart consumption is typically limited. The limitations stem from the lease which defines the scope of the renters' authority. Thus, one way to enable renters' participation is by tweaking the terms of the lease.

Envision a "distributed energy lease" or "smart energy lease", which could actually be just a few clauses within the general lease agreement, and which operates to enable the participation in distributed energy. Most immediately, it can grant authority to access and make improvements onto the necessary facilities such as rooftops for panels and basements for batteries. But it can also include provisions that allow for "buy back" provisions between the landlord and tenant, or cost-splitting mechanisms. I imagine these leases could benefit from the experience gained in the context of "green leases" that are intended to enable investment in energy efficiency.[124]

Smart energy leases, in contrast to building mandates, are a voluntary mechanism. The idea is that parties can choose to adopt them given the benefits that accrue to them from the ability to participate in the smart energy world.

The benefits of smart energy leases to tenants are readily understood. Tenants could benefit significantly from lower electricity

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123. CALIFORNIA ENERGY COMMISSION, ENERGY EFFICIENCY STANDARDS, 2019 Title 24, Part 6, § 150.1.14 (2018) ("All low-rise residential buildings shall have a photovoltaic (PV) system meeting the minimum qualification requirements . . . with annual electrical output equal to or greater than the dwelling's annual electrical usage . . . .").

124. *See* DOE, PV ON LEASED BUILDINGS, *supra* note 117, at 1 ("[T]he concept of green lease has been tested and discussed for years; and while there is no distinct definition as to what constitutes a green lease, it is considered an effective mechanism for resolving legal/ownership challenges in the leased building market."); Announcement from U.S. Dep't of Energy, Green Lease Leaders Releases Program Enhancements (Oct. 26, 2017), https://www.energy.gov/eere/buildings/articles/green-lease-leaders-releases-program-enhancements (noting that "adding simple clauses to the lease can create win-win agreements that align costs and benefits of energy and water efficiency investments for both parties").

costs, and again, more control over their operating costs in the case of commercial tenants.[125] Landlords could also benefit from smart energy infrastructure. Although under a typical lease landlords do not shoulder the cost of energy directly, improving the infrastructure of their units can be beneficial to them as well. It can serve, first, to enhance the marketability of their buildings. Since it provides their tenants with the opportunity of costs savings it can also allow them to charge a certain premium for the added amenity they provide, and for the same reason could also improve their tenant retention rates.[126]

Smart energy leases could be particularly useful and appealing to commercial tenants, or tenants with large campuses such as universities and health care facilities.[127] Staples, a multinational office supply corporation, for example, has been adding clauses to its new leases for over a decade (since 2007), which facilitate the installation of solar PV on its leased stores.[128] For residential tenants, however, the challenge could be the relative lack of bargaining power and problems of collective action. A young family who has recently moved to a big city does not necessarily have the clout to insist that their landlord include solar-enabling clauses in their leasing agreements. It is possible, however, that the market for residential housing will allow for differential pricing, much like with other features such as parking and on-site sports facilities, such that smart-energy amenities will be considered a premium product. In such a case, at least some landlords might choose to enable the smart-energy features in order to reap the benefits of increased marketability and greater tenant retention.

3. *"We-Solar"*

A second way to overcome the difficulties of renters' limited authority and short-term interest is by pooling their interests with regard to distributed energy—sharing distributed energy resources.

The idea is that much like renting a parking space in a shared building, or sharing an apartment (Airbnb), a car (Zipcar, Uber, Lyft), or workspace (WeWork), one can rent a solar panel. Distributed generation is thus shareable over time. Just as the sharing economy

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125. *See* DOE, PV ON LEASED BUILDINGS, *supra* note 117, at 2; Stephen Lacey, *I'm Trying to Convince My Office Building Owner to Install Solar. What Are My Options?*, GTM RESEARCH (May 8, 2018), https://www.greentechmedia.com/articles/read/im-trying-to-convince-my-office-building-owner-to-install-solar#gs.CkmR0EY.

126. *See* DOE, PV ON LEASED BUILDINGS, *supra* note 117, at 2.

127. Some of these institutions might also have taken on commitments to reduce their greenhouse gas emissions, in which case they are not only motivated by the benefits in terms of watts but also in terms of avoided emissions.

128. *See* FELDMAN ET AL., *supra* note 23, at 29 fn. 32 ("Staples has added standard language to all the new leases it signs with property owners since 2007 to facilitate installing PV on its stores.").

opened up a world of economic possibilities, so can the sharing of distributed energy.

In the language of property, this practice is essentially carving out time-slices for usage by multiple right-holders. Sharing in this context does not necessarily refer to joint-holdings (although that too is possible). Instead, sharing in this context suggests that the property entitlements to the asset in question are structured such that rather than one single user getting access to the asset at all times, multiple users can access the asset at different times. "Sharing" thus refers to dividing access over time, which is functionally similar to a lease or a set of leases.

There are already a few examples of successful shared solar projects, also sometimes known as "community solar."[129] However, such mechanisms are still far from reaching their potential and generally focus on off-site generation.[130] The broader project of sharing distributed energy resources, I propose, encompasses not only off-site projects but rather a broader menu of options. Also, importantly, the same sharing mechanisms likely could be applied not only to solar but likewise to batteries ("We-storage") or other distributed energy mechanisms. For ease of exposition, however, I term these sharing mechanisms for any kind of distributed generation and consumption collectively "We-Solar." The following discussion offers a typology of We-Solar mechanisms and discusses how such projects might advance.

a. *On-site We-Solar*

We-Solar projects can be of several types.[131] The first type serves a

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129. *See* SMART ELECTRIC POWER ALLIANCE, COMMUNITY SOLAR PROGRAM DESIGN MODELS (2018) (providing an overview of all existing *off-site* shared solar programs). Community solar has shown significant growth recently: "The total installed capacity of community solar programs has expanded to 734 megawatts (MW), with approximately 387 MW of that being installed in 2017. This corresponds with a year-over-year growth in capacity last year of 112%." *Id.* at 6.. This growth is expected to continue "in the short term," although "[w]hether this growth continues in the long term . . . is undetermined." *Id.*

130. *See* SMART ELECTRIC POWER ALLIANCE, *supra* note 127, at 7 (2018) ("Despite its continued growth, community solar is still a relatively small part of the solar marketplace . . . . [There were] 47.5 gigawatts (GW) of total installed solar in the U.S. in all markets through the third quarter of 2017. . . . Community solar was responsible for just over 1% of this installed solar capacity."). A recent study suggests that "the total potential community solar market was 6.5 million households. At this point, less than 300,000 have subscriptions." *Id.* One of the key uncertainties shared solar currently faces is whether an interest in a shared solar project is a "security", in which case securities requirements for registration and disclosure would apply. *See* FELDMAN ET AL., *supra* note 23, at vi-vii ("One of the top concerns raised by shared solar stakeholders is uncertainty about the applicability of Securities and Exchange Commission (SEC) requirements for registration and disclosure of shared solar projects. Central to this issue is whether an interest in a shared solar project is a 'security.'").

131. *See* U.S. DEP'T OF ENERGY, SUNSHOT, A GUIDE TO COMMUNITY SHARED SOLAR: UTILITY, PRIVATE, AND NONPROFIT PROJECT DEVELOPMENT, 6-7 (May 2012), https://www.nrel.

multi-family or co-op building, where the solar array is located on their shared roof.[132] In this case, the production and consumption are both on-site, exactly as they would be with a single owner and her rooftop panel. This model is akin to behind-the-meter production and consumption[133] in the sense that production and consumption are both on-site, and do not need to go through the grid.[134]

To illustrate, assume there is an apartment building with solar panels installed on the shared roof. Resident A and Resident B are both participants in the shared-solar project. Resident A consumed 1000 kWh of electricity last month, but since her share of the project produced 700 kWh, she only needed to buy from the grid the remaining 300 kWh. Thus, her electric bill for last month would be only for 300 kWh. Resident B also consumed 1000 kWh last month, but his share in the joint-solar project produced 300 kWh, so he bought the remaining 700 kWh from the grid. The same analysis would apply if there were a shared battery installed in the building. Figure 1 illustrates.

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gov/docs/fy12osti/54570.pdf (providing an overview of several models of shared solar). Participants in shared solar are not limited to a single household or business entity. Entities based on various forms of shared ownership can also participate. FELDMAN ET AL., *supra* note 23, at 11 (explaining that, for example, a cooperative can participate in a share solar project as an entity in itself, and then "reduce co-op fees proportionally to offset electricity credits from a shared solar system").

132. Pooled solar could be structured like a rental agreement between one landlord and multiple tenants, or as a joint holding, like a co-op time-share kind of arrangement. FELDMAN ET AL., *supra* note 23, at 19. With regard to tax credits, "[f]ederal tax credits that support PV deployment historically have been designed for use by a single entity; shared solar projects that involve multiple entities can pose challenges to allocating tax-credit benefits. However, in some instances, shared solar programs can function similarly to single-entity solar projects for tax-credit purposes." *Id.* at vi.

133. *See supra* note 51 and accompanying text (discussing offsetting consumption of electricity by a single owner).

134. Of course residents of the building would still need a mechanism to figure out their contributions and gains from this shared system. In this case, the mechanisms for managing other shared amenities in the building could provide a useful framework.

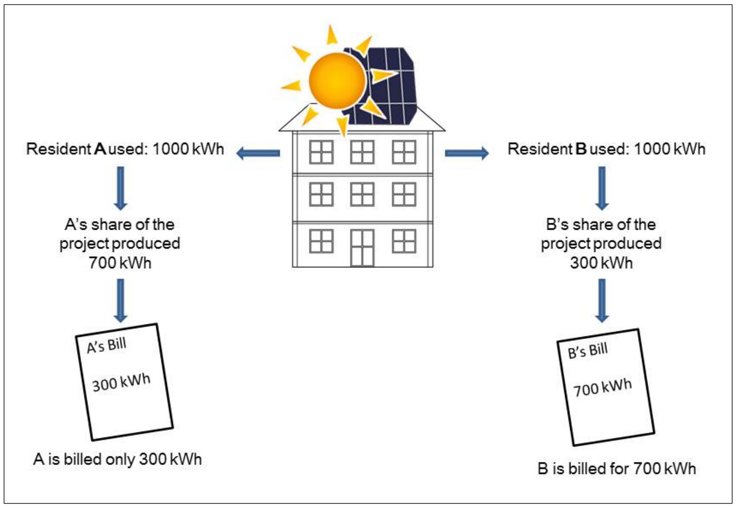

Figure 1: On-site Shared Distributed Generation

In the hypothetical example above, residents in the building are sharing the entitlements to the solar panel or battery and the "fruit" it produces in the form of electricity. They are not sharing their individual consumption. Nor are they, necessarily, sharing their financing mechanisms. They could each be financing their investment in the joint project from completely different sources. The shared element, again, pertains just to the distributed generation itself—the facility and the equipment (i.e., the roof, panel, basement, battery) and the fruit it produces (i.e., the electricity).

Also note that in the example above, the sharing mechanism is prorated to the residents' investment in the joint project. But that need not be the case. We can imagine a range of sharing mechanisms; for example, each resident could get electricity (watts) equivalent to their share in the building's total area (e.g., if Resident A's apartment is 1000 square feet, out of the total 10,000 square-foot built area in the building, Resident A would get ten percent of the produced watts).[135] The point is that a wide range of sharing mechanisms could be applied toward a joint solar panel or battery.

b. *Off-site We-Solar*

The second model of We-Solar pertains to *off-site* production. In this case, imagine a solar array located on a neighborhood school, or on top of a shopping mall. Participants can purchase or subscribe to portions of this larger solar array, again, much like renting a parking spot in a larger parking garage.

135. The relative merits and shortcomings of various sharing mechanisms deserve a separate discussion, which I leave for future work.

So, what do participants in We-Solar get, when the solar arrays are off-site? Participants can either get kilowatt-hour equivalents deducted from their electricity bill, or some other form of credits, in correlation with their share in the solar project.[136] When the solar (or, potentially, battery) project is further away, a mechanism is required to "translate" the equivalent of production at the project site to reductions in the consumers' electricity bill at another location. Some states have "virtual net metering" programs, which allow participants to get the direct benefits from electricity generation that is not physically located at the same place as the consumer's meter.[137]

To illustrate, assume you used 1000 kWh of electricity last month.[138] You have also leased a portion of an off-site We-Solar project. Your portion in that project has produced 700 kWh of electricity this month. For the production of your solar patch you get 700 kWh worth of credits. Your electricity bill then shows a charge of only 300 kWh, which is the difference between your consumption (1000 kWh) and the electricity you contributed through your solar patch (700 kWh). Figure 2 illustrates.

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136. *See* FELDMAN ET AL., *supra* note 23, at vi ("Electricity benefits are typically allocated on a capacity or energy-production basis. Participants in capacity-based programs own, lease, or subscribe to a specified number of panels or a portion of the system and typically receive electricity or monetary credits in proportion to their share of the project.").

137. *Id.* ("[Virtual Net Metering] enable[s] the allocation of benefits from an electricity-generating source that is not directly interconnected to the energy consumer's electricity meter."); Nat'l Renewable Energy Lab., *Net Metering*, https://www.nrel.gov/state-local-tribal/basics-net-metering.html (last visited Mar. 29, 2019) ("Virtual net metering utilizes the same compensation mechanism and billing schemes as net metering, without requiring that a customer's [distributed generation] system . . . be located directly on site . . . . Net metering credits appear on a customer's bill as if the distributed generation were actually located on his or her property."). The policies for virtually crediting off-site distributed generation vary per state. SMART ELECTRIC POWER ALLIANCE, *supra* note 132, at 5 (2018) ("Currently, 17 states plus the District of Columbia have enacted shared solar policies . . . . [P]roposed legislation has been introduced in at least nine states . . . to open or expand existing community solar programs in the last year."). State virtual net metering policies have been found to "often (but not always)" drive growth in the relevant jurisdiction. *Id.* at 9. However, some states restrict the use of virtual net metering., FELDMAN ET AL., *supra* note 23, at 12 ("Connecticut restricts VNM to municipal, state, or agricultural customers . . . . Other states do not have regulatory frameworks in place that explicitly allow alternative bill credit mechanisms.").

138. The average American home uses about 900 kWh per month. *Frequently Asked Questions: How Much Electricity Does an American Home Use?*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/tools/faqs/faq.php?id=97&t=3 (last visited Jun. 11, 2018).

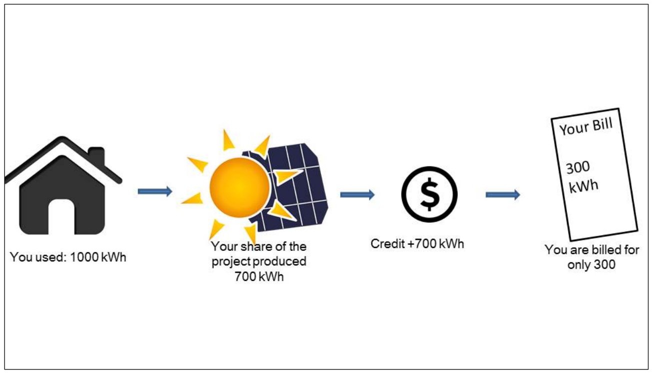

Figure 2: How Off-site Shared Solar Works

Off-site We-Solar projects are managed, primarily, by third-party providers.[139] However, in some cases a utility runs the projects. This arrangement mostly arises when the utility is structured as a cooperative utility (as compared to investor-owned utilities and public power utilities).[140] Importantly, even when the We-Solar project is administered by a utility, it is not a utility-scale project. It still retains the characteristics of distributed generation in terms of scale, direct participation, and the proximity to the users. In classic utility-scale production, a single entity installs a very large solar facility. (To illustrate the vast difference in scale: most off-site We-Solar projects have a generating capacity of less than 1 MW;[141] whereas utility-scale solar projects usually have a capacity of about 50 MW.[142]) These huge projects are typically located far from population concentrations. The electricity produced from such a utility-scale project is then sold into the main grid. Individual customers purchase electrons off the grid,

139. *See* SMART ELECTRIC POWER ALLIANCE, *supra* note 129, at 6 ("A majority of the total installed capacity is being administered by a third-party community solar provider. These organizations are responsible for 495 MW, or approximately 67% of the total installed capacity.").

140. *See id.* at 8 ("In terms of the number of community solar programs, cooperative utilities have been trailblazers. At present, 160 cooperative utilities have a program in their territory. This far exceeds the total in investor-owned utilities (31 programs) and public power utilities (37 programs) combined.").

141. *See* SMART ELECTRIC POWER ALLIANCE, *supra* note 129, at 8 ("Only 30% of programs have a total generating capacity greater than 1 MW.").

142. *Renewable Energy in the California Desert: Mechanisms for Evaluating Solar Development on Public Lands*, UNIV. OF MICH. SCHOOL OF NAT. RES. AND ENV'T., http://webservices.itcs.umich.edu/drupal/recd/?q=node/154 (last visited Aug. 14, 2018) ("While there is currently no set definition of utility-scale solar, these facilities generally have a nameplate capacity of over 50 MW and produce electricity that is fed back into the electric grid."). Notably, though, utility-scale solar comes in a wide range of sizes. *See* Patrick Donnelly-Shores, *What Does 'Utility-Scale Solar' Really Mean?*, GTM RESEARCH (Jul. 13, 2013), https://www.greentechmedia.com/articles/read/what-does-utility-scale-solar-really-mean#gs.3ECv2NU (last visited Aug. 14, 2018).

regardless of how and where the electrons were produced. In the case of shared solar, in contrast, consumers are subscribing to a patch of solar panels at a specific nearby location, for a specific use.[143]

c. *Microgrids and crowd-funding solar*

In between those two types of We-Solar—directly on-site and completely off-site—there could be a range of options with regard to the location of the panels (or batteries) and the mechanisms by which participants get their electricity. One example is a "microgrid", which is essentially a small interconnected electricity-network. A microgrid may also connect to the external grid.[144] The Brooklyn microgrid typifies a microgrid in a residential neighborhood,[145] although more common examples include college campuses and corporate headquarters. In the case of We-Solar within a microgrid, even if the project is not directly on-site, the offsets could still be delivered fairly directly, since there is potentially no need to go through the larger grid. In that sense, it operates like off-site production but with on-site-like delivery.

Notice, also, the distinction between *shared* solar and *crowd-funded* solar. In the latter case, a developer seeks to finance a solar generation project through crowd-funding.[146] This means that contributors (the crowd) put money toward a project, but the project does not necessarily provide them with a direct property interest in a specific solar panel. Nor do they get watts offset from their electric bill or the equivalent thereof. They simply get a monetary return on their investment, like with any other type of investment. Moreover, a project financed by crowd-funding does not have to be distributed; it can be utility-scale, for that matter. To understand the distinction, think of the difference between crowd-funding to raise money for an investment in a new building, and leasing a specific apartment in the building. Thus, one could invest in crowd-funded solar and get a monetary return on that investment (just

143. To be clear, unless the WeSolar is on-site, what the users are getting is the same amount of electrons their solar panels produced (or equivalent credits), but they do not necessarily get the specific electrons that were produced there. To illustrate the distinction, think of the way our money system works: the return on an investment you made is directly tied to the specific asset you invested in. You get back exactly the amount generated by your investment in a given period. But you don't get back the exact same dollar-bills you put in. Rather, you get the currency equivalent.

144. Microgrids provide "small-scale prosumers and consumers with a market platform to trade locally generated energy within their community". Esther Mengelkamp et al., *Designing Microgrid Energy Markets: A Case Study: The Brooklyn Microgrid*, 210 APPLIED ENERGY 870, 871 (2018). They do not necessarily have to be physically interconnected: "[v]irtual microgrids are the aggregated control of multiple energy producers, prosumers, and consumers in a virtual community" *Id.* Microgrids can either be connected to the larger grid or work in "island-mode". *Id.*

145. *See id*. at 875-79 (providing a detailed review of the Brooklyn microgrid).

146. One example of crowd-funding via a blockchain based platform is WePower. *Project Financing*, WEPOWER, https://wepower.network/project-financing (last visited Jul. 31, 2018).

like any other investment), and regardless have a specific solar panel from which the household or business consumption is offset.

The following chart summarizes the types of We-Solar projects and the differences between them.

Type	**Location**	**What you get**	**Number of Participants**
Classic rooftop solar/ basement battery	On-site	Electricity	Single
Direct on-site We-Solar (e.g., multi-unit house)	On-site	Electricity	Multiple
Microgrid We-Solar	On-site/ Off-site	Electricity	Multiple
Off-site We-Solar (e.g., on local school)	Off-site	Electricity / credit equivalents	Multiple
Crowd-funding Solar	Off-site	Monetary return on investment	Multiple
Peer-to-peer energy trading	On-site	Electricity (buyer); monetary compensation (seller)	Multiple

d. *The key advantages of We-Solar*

Shared solar can solve the property barriers through property-based tools. First, the pooling mechanisms answer home-renters' needs for flexibility and mobility. They create a kind of "follow me" solar in that sense. If you move to a different city or neighborhood, you can either move your shared solar with you or sell it.[147] Second, and relatedly, shared solar allows distributed energy to be consumed at sites other than where it was generated, and in that way overcomes the specificity of

147. *See* FELDMAN ET AL., *supra* note 23, at 4 ("In the event a customer moves, his or her solar share can be transferred separately from his or her residence to a new home within the same utility service territory or sold to another entity."); *id.* at 33 ("Shared solar is also potentially more attractive because it is more fungible than ownership of an on-site PV facility. Having an easier exit option over the lifetime of the solar investment may make it more attractive to potential customers.").

location that otherwise characterizes and limits solar generation.[148]

Because of these advantages, in some cases even homeowners or business owners that do have the necessary property rights to install a solar panel or battery might choose to participate in one of the We-Solar options.[149]

Shared solar also enables other types of users to participate in distributed generation, in addition to renters, who are otherwise limited in their ability to install solar PV. Most notable among these other users are those who live in high-rise buildings or multi-unit housing. High-rise dwellers often face restrictions on their ability to install solar PV (or large batteries, for that matter), since they typically do not own a specified portion of the roof, but rather are designated tenants in common.[150] Collective action problems might make it harder for a large number of residents to get together and agree to install solar panels on the roof or batteries in the basement. Multi-unit buildings also have a smaller rooftop-per-built area ratio than single-unit buildings, which means that the amount of electricity each apartment can produce is smaller.[151] This category makes up a significant portion of the market: the National Renewable Energy Laboratory (NREL) estimates that approximately thirty-six percent of U.S. households reside in buildings of five units or more.[152]

Lastly, another group that might benefit from We-Solar options are those living in buildings that do not have the *physical* conditions that allow solar PV (or batteries) due to the size of their roof or other parameters.[153] Although the problem in these cases is not one of misaligned property rights, but rather the physical attributes of the building, this group of residents could benefit from We-Solar nonetheless.

Taken together, including renters and high-rise dwellers, and any others who do not have physical conditions that allow solar PV,—NREL

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148. *See* Part III.A *supra* (discussing the importance of location-specific activities).

149. *See* DAVID FELDMAN & ROBERT MARGOLIS, TO OWN OR LEASE SOLAR: UNDERSTANDING COMMERCIAL RETAILERS' DECISIONS TO USE ALTERNATIVE FINANCING MODELS (Nat'l Renewable Energy Lab. 2014) (explaining the tradeoffs involved in each option for those that have the ability to choose between them).

150. *See* FELDMAN ET AL., *supra* note 23, at 22 ("High-rise buildings and/or multi-unit housing can present barriers to customers hosting a PV system because individual owners typically do not own a specified portion of the roof space.").

151. *Id.* ("[T]he roof space per household is frequently very small, particularly for high-rise buildings, meaning that the proportional electricity production credit allocation per unit owner will likewise be small").

152. *Id.* at 22 fn. 23. Note that there is significant overlap between the percentage of residents who are renters and the percentage who live in multi-unit residences.

153. *Id.* at 24. There is some variability depending on the region of the country. In the Northwest, 73% of buildings have enough suitable rooftop space in order to host a PV system, as compared to 86% of residential buildings in the Southwest. *Id.*

estimates that forty-nine percent of households and forty-eight percent of businesses in the United States are unable to host a solar PV system.[154] Thus, "shared solar has the potential to *double* the commercial market by offering PV to the [forty-eight percent] of businesses that cannot host a PV system."[155] Opening the market for these participants is, thus, very significant.

4. *Facilitating peer-to-peer energy trading*

The next step in the penetration of distributed generation, as mentioned, is peer-to-peer energy trading. The idea is that, in addition to using the electricity from your solar panel for self-consumption, you can sell it to your neighbor. Your neighbor, in turn, can choose to buy electricity from you (or from other neighbors), or from the grid. In that sense, peer-to-peer energy trading opens up a whole range of possibilities for those who cannot otherwise install solar panels or batteries in their residences or businesses. It gives them a way to access electricity that was produced in a distributed manner, directly from where it was produced.

Although peer-to-peer energy trading is only in its infancy, its popularity will likely increase as the technology evolves to make it easier and quicker for users.[156] A few platforms that enable peer-to-peer energy trading have already emerged or are currently being tested.[157] One example is Power Ledger, an Australian based company that uses blockchain-based technology to create a platform for trading solar energy among neighbors. Power Ledger has been running pilot programs in Australia and New Zealand since 2016 and has recently launched its first commercial application in Chicago.[158] Other

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154. *Id.* at v (stating that forty-nine percent of households and forty-eight percent of businesses in the U.S. are unable to host a solar PV system; "[S]hared solar could represent 32%–49% of the distributed PV market in 2020, thereby leading to growing cumulative PV deployment growth in 2015–2020 of 5.5–11.0 GW, and representing $8.2–$16.3 billion of cumulative investment.").

155. FELDMAN ET AL., *supra* note 23, at 30 (emphasis added).

156. *See* David Spence, *Blockchain and Electricity Trading: In Praise of (Regulatory) Skepticism*, SABIN CENTER FOR CLIMATE CHANGE LAW, CLIMATE LAW BLOG (Feb. 21, 2018), http://blogs.law.columbia.edu/climatechange/2018/02/21/blockchain-and-electricity-trading-in-praise-of-regulatory-skepticism/ ("The Brooklyn Microgrid is an ongoing experiment in blockchain-based local electricity trading, and the State's "Reforming Energy Vision" program promises to actively promote P2P electricity trading in New York.").

157. For a review of the current available projects, *see generally* Chenghua Zhang et al., *Review of Existing Peer-to-Peer Energy Trading Projects*, 105 ENERGY PROCEDIA 2563 (2017); Yue Zhou et al., *Performance Evaluation of Peer-to-Peer Energy Sharing Models*, 143 ENERGY PROCEDIA 817 (2017).

158. *See* Butcher, *supra* note 3.

blockchain-based peer-to-peer platforms are being tested in Brooklyn[159] and in East London.[160]

Of the types of We-Solar discussed in this Article, the peer-to-peer model comes closest to what we think of as the "sharing economy." Putting your surplus electricity up for sale is just like renting out an extra room on Airbnb. Intuitively, it makes good use of the resource.[161] Thus, peer-to-peer energy trading is an appealing option available on the We-Solar menu.

At the same time, peer-to-peer trading is restricted by the fact that at least thirty percent of U.S. residents and businesses do not have property entitlements that would support their participation.[162] This reality is especially clear from energy seller's perspective (one needs to have a solar panel in order to sell the excess energy from that same panel). Even from the buyer's side, smart-monitors are necessary in order to participate in a sophisticated peer-to-peer market, requiring installations in the residence or commercial real estate.

In that sense, peer-to-peer trading is not only another option on the We-Solar menu; it is enabled by the other We-Solar options on the same menu. To illustrate, consider the following hypothetical. Assume again that you are renting your current residence, and that you have chosen to participate in your building's We-Solar project. You get your pro-rated portion of electricity every month. Suppose you go away for the summer, or even just the weekend. What do you do with your electricity? You can sell it through a peer-to-peer platform to your neighbor, either in the same building, or across the street. In this example, your participation in the We-Solar project enabled your

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159. *See* Diane Cardwell, *Solar Experiment Lets Neighbors Trade Energy Among Themselves,* NEW YORK TIMES (Mar. 7, 2017); *"It's Like the Early Days of the Internet," Blockchain-based Brooklyn Microgrid Tests P2P Energy Trading*, MICROGRID MEDIA (Mar. 9, 2016), http://microgridmedia.com/its-like-the-early-days-of-the-internet-blockchain-based-brooklyn-microgrid-tests-p2p-energy-trading/. To clarify, there are several other blockchain-based applications for energy (for a review, *see* COLLEEN METELISTA, GTM RESEARCH, BLOCKCHAIN FOR ENERGY 2018: COMPANIES & APPLICATIONS FOR DISTRIBUTED LEDGER TECHNOLOGIES ON THE GRID (Mar. 2018)). The focus here is specifically on those applications that enable the trade of electricity between distributed generation agents.

160. Liam Stoker, *Blockchain-powered P2P Energy Trading On Trial at Britain's Biggest Social Housing PV Installation*, PVTECH (Nov. 22, 2017), https://www.pv-tech.org/news/blockchain-powered-p2p-energy-trading-on-trial-at-britains-biggest-social-h.

161. *See supra* notes 90-91 and accompanying text (discussing the sharing economy and why it makes sense to rent out your extra bedroom). Note the distinction the literature on the sharing economy draws between shared ownership of a resource (like a shared roof of an apartment building) and sharing-over-time of otherwise underutilized assets (like spare rooms through Airbnb). *See* Dyal-Chand, *Regulating Sharing: The Sharing Economy as an Alternative Capitalist System*, *supra* note 90; Finck & Ranchordas, *Sharing and the City*, *supra* note 90).

162. *See supra* notes 95-99 and accompanying text (stating that over a third of residents in many U.S. cities are renters, who are limited in their ability to participate in distributed energy resource ventures). In addition to the property rights threshold, there are regulatory requirements that must be satisfied in order for a P2P market to operate successfully. I reserve the discussion of the latter regulatory issue for future work.

participation in the peer-to-peer market.

B. *Private Law-Based Climate and Energy Litigation*

Understanding the importance of private law to energy helps us identify the ways in which the underlying property rights impact the spread of distributed energy. It also has broader implications for energy law and policy. The central point here is that involving property holders (either owners or renters) in energy production en masse creates a new interest group in energy law and policy. In a world where consumers are no longer just electricity buyers, the property holders' interest group might seek to advance or protect its interests through various channels. They might do so through political channels (for example, by protesting city efforts to rezone areas in ways that inhibit access to sunlight or prevent the installation of batteries in buildings). Another way in which they might seek to advance their interests is through property-based litigation.

The notion of using private law tools for shaping public policy is not in itself a new one. For example, litigants seeking to prevent fracking activities in particular areas have sued in trespass, a tort based on property entitlements in land.[163] However, the increased involvement of property law in energy operations opens new avenues for using private law tools in climate and energy contexts.

As a doctrinal matter, trespass and private nuisance are known as "property torts" and are rooted in property holdings. According to the Restatement Fourth of Property, which is underway, "[a] trespass to land is an intentional physical intrusion upon land possessed by another that interferes with other's interest in exclusive possession."[164] Trespass thus involves intrusions upon land, and the requirement to hold property rights in land in order to make such a trespass claim is imbedded within. Under private nuisance, "an actor is subject to liability to another . . . if the actor engages in an activity, or is responsible for a condition, that substantially and unreasonably interferes in a nontrespassory manner with the use and enjoyment of land in the other's possession."[165] Here again, holding property entitlements is a prerequisite to bringing suit under private nuisance. Trespass and private nuisance are both essentially ways of protecting the property entitlements. They are vehicles through which right-holders can act to defend their

163. Coastal Oil & Gas Corp. v. Garza Energy Tr., 268 S.W.3d 1, 11 (Tex. 2008) (holding that injection of fluid and proppants (a mixture of materials used in the fracking process) beneath neighboring lands did not amount to trespass).

164. RESTATEMENT (FOURTH) OF PROP ch. 1 § 1 (AM. LAW INST., Tentative Draft No. 3, 2017).

165. *Id.*

entitlements.[166]

In an age when increasing numbers of property holders are involved in the energy cycle, one can also imagine increasingly numerous opportunities to use the property holdings and the doctrinal tools available to defend them as a platform for shaping energy and climate policy.

Municipalities have used property rights to ground energy and climate litigation. As an example—although not in a distributed context—on January 9, 2018, New York City filed suit against several major oil companies, including British Petroleum (BP), Chevron, ExxonMobil and Shell.[167] The City claims the oil companies are responsible for harms caused by the use of fossil fuels, which results in global warming. Although the New York suit has been dismissed,[168] it remains notable that the claims were not based on an alleged violation of public law doctrines. Rather, they were anchored in private and public nuisance and trespass on city property.[169] Recall that private nuisance and trespass are available to property owners or holders of property in land, and can serve as a tool for allowing right-holders to defend their interest in the property. Thus, the city in this case is suing in its capacity as a landowner. Several other municipalities across the nation have filed similar suits against Big Oil corporations anchored in private law claims, including trespass and nuisance.[170]

Regardless of whether these municipalities-versus-Big-Oil suits succeed (and which yard-stick we use to measure their success), they demonstrate the potential for property holders to bring suits based on climate- and energy-related harms to their property interests. In an era when new avenues for electricity production have opened up, and so many property holders are involved in the energy system—including basically anyone with a solar panel on their roof, or anyone who cannot

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166. *See* Henry E. Smith, *Exclusion and Property Rules in the Law of Nuisance*, 90 VA. L. REV. 965, 992 (2004); Thomas W. Merrill, *Trespass, Nuisance, and the Costs of Determining Property Rights*, 14 J. LEGAL. STUD. 13, 14 (1985); MERRILL & SMITH, PROPERTY: PRINCIPLES AND POLICIES, *supra* note 85, at 1-16 (discussing generally the use of trespass to defend, and to some extent define, property in land).

167. City of N.Y. v. BP P.L.C., 325 F. Supp. 3d 466 (S.D.N.Y. 2018).

168. *Id.* at 476.

169. *Id.* at 470. *See also* RESTATEMENT (THIRD) OF PROP., (AM. LAW INST., Tentative Draft No. 3, 2017) (discussing property torts). Private nuisance is based on property holdings, as opposed to public nuisance. On the latter, *see generally* Thomas W. Merrill, *Is Public Nuisance a Tort?*, 4 J. TORT L. (2011).

170. *See, e.g.,* City of Oakland v. BP P.L.C., 325 F. Supp. 3d 1017 (N.D. Cal. 2018); California v. BP P.L.C., WL 1064293 (N.D. Cal. Feb. 27, 2018); City of San Mateo v. Chevron Corp., 294 F. Supp. 3d 934 (N.D. Cal. 2018), *appeal docketed*, No. 18-15499 (9th Cir. Mar. 27, 2018); King County v. BP P.L.C 2018 WL 4385454 (W.D.Wash. 2018); Mayor and City Council of Baltimore v. BP P.L.C., 1:18-cv-02357-ELH (D. Md. 2018); State of Rhode Island v. Chevron Corp., 2018 WL 4203808 (D.R.I. 2018). Like the New York suit, several of these municipal suits have also been dismissed, and others are under appeal. They serve, nonetheless, to show the potential for use of private law-based litigation.

install one because of restrictive property rights——new litigation avenues may open up as well.

V. CONCLUDING REMARKS

Fundamental changes are underway in our energy system. The central utility model that has dominated the generation of electricity over the past century is increasingly evolving into a much more dispersed model. In the era of distributed generation, individuals with solar panels on their roofs and batteries in their basements are active participants in the system. Along with the shifts in the energy systems comes a shift in the legal management tools.

This Article seeks to add another lens through which to view the energy picture. It shows that in the era of private energy, fields of private law, including property and contracts, are becoming an increasingly important part of the picture. It strives toward a more nuanced understanding of our energy management, one which undertakes both the private and the public law aspects of the system. And much like the energy system itself has become more of a dialogue between the central and the distributed, so have the management tools employed to govern it. The private and the public law aspects are in conversation in the energy sphere, and complement each other in many ways, that we are only now beginning to understand.

Property was traditionally seen as significant primarily for the resource side of the energy system. Today, however, with the rise of distributed generation, property also plays a role on the production and consumption sides of the energy system. This new property-energy connection can be summarized as follows: if you want to put a solar panel on your roof, it has to be *your* roof. In other words, you need the right property rights. Thus, although individuals can now participate in the energy field in avenues that previously were not available to them, their participation is enabled by a web of underlying rights to specific locations and resources. These rights can act to either facilitate or inhibit the advancement of specific energy policies. Policy-makers seeking to advance the adoption of distributed generation should thus pay attention to the underlying web of private law rights and obligations.

One insight that emerges from this private energy analysis is the ability of property regimes to shape policy. Though we can imagine torts playing a role in shaping public opinion and public policy, we do not usually think of property in the same way. We can imagine how a well-publicized torts case can bring about a shift in public policy, but typically we do not think our agreement with our landlord will similarly impact public policy. This Article, however, begins to shed light on the ways in which that might occur and, on the dialogue between the private and public domains in this regard.

Private energy analysis could also inform the discussion regarding the distributional impacts of distributed generation. Some energy law scholars have correlated the shifts toward more participatory energy mechanisms with a new "Energy Democracy."[171] Although the democratization of the energy field has been criticized on other grounds,[172] the private energy analysis adds another layer to that critique: "full" ownership is (at least at present) a precondition for participating in the new era of distributed generation. If property is a precondition for participation, that entails a significant barrier to entry. One may thus question to what extent the shifts in energy production truly represent a democratic turn.

While this Article focuses primarily on the new *property*-energy connection and its implications, other aspects of private law could emerge as significant in the age of distributed energy. Consider, for example, the implications for distributed energy *contracts*. When you trade your electricity with your neighbor, you are inevitably entering into some contract with her. The platform through which you trade the electricity (for instance, a blockchain-based microgrid) likely involves a contract as well. And when you decide to join a We-Solar venture, you are most likely entering into a contract. Energy contracts are thus posed to become both ubiquitous and influential as distributed energy evolves.

Lastly, the next major energy transition could come from peer-to-peer trading. This analysis began to unpack the implications of this nascent shift, although whether and how it changes our energy world is yet to be seen. What does it mean to own electricity for the purpose of selling it to your neighbor? Is electricity tangible or intangible, and should that affect how we think of property therein? These questions remain open for the time being. What is clear at the moment is that electricity trading among individuals in a dispersed manner will require a more nuanced understanding of our energy system, one that accounts for both the public and the private aspects of the world of private energy.

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171. *See generally* Welton, *Grasping for Energy Democracy*, *supra* note 1 (providing an insightful review and a critique of the literature on energy democracy).

172. *See id.*