MANAGING THE FUTURE OF THE ELECTRICITY GRID: DISTRIBUTED GENERATION AND NET METERING

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Abstract

As distributed energy generation is becoming increasingly common, the debate on how a utility's customers should be compensated for the energy they sell back to the grid is intensifying. And net metering, the practice of compensating for such energy at the retail rate for electricity, is becoming the subject of intense political disagreement. Utilities argue that net metering fails to compensate them for grid construction and distribution costs and that it gives rise to regressive cost shifting among customers. Conversely, solar energy proponents argue that the compensation should be higher than the retail rate to account for other benefits that distributed generation systems provide, such as greenhouse gas emission reductions, improved air quality, and reduced utility spending on new capacity installations. This ongoing debate is leading to significant changes to net metering policies in many states.

This Article provides a thorough analysis of benefits and costs of distributed generation. It also highlights the analytical flaws and missing elements in many of the competing positions and existing state policies. We propose an alternative approach that properly recognizes the respective contributions to the electric grid of utilities on the one hand and of distributed generators on the other. We show, however, that this policy is second-best as a result of certain constraints on how electricity can currently be priced. For the longer run, when these constraints might no longer be present, we discuss the need to consider net metering as part of a more comprehensive energy reform that would ensure the efficient integration of all types of distributed energy resources into the electricity grid. These reforms are needed to secure our Nation's clean energy future.

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Introduction

"Distributed generation" is a term used to describe electricity that is produced at or near the location where it is used.[1] Distributed generation systems, also known as "distributed energy resources," can rely on a variety of energy sources, such as solar, wind, fuel cells, and combined heat and power.[2] Distributed solar energy is produced by photovoltaic cells, popularly referred to as solar panels, which can be placed on rooftops or mounted on the ground.[3] Over 90% of the current distributed generation capacity in the United States is solar,[4] and

1. *Distributed Solar*, Solar Energy Indus. Ass'n, https://perma.cc/MA74-45JJ.
2. Am. Pub. Power Ass'n, Distributed Generation: An Overview of Recent Policy and Market Developments 3 (2013), https://perma.cc/62YC-P85G.
3. *See id.* at 2–3.
4. *Id.*

the number of installations is increasing rapidly.[5] Even though distributed generation still accounts for a relatively small fraction of total energy generation nationwide, it is becoming increasingly important as many states are in the process of changing their utility structures and regulatory policies to accommodate more distributed energy resources.[6]

Some distributed generation systems are isolated, in that they are not connected to a utility's power grid, but most are "grid-tied," which means that they are connected to the grid.[7] Customers with connected distributed generation systems can buy power from their electric utility when they are not producing enough electricity to meet their needs, and they can sell power back to the utility company when their systems are producing more electricity than they are using.[8] This possibility raises the important question of how these customers should be compensated for the electricity they send to the grid.

This compensation question has three critically significant policy implications. First, it plays a key role in determining the economic feasibility of clean electricity relative to electricity produced by fossil fuels. Unlike electricity produced from solar, wind, or hydro sources, electricity produced from fossil fuels gives rise to large quantities of pollutants that affect public health, as well as greenhouse gases that lead to climate change.[9] Second, distributed generation has benefits for the resiliency of the electric grid, as it provides a more diversified portfolio of energy sources than schemes that rely exclusively on electricity produced by large power plants.[10] The serious electric outage in New York City during Superstorm Sandy, which caused enormous economic dislocations, illus-

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5. *See* Interstate Renewable Energy Council, Trends Shaping Our Clean Energy Future: The 2014 IREC Perspective 25 (2014), https://perma.cc/359X-ZMTW [hereinafter IREC, Trends Shaping Our Clean Energy Future].

6. *See, e.g.*, *DPS—Reforming the Energy Vision,* N.Y. Dep't Pub. Serv., https://perma.cc/BB5Y-VFPA (announcing broad regulatory changes that promote "wider deployment of 'distributed' energy resources"); D.C. Pub. Serv. Comm'n, Formal Case 1130, Comment on the Scope of the Proceeding 2 (Aug. 31, 2015), https://perma.cc/EG5M-PK68 (calling for grid modernization with a "focus on deployment of distributed energy resources"); Mass. Dep't of Pub. Utils., Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid, D.P.U. Order 12-76-B, 2 (June 12, 2014), https://perma.cc/6FZR-8J5Q (requiring every Massachusetts electric provider to submit a 10-year plan outlining how the utility will "integrate[ ] distributed resources").

7. Today, over 95% of solar installations are grid-tied. *Net Metering*, Sunlight Elec., https://perma.cc/6S48-YKKQ.

8. Edison Elec. Inst., Straight Talk About Net Metering 1–2 (2016), https://perma.cc/E5FF-C54F.

9. *See Sources of Greenhouse Gas Emissions*, EPA, https://perma.cc/G626-BR9E (noting coal combustion represents 39% of electricity generation but 77% of CO_2 emissions from electricity generation sector).

10. Devi Glick et al., Rocky Mountain Inst., Rate Design for the Distribution Edge: Electricity Pricing for a Distributed Resource Future 16 (2014), https://perma.cc/JNK4-52T7.

trated the negative consequences of a lack of diversification.[11] Finally, the details of how distributed generation is compensated for various benefits relative to utility-scale renewable generation will affect the composition of future clean energy projects. A price that is inconsistent with the actual benefits provided by distributed generation relative to utility-scale renewables would lead to inefficiently low or inefficiently high penetration of distributed generation, and may hinder policy goals such as achieving clean energy targets in a cost-effective manner.

President Obama's energy policy initiatives have sought to accelerate the nationwide deployment of clean energy resources, like solar power.[12] In August 2015, the President announced $1 billion in loan guarantees for distributed generation projects, particularly residential solar, and $24 million in new grants for solar research and cost reduction efforts.[13] As the use of distributed generation intensifies, it becomes more important to create the right incentives for distributed generation. A variety of government policies, such as tax subsidies for renewables, encourage the development of distributed generation.[14] This Article focuses on the incentive that is currently receiving the most attention and scrutiny: the pricing for distributed generation.[15]

Net metering is the most commonly used approach for setting such a price, though it is increasingly being challenged.[16] The "traditional" net metering approach is functionally equivalent to having a single meter that runs forwards when the customer needs more power than she produces, and backward when she sends excess power to the grid because she produces more power than she needs.[17] At the end of the billing period, the customer is billed at the retail electricity rate—which is the volumetric rate a residential customer pays per kilowatt-hour (kWh) of electricity usage—for the net power used.[18] Thus, in

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11. Peter Fox-Penner, Brattle Grp., Public Power in the Age of Smart Power 12 (2014), https://perma.cc/J99P-2HUQ.

12. *See, e.g.*, U.S. Dep't of Energy, SunShot Vision Study (2012), https://perma.cc/7TFR-UUVG.

13. *President Obama Announces New Actions to Bring Renewable Energy and Energy Efficiency to Households Across the Country*, Office of the White House Press Secretary (Aug. 24, 2015), https://perma.cc/KUQ4-JJVQ; *accord* President Barack Obama, Remarks at National Clean Energy Summit (Aug. 24, 2014) ("[W]e're going to make it even easier for individual homeowners to put solar panels on their roof with no upfront cost.").

14. *See* U.S. Energy Info. Admin., Direct Fed. Fin. Interventions & Subsidies in Energy in Fiscal Year 2013, at 15–19 (2015), https://perma.cc/EW42-AJHA.

15. *See, e.g.*, Straight Talk, *supra* note 8 (laying out electric industry arguments against net metering).

16. *Id.*

17. *Id.* at 2.

18. *Id.*

effect, net metering policies pay distributed generation suppliers at the retail rate for their excess generation.[19]

As of October 2016,[20] forty-five states and the District of Columbia compensated utility customers with distributed generation for the power they generated.[21] Although such policies are regularly grouped together as "net metering," they exhibit significant variations.[22] Many jurisdictions, for example, employ the traditional net metering scheme. Some jurisdictions use traditional net metering, but switch to lower rates once a customer's net energy consumption falls below zero. Other jurisdictions mandate different prices for a customer's purchases and sales, a buy all/sell all scheme that usually requires two different meters in order to track consumption and production separately. In states where the public utility commissions have set a different compensation scheme for excess generation, distributed generation sold to the grid often commands a lower price than the retail rate customers pay utilities for electricity.[23] Typically, these lower rates are based on a utility's "avoided cost": the cost the utility would incur if it had to provide one more unit of electricity itself.[24] Moreover, several jurisdictions impose special charges, such as standby charges,

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19. Naïm R. Darghouth et al., Lawrence Berkeley Nat'l Lab., LBNL- 183185, Net Metering and Market Feedback Loops: Exploring the Impact of Retail Rate Design on Distributed PV Deployment 1 (2015), https://perma.cc/Y7GK-69WW.

20. Information on current state policies are based on the best available data sources at the time that this manuscript was being prepared for publication. Due to the fast-changing nature of this policy arena, readers are encouraged to check the cited databases for any updated policy information.

21. The only states that do not offer a statewide net metering policy are Alabama, Idaho, South Dakota, Tennessee, and Texas. Best Practices in State Net Metering Policies and Interconnection Procedures, Freeing the Grid 2015, https://perma.cc/USG7-HR3U [hereinafter Best Practices]. Though not a state-initiated program, Alabama and Tennessee all offer feed-in tariff compensation, discussed *infra*, through the Tennessee Valley Authority utility. *Feed-in Tariffs & Similar Programs,* U.S. Energy Info. Admin. (June 4, 2013), https://perma.cc/FYV4-Y8KD [hereinafter EIA, *Feed-in Tariffs & Similar Programs*]. Austin, Texas and the state of Minnesota offer compensation through a "value-of-solar" program. Thomas E. Hoff & Ben Norris, Clean Power Research, 2014 Value of Solar Executive Summary, 3 (2013), https://perma.cc/45PJ-F4XW; Thomas E. Hoff & Ben Norris, Clean Power Research, Minnesota Value of Solar: Methodology, at ii (2014) https://perma.cc/V7FW-CPA7 [hereinafter Minn. VOST].

22. *See generally* Best Practices, *supra* note 21.

23. *Id.*

24. *Id.* As of 2015, Mississippi, Missouri, Nebraska, Nevada, New Mexico, North Dakota, and Rhode Island reconciled excess generation monthly at avoided cost rates. *Id.* Ohio credited net excess generation to customer's next bill at the utility's unbundled generation rate. *Id*. At the moment, a number of states are considering proposals that would reduce the rate paid for net excess generation to avoided cost. *See generally* N.C. Clean Energy Tech. Ctr., The 50 States of Solar Q1 2016 Quarterly Report (2016), https://perma.cc/FX4D-HZFA [hereinafter 50 States, Q1 2016].

on their net-metered customers.[25] And, a few jurisdictions have attempted to set prices that are linked to the actual value of distributed generation, by including benefits to the grid, environmental benefits, and avoided generation costs in a separate "Value-of-Solar Tariff" rather than either the retail or the utility's avoided-cost rate.[26] In this Article, we use the term "net metering" to refer to the practice of compensating distributed generation customers at the retail price, which remains the most common practice.[27]

At the federal level, Congress has refrained from considering or adopting a national net metering policy, though recent competing efforts by Democratic and Republican senators suggest that this may change. In January 2016, Senators Angus King (I-Maine) and Harry Reid (D-Nevada) introduced legislation to prevent state utility commissions from lowering net metering rates unless the commission "demonstrates . . . that the current and future net benefits of the net-metered system to the distribution, transmission, and generation systems of the electric utility are less than the full retail rate.[28] The King-Reid legislation would also prevent state utility commissions from adopting charges that exclusively target net metering customers, or from enacting any amendment to the state's net metering policy that has retroactive effect.[29] From the other side of the political aisle, Senator Jeff Flake (R-Arizona) introduced rival legislation to require that all state utility commissions evaluate whether state policies, like net metering, produce cost shifts among utility customers.[30]

As a result of a steady growth in distributed generation,[31] utilities that are concerned about lost revenues have begun to advocate for reconsideration of state net metering policies, urging state legislatures and public service commis-

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25. *See, e.g.*, Best Practices, *supra* note 21 (describing New Mexico's approval of standby charges potentially high enough to exceed a customer's net excess generation, and Virginia's standby charges once a system exceeds a relatively small size).

26. *See, e.g.*, Minn. VOST, *supra* note 21.

27. *See* Steven Ferrey, *Virtual "Nets" and Law: Power Navigates the Supremacy Clause*, 24 Geo. Int'l Envtl. L. Rev. 267, 267 (2012); Benjamin Hanna, *FERC Net Metering Decisions Keep States in the Dark*, 42 B.C. Envtl. Aff. L. Rev. 133, 133–34 (2015).

28. The legislation was introduced as an amendment to a broader energy bill the Senate is currently debating, called the Energy Policy Modernization Act of 2015. *See* Joseph Bebon, *King-Reid Amendment Would Protect Against Retroactive Solar Net-Metering Changes*, Solar Indus. Mag. (Feb. 3, 2016), https://perma.cc/D7LH-YJ6M; *see also* S. Amdt. 3120, 114th Cong. (2016).

29. S. Amdt. 3120, 114th Cong. (2016); *see also* Bebon, *supra* note 28.

30. S. Amdt. 3053, 114th Cong. (2016); *see also* Jim Swift, *Senators Dueling over Solar Subsidies*, Wkly. Standard (Feb. 3, 2016), https://perma.cc/7V7E-8482.

31. Since 2003, the installation of residential solar panels, the number of net-metered customers, and the volume of distributed generation has grown rapidly. IREC, Trends Shaping Our Clean Energy Future, *supra* note 5, at 25. By the end of 2014, utilities reported over 600,000 residential net-metered customers, 170,000 more than at the beginning of the year. U.S. Energy Info. Admin., Monthly Electric Utility Sales and Revenue Report with State Distributions (2014), https://perma.cc/A6LP-SWPE.

sions to impose special fixed charges for net metering customers and to decrease the rate of compensation those customers receive for the energy they generate.[32] In addition, many industry trade associations and conservative groups have begun to challenge net metering policies in different states, publishing issue briefs and calling for legislation designed to make distributed generation less attractive.[33] Finally, high-profile detractors of net metering like Warren Buffett, whose Berkshire Hathaway Energy owns utilities across the United States, have brought increased attention to the debate.[34]

As a result, net metering has become a central battleground in the debate over our nation's energy future.[35] Utilities and their unlikely allies—consumer groups—have vocally argued for restricting net metering based on the arguments that it will hurt the cost-recovery prospects of the utilities and thus will lead to future rate hikes. Environmentalists, who want the producers of clean energy to be compensated appropriately, and individuals seeking to generate their own electricity for financial or libertarian reasons have argued opposite positions. While the rhetoric used in net metering debates has not yet reached the fevered intensity of the so-called "war on coal"[36] (the lexicon used by the opponents to President Obama's Clean Power Plan), inflammatory language is not alien to these debates.[37]

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32. *See* Peter Kind, Edison Elec. Inst., Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business 18 (2013); *see also* Solar Energy Indus. Ass'n, Solar Market Insight Report: 2014 Year in Review (2015).

33. An institute of The Edison Foundation argues that net-metered customers must pay more for their services in order to avoid cost-shifting to other customers or other negative repercussions. *See generally* Robert Borlick & Lisa Wood, Edison Found., Net Energy Metering: Subsidy Issues and Regulatory Solutions (2014).

34. For example, net metering policies in Nevada remain in the spotlight after a two-year effort by NV Energy, a Berkshire Hathaway Energy subsidiary and the state's dominant utility, to reduce net metering rates from the $0.116 per-kWh retail rate. *See* Nev. P.U.C., Application of Nevada Power Company d/b/a NV Energy For Approval of Cost Service Study and Net Metering Tariffs, Docket No. 15-07041 48,179 (July 31, 2015), https://perma.cc/F5S5-ZLHV. In September 2016, the state public utility commission endorsed a plan to reduce rates over 400% by 2028, grandfathering in about 32,000 existing solar customers at the retail rate for twenty years. *See* Nev. P.U.C. Draft Order 17-16 No. 2C, Docket No. 16-07028, 21, 35, https://perma.cc/K479-QY3D; *Net Metering*, NV Energy, https://perma.cc/2YND-GAYU (NV Energy net metering rate schedules); Julia Pyper, *Nevada Regulators Restore Net Metering for Existing Solar Customers*, Green Tech Media (Sept. 16, 2016) https://perma.cc/NVR3-P34U.

35. Office of Energy Policy & Sys. Analysis, U.S. Dep't of Energy, Quadrennial Energy Review 1-3 to 1-18 (2015) [hereinafter QER], https://perma.cc/3JCL-TVWA.

36. *Cf.* Richard L. Revesz & Jack Lienke, Struggling for Air: Power Plants and the "War on Coal" (2016) (describing the regulatory fights surrounding the regulation of coal-fired power plants under the Clean Air Act).

37. *See, e.g.*, Charles E. Bayless, *Piggybacking on the Grid*, Pub. Utils. Fort. (July 2015), https://perma.cc/SH9U-KJTD (likening net metering to an airline called "Piggyback Air," which

One goal of this Article is to evaluate the respective arguments. In this connection, we show that each side misses an important part of the problem, and that the competing positions lack nuance and do not provide a good basis for setting desirable policy on how to compensate residential producers of distributed energy. The increasing importance of integrating more renewable resources in order to achieve environmental and climate policy goals, combined with the recent rapid deployment of distributed generation systems, warrant an assessment of distributed generation policies from a societal perspective. We argue that the potential environmental and health benefits of cleaner energy should be taken into account in an ideal pricing mechanism, as environmental groups suggest. But, consistent with the position of utilities,[38] we also argue that the grid-related costs resulting from distributed generation, such as the potential negative impact of bi-directional energy flow, increased challenges of balancing supply and demand, and intermittency and variability of distributed generation should also be taken into account.

Our second goal is to provide an alternative compensation structure for distributed solar generation that can also be used to value other types of distributed energy. Only a compensation formula that can be used consistently and fairly for all types of energy resources would lead to an efficient development of all clean energy resources including distributed energy resources.

Our final goal is to highlight the need to analyze net metering in the context of more comprehensive energy policies. Indeed, net metering reform should be considered alongside another much-needed reform in electricity pricing policy, which involves a restructuring of retail electricity rates. Currently, almost all residential customers pay a flat, time-invariant per-kWh energy consumption charge.[39] This charge is set at a level designed to recover most of the system's costs, including the substantial share of costs that are fixed, in addition to the cost of generating electricity. This charge also provides a reasonable rate

travels by surreptitiously bolting its aircraft to the back of those of a competitor, "Sitting Duck Air"); Michael T. Burr, *Reverse Robin Hood: Declaring War on Non-Utility PV*, PUB. UTILS. FORT. (July 2013) (recounting a California debate during which a state senator described net metering as "robbin' the hood," to express his belief that lower income ratepayers were subsidizing wealthier solar owners); TELL UTILITIES SOLAR WON'T BE KILLED (2015), https://perma.cc/ZU7W-8JD2 ("Monopoly utilities want to extinguish the independent rooftop solar market in America to protect their socialist control of how we get our electricity.").

38. *See, e.g.*, TOM TANTON, AM. LEGISLATIVE EXCH. COUNCIL, REFORMING NET METERING: PROVIDING A BRIGHT AND EQUITABLE FUTURE 1 (2014), https://perma.cc/K4XF-6BRD ("New distributed generation technologies rely extensively upon the electric grid to operate efficiently. . . . Ironically, however, net metering policies permit distributed generators to avoid paying their share of the costs of these grid investments, leaving the costs to be paid by other electricity users.").

39. GLICK ET AL., *supra* note 10, at 12.

of return for the utility.[40] Further, though the cost of energy generation varies significantly by time, consumers pay the same constant per-kWh rate at all times.[41] These shortcomings of the current retail electricity rate design lead to inefficiencies and create the possibility of cost shifting among different customer groups.[42] The full value of distributed generation cannot be unlocked until the inefficiencies inherent in electricity pricing can be corrected.

The remainder of this Article is organized as follows: Part I summarizes the history of state net metering policies. Part II discusses current pricing approaches to distributed generation and shows why they are inadequate. Part III considers the contributions of distributed generation to the electric grid. Part IV evaluates the social benefits of distributed generation. Part V argues for a pricing approach that takes proper account of both contributions; this approach differs from net metering and is at odds with the positions on distributed generation of both utilities and environmentalists. Part VI shows how decisions concerning net metering are affected by broader questions concerning the retail pricing of electricity.

I. History of the Net Metering Debate

In 1978, less than 1% of electricity consumed in the United States came from solar or wind sources,[43] and in 1979 all but 3% came from utility-owned generators.[44] Yet, a combination of federal and state initiatives begun in that year would fundamentally restructure U.S. energy policy and usher in enormous growth of moderate- and small-scale renewable sources of electrical generation.[45] Federal legislative action in 1978 and succeeding decades altered the then-prevailing view that vertically integrated utilities were the only reliable or efficient means of electrical generation, and prompted an initial wave of investment in renewable generation technologies.[46] Additionally, state measures developed since then, such as renewable portfolio standards, contributed to the development of small-scale, often residential, renewable sources of generation,

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40. Borlick & Wood, *supra* note 33, at 4.

41. *See* Ahmad Faruqui et al., Reg. Assistance Project, Time-Varying & Dynamic Rate Design 9 n.7 (2012), https://perma.cc/5KD7-4TH8.

42. David Schmitt, *Net Metering: Getting Beyond the Controversy*, 2011 A.B.A. Recent Dev. Pub. Util. Comm. & Transp. 417, 425.

43. Richard Schmalensee, *Renewable Electricity Generation in the United States*, *in* Electric Power Systems: Theory, Practice, Policy 210 (Boaz Moselle et al. eds., 2010).

44. U.S. Energy Info. Admin., The Changing Structure of the Electric Power Industry: 1970–1991 vii (1993), https://perma.cc/VW99-C2R7.

45. *See* Jeffrey S. Dennis, *Twenty-Five Years of Electricity Law, Policy, and Regulation: A Look Back*, 25 Nat. Resources & Env't 33, 33–35 (2010).

46. *See id.* at 34.

like rooftop solar panels and backyard wind turbines.[47] As a result of both state and federal policy initiatives, net-metered distributed generation has evolved into a significant, and growing, source of domestic energy production.[48] This Part discusses the historical influence of federal as well as state policy actions on the electrical generation landscape and discusses the current state of net metering debates.

A. PURPA and Its Progeny

Since the 1930's, the Federal Energy Regulatory Commission ("FERC") and state public utility commissions have jointly regulated domestic electric markets.[49] Federal regulators administer procedures for the interstate transmission and wholesale sale of electricity occurring interstate, leaving state entities to regulate the retail rates that utilities charge end-use consumers.[50] Importantly, state regulators have historically had exclusive authority to issue permits granting monopoly franchises to individual utility companies that provide service within a given geographic area.[51] Under this regulatory framework, and particularly as a consequence of state-issued monopoly permits, the electric industry traditionally consisted of large, vertically integrated utilities that owned the transmission, distribution, and generation facilities necessary to deliver electricity to end-use consumers.[52] Until the late 1960s, this model appeared to function reasonably well. Vertically integrated utilities consistently met increasing consumer demand while improvements in generation and transmission technology enabled them to do so at decreasing cost.[53] However, by the late 1970s domestic confidence in traditional sources of energy, and the hulking utilities that generated 97% of all electricity, was waning.[54] Two decades of rising demand for electricity, growing environmental consciousness, and a parade of energy crises that included the 1973 Oil Embargo and 1977 natural

47. *See* Warren Leon, Clean Energy States All., The State of State Renewable Portfolio Standards 3–7 (2013), https://perma.cc/EJD9-5Q8Q.

48. Solar Electric Power Ass'n, Ratemaking, Solar Value and Solar Net Energy Metering—A Primer 1–2 (2013).

49. Prior to FERC's establishment in 1977, the Federal Power Commission regulated interstate electrical transactions. U.S. Energy Info. Admin., *supra* note 44, at 33.

50. *See* Dennis, *supra* note 45, at 33–34.

51. *Id.* at 33.

52. *See id.* at 33.

53. Elec. Energy Mkt. Competition Task Force, Report to Congress on Competition in Wholesale and Retail Markets for Electric Energy 19 (2006), https://perma.cc/WKL7-TEBL [hereinafter FERC Study].

54. *See id.* at 19–20.

gas shortage, all led to calls for a comprehensive reexamination of U.S. energy policy.[55]

In 1978, during the Carter Administration, Congress enacted the Public Utilities Regulatory Policies Act ("PURPA"),[56] the first major piece of energy legislation in forty-three years.[57] By offering a series of regulatory and marketplace incentives to non-utility "qualifying facilities" that satisfied size, ownership, and renewable resource stipulations, PURPA marked a departure from the monopoly structure that had been in place at the time.[58] In addition to exempting qualifying facilities from federal and state regulations that governed utility financing and organization,[59] PURPA required incumbent utilities to interconnect qualifying facilities with utility-owned grids, subject to use and access fees, thereby ensuring that a new class of energy producers could deliver output to wholesale and retail customers.[60] Finally, PURPA guaranteed qualifying facilities a market to sell electricity by mandating that utilities purchase a qualifying facility's output at pre-determined rates.[61] As defined by FERC, these pre-determined rates, known as "avoided cost" rates, were "the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase from the qualifying facility or qualifying facilities, such utility would generate itself or purchase from another source."[62] In other words, the avoided cost is what the utility would pay to generate comparable electricity itself or to purchase electricity from a third party.

Notwithstanding the avoided-cost price cap, PURPA's essential guarantee that utilities interconnect and purchase power from qualifying facilities triggered substantial development of non-utility, small-capacity generators.[63] By 1991, such facilities accounted for 6% of the total electricity generation capacity in the United States,[64] and throughout the early 1990s, qualifying facilities accounted for more than half of new generation capacity added annually.[65]

In both 1992 and 2005, Congress and federal regulators aggressively expanded support for non-utility, small-scale generators seeking to enter whole-

55. Richard D. Cudahy, *PURPA: The Intersection of Competition and Regulatory Policy*, 16 ENERGY L.J. 419, 421 (1995).

56. Public Utilities Regulatory Policies Act of 1978, Pub. L. No. 95-617, 92 Stat. 3117 (codified as amended in sections of 15, 16, and 42 U.S.C. (2012)).

57. Dennis, *supra* note 45, at 33.

58. 16 U.S.C. § 796(17) (2012).

59. 16 U.S.C. § 824a-3(e)(1).

60. 16 U.S.C. § 2621(d).

61. 16 U.S.C. § 824a-3(b), (d) (noting rates could not exceed the "incremental cost to the electric utility of alternative electric energy").

62. 18 C.F.R. § 292.101(b)(6) (2016).

63. FERC STUDY, *supra* note 53, at 20–22.

64. *Id.* at 22.

65. Jeffrey D. Watkiss & Douglas W. Smith, *The Energy Policy Act of 1992—A Watershed for Competition in the Wholesale Power Market*, 10 YALE J. ON REG. 447, 454 (1993).

sale electricity markets.[66] First, in order to accommodate an influx of non-utility generators that did not meet PURPA's "qualifying facility" renewable fuel or particular ownership constraints, the Energy Policy Act of 1992 established a class of "exempt wholesale generators."[67] Under PURPA alone, non-utility electricity developers attempting to enter wholesale electricity markets while avoiding the financial and structural regulations that applied to utilities had few available alternatives. These entities could either comply with PURPA's renewable fuel and ownership restrictions or resort to contorted and fragmented ownership models that divorced operating control from plant ownership. Such ownership models were generally viewed unfavorably by potential lenders.[68] After passage of the Energy Policy Act in 1992, becoming an exempt wholesale generator offered non-utilities an attractive third alternative.

Like PURPA's qualifying facilities, exempt wholesale generators were excused from federal regulations that applied to utilities and they received access, subject to a case-by-case FERC determination, to utility-owned grids.[69] However, unlike qualifying facilities, exempt wholesale generators *could* be utility-owned, use *any* fuel source, and were permitted to charge market-based rates for electric output rather than the "avoided cost" prices mandated by PURPA.[70]

Compared to PURPA's avoided-cost rates and the multi-year purchase contracts between utilities and qualifying facilities, market-based rates provided incentives for generators capable of responding to volatile fuel costs or changes in generation expenses.[71] In markets where the costs of meeting consumer demand were low, avoided-cost rates generally remained low as well, and the incentive to build qualifying facilities was small.[72] In contrast, market-based rates offered transacting parties flexibility to negotiate prices reflecting the costs of electricity generation and distribution.[73] For example, temporary periods of electricity scarcity would lead to higher wholesale rates.[74] By offering exempt wholesale generators the freedom to stipulate prices for electrical output rather than merely receive a pre-arranged "avoided cost" rate, the 1992 Energy Policy

66. Dennis, *supra* note 45, at 34–35.

67. Cudahy, *supra* note 55, at 424; Energy Policy Act of 1992 § 711, 15 U.S.C. § 79 (repealed 2005).

68. Watkiss & Smith, *supra* note 65, at 465.

69. 16 U.S.C. §§ 824j, k (2012).

70. Energy Policy Act of 1992, 102d Cong. § 721-22 (1992); 16 U.S.C. §§ 824j–824k; MONICA GREER, ELECTRICITY MARGINAL COST PRICING: APPLICATIONS IN ELICITING DEMAND RESPONSES 72 (2012).

71. Joseph T. Kelliher, *Pushing the Envelope: Development of Federal Electric Transmission Access Policy*, 42 AM. U. L. REV. 543, 588–89 (1993); Leonard S. Greenberger, *The PUHCA: Busting the Trusts*, PUB. UTILS. FORT. 19, 22 (1991) (noting the Northeast generally had a dearth of qualifying facilities).

72. Watkiss & Smith, *supra* note 65, at 453–54.

73. Dennis, *supra* note 45, at 36.

74. FERC STUDY, *supra* note 53, at 2.

Act rewarded efficient generators that could produce electricity below avoided-cost rates.[75] Thus, while regional variation among avoided-cost rates produced an uneven landscape of qualifying facility development, market-based rates enabled exempt wholesale generators to effectively compete in most wholesale markets across the United States.[76]

To complement legislative efforts like PURPA and the Energy Policy Act of 1992, which lowered entry barriers to non-utility generation, federal regulators also sought to encourage non-utility development by opening access to grid transmission lines.[77] In the 1990s, the grid was still a monopoly owned by vertically integrated utilities.[78] Citing pervasive anti-competitive conduct by utilities, including discriminatory pricing for transmission services provided to non-utilities,[79] FERC issued a series of orders during the mid-1990s that transferred significant operating control over transmission grid away from utilities.[80] The orders increased transparency over the fees utilities charged for transmission services, established independent entities to monitor grid access, and broadly expanded non-utility access to the grid by abandoning FERC's cumbersome case-by-case assessment and adopting universal access.[81]

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75. Kelliher, *supra* note 71, at 547.

76. FERC STUDY, *supra* note 53, at 23–24; Kelliher, *supra* note 71, at 590.

77. Alexander K. Obrecht, *Energy Policy Act of 2005: Pseudo-Fed for Transmission Congestion*, 7 PITT. J. ENVTL. PUB. HEALTH L. 159, 167 (2012–2013); FERC STUDY, *supra* note 53, at 24.

78. QER, *supra* note 35, at 3–4.

79. FERC STUDY, *supra* note 53, at 24.

80. Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities, Recovery of Stranded Costs by Public Utilities and Transmitting Utilities, 888, 61 Fed. Reg. 21,540 (May 10, 1996) [hereinafter Order No. 888], FERC STATS. & REGS. ¶ 31,036 (1996), *order on reh'g*, Order No. 888-A, FERC STATS. & REGS. ¶ 31,048 (1997), *order on reh'g*, Order No. 888-B, 62 Fed. Reg. 64,688 (Dec. 9, 1997), 81 FERC ¶ 61,248 (1997), *order on reh'g*, Order No. 888-C, 82 FERC ¶ 61,046 (1998), *aff'd in part sub nom.*, Transmission Access Policy Study Grp. v. Fed. Energy Regulatory Comm'n, 225 F.3d 667 (D.C. Cir. 2000), *aff'd sub nom.*, New York v. Fed. Energy Regulatory Comm'n, 535 U.S. 1 (2002) (authorizing creation of Independent System Operators ("ISOs")); Regional Transmission Organizations, Order No. 2000, 65 Fed. Reg. 810 (Jan. 6, 2000) [hereinafter Order No. 2000], 89 FERC ¶ 61,285, *order on reh'g*, Order No. 2000-A, 65 Fed. Reg. 12,088 (Mar. 8, 2000), *aff'd sub nom.*, Pub. Utility Dist. No. 1 v. Fed. Energy Regulatory Comm'n, 272 F.3d 607 (D.C. Cir. 2001) (authorizing creation of Regional Transmission Organizations ("RTOs")).

81. Open Access Same-Time Information System (Formerly Real-Time Information Networks) and Standards of Conduct, Order No. 889, 61 Fed. Reg. 21,737 (May 10, 1996), FERC STATS. & REGS. ¶ 31,035 (1996), *order on reh'g*, Order No. 889-A, FERC STATS. & REGS. ¶ 31,049 (1997), *order on reh'g*, Order No. 889-B, 81 FERC ¶ 61,253 (1997) (establishing the Open Access Same-Time Information System ("OASIS") containing day-to-day information regarding transmission tariffs); Order No. 888, at 31,655 (establishing universal "comparable transmission services" for third-parties, requiring owners of transmission grid to

Also recognizing that optimal sites for wind and solar generation could be geographically isolated, the federal government has sought to further facilitate the development of renewable energy by expanding the transmission grid to connect remote sites of wind or solar generation to urban areas where electricity could be delivered to end-use consumers.[82] The Energy Policy Act of 2005 offered incentives for private infrastructure investment and granted FERC the authority to supervise the development of *intra*state grids as long as such development influenced *inter*state transmission of electricity.[83] The 2005 Act also expanded FERC's authority to police utilities and pursue civil penalties for manipulative conduct, like utility pricing practices that discriminate against non-utilities seeking access to the utility-owned grid lines.[84]

Recognizing that previous legislative and regulatory efforts had led to growing competition between non-utility and utility generators,[85] the 2005 Act also gave FERC authority to terminate a utility's obligation to purchase electricity from qualifying facilities—first required under PURPA.[86] Ultimately, PURPA's purchase obligations were lifted in markets accounting for approximately 29% of qualifying facility generation capacity.[87] Since 2005, qualifying facility development has noticeably stagnated.[88] The 2% average annual growth

offer third-parties access under comparable terms and conditions as the transmission owner's own use of the system).

82. *See* CONG. RES. SERV., ELECTRIC POWER TRANSMISSION: BACKGROUND AND POLICY ISSUES, CRS REPORT R40511, 10 (Apr. 14, 2009), https://perma.cc/8KPH-BHKH (noting renewable generators may have "limited access to transmission lines" and Congressional proposals that are "explicitly focused on expanding the grid to serve these remote renewable resource areas"); JUDY CHANG ET AL., BRATTLE GRP., TRENDS & BENEFITS OF TRANSMISSION INVESTMENTS: IDENTIFYING AND ANALYZING VALUE (2013), https://perma.cc/HG7W-ZR6H (showing increase in infrastructure investment since 2005).

83. 16 U.S.C. § 824p(e) (2012).

84. *See* 16 U.S.C. § 824v(a) Charles J. Time Engel III & Brandon E. Reavis, *FERC's Market Manipulation and Enforcement Process*, 2 FIN. FRAUD L. REPORT 54 (2010), https://perma.cc/HK6H-E66U.

85. Dennis, *supra* note 45, at 35.

86. 16 U.S.C. § 824a-3(m). However, FERC rules require any utility seeking to terminate a purchase contract with a qualifying facility generating 20 MW or less to overcome a rebuttable presumption that the qualifying facility lacks access to wholesale markets and transmission. 18 C.F.R. § 292.309(d)(1) (2014).

87. New PURPA Section 210(m) Regulations Applicable to Small Power Production and Cogeneration Facilities, 18 C.F.R. § 292 (2006); U.S. ENERGY INFO. ADMIN., FORM EIA-860 DETAILED DATA (2013) [hereinafter FORM EIA-860 2013].

88. Peter Maloney, *The Public Utility Regulatory Policies Act May Find a New Reason for Being*, S&P GLOBAL PLATTS (Oct. 16, 2012), https://perma.cc/2AUS-NTPP (showing a decline in year-over-year qualifying facility capacity additions, with capacity additions reaching nearly 5,000 MW per year in early 2000's, but never reaching more than 2,000 MW per year since 2005).

in qualifying facility generation capacity between 2006 and 2013 is well below the 8.6% average annual growth experienced between 2001 and 2005.[89]

Nonetheless, due in part to federal efforts begun under PURPA, 37% of U.S. electricity by 2013 was generated by non-utility, independent power producers.[90] Equally important, the gradual but significant shift away from vertically integrated utilities helped recast traditional economies of scale for electricity generators.[91] Federal efforts also produced tax incentives for renewable generation and earmarked funds for research and development of smaller electric turbines and distributed energy resources.[92]

B. *State Renewable Portfolio Standards*

A second driver of small-scale generators and renewable fuel sources has been state policies, particularly renewable portfolio standards ("RPS").[93] State renewable portfolio standards require or encourage load serving entities to source a certain amount of their electricity from renewable sources.[94] By 2015, twenty-nine states and the District of Columbia had a renewable portfolio standard, and eight additional states had a non-binding renewable portfolio goal.[95] Given the current capacity available, an additional 22 GW of renewable energy capacity by 2020 and an additional 60 GW of capacity by 2030 is needed.[96] This would represent roughly a doubling of total RPS capacity built by 2016.[97]

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89. FORM EIA-860 2013, *supra* note 87.

90. Severin Borenstein & James Bushnell, *The U.S. Electricity Industry After 20 Years of Restructuring*, 7 ANN. REV. ECON. 437, 442 (2015); *Net Generation for Independent Power Producers*, U.S. ENERGY INFO. ADMIN., https://perma.cc/4GN5-EAMT.

91. *See* U.S. ENERGY INFO. ADMIN., THE CHANGING STRUCTURE OF THE ELECTRIC POWER INDUSTRY 2000: AN UPDATE 44 (2000) ("No longer is it necessary to build a 1,000-megawatt generating plant to exploit economies of scale.").

92. 26 U.S.C. § 45 (2012) (establishing the Production Tax Credit for qualifying facilities); 42 U.S.C. § 16211 (2012) (earmarking $768 million for fiscal years 2007 through 2009 for "programs of research, development, demonstration, and commercial application on distributed energy resources and systems reliability and efficiency"). See Nick Johnstone et al., *Environmental Policy Stringency and Technological Innovation: Evidence from Survey Data and Patent Counts*, 44 APPLIED ECON. 2157, 2157–70 (2012), for a statistical analysis of the influence of policy on technological innovation.

93. RYAN WISER ET AL., LAWRENCE BERKELEY NAT'L LAB., EVALUATING EXPERIENCE WITH RENEWABLE PORTFOLIO STANDARDS IN THE UNITED STATES 1 (2004), https://perma.cc/DZ7G-P6E2. For a broad picture of state RPS policies, see *Renewable Portfolio Standard Policies*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (2004), https://perma.cc/DZ7G-P6E2 [hereinafter DSIRE, *RPS Policies*].

94. WISER ET AL., *supra* note 93, at 1.

95. DSIRE, *RPS Policies*, *supra* note 93.

96. GLEN BARBOSE, LAWRENCE BERKELEY NAT'L LAB., U.S. RENEWABLES PORTFOLIO STANDARDS 2016 ANNUAL STATUS REPORT 20 (2016), https://perma.cc/6Q4Y-M6ZU.

97. *Id.*

State renewable portfolio standards range from modest to very ambitious, with a 10% by 2015 standard in Michigan[98] and Wisconsin,[99] 50% by 2030 in New York,[100] and a 100% by 2045 standard in Hawaii.[101] Twenty-three jurisdictions impose a renewable standard of 15% or greater,[102] and twelve have standards of at least 25%.[103] More than half of all state renewable portfolio standards also include solar or distributed generation "carve-out" provisions.[104] These provisions require a certain minimum percentage of an electrical producer's supply be generated by a specific source, like solar, rather than from any other renewable source.

In contrast to the stagnating growth of PURPA's qualifying facilities over the past decade, renewable portfolio standards have catalyzed enormous expansion of renewable resource generation. In particular, solar has been among the fastest-growing renewable sources of generation, growing more than 3000% since 2000.[105] By year-end 2013, total photovoltaic capacity reached 12.1 GW, 82% of which was installed in just the preceding *three* years.[106]

Perhaps one of the most significant consequences of the federal and state initiatives has been the decrease in the cost of manufacturing, installing and maintaining solar generators. Since 2006 alone, the total cost of installing solar panels has dropped more than 73%.[107] While some of the declining cost is most likely attributable to independent technological advancement, federal and state

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98. DSIRE, *RPS Policies*, *supra* note 93.

99. *Id.*

100. Order Adopting A Clean Energy Standard, New York State Public Service Commission Case No 15-E-0302 (Aug. 1, 2016).

101. DSIRE, *RPS Policies*, *supra* note 93.

102. *Id.*

103. *Id.* Jurisdictions with standards of 15% or greater include: Arizona, California, Colorado, Connecticut, District of Columbia, Delaware, Hawaii, Illinois, Maine, Massachusetts, Maryland, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, Nevada, Oregon, Pennsylvania, Vermont, and Washington. Jurisdictions with a standard of at least 25% include: California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Maine, Minnesota, New York, Nevada, Oregon, and Vermont. For the purposes of this Article, we chose not to count states that have a non-binding renewable portfolio "goal" in lieu of the binding standard.

104. See Wiser et al., *supra* note 93, at 5–7, for individual state statues. Jurisdictions with specific solar requirements in RPS policies are: Arizona, Delaware, District of Columbia, Illinois, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, and Pennsylvania. Jurisdictions with specific solar requirements above 1.5% in RPS policies are: Arizona, Delaware, District of Columbia, Illinois, Maryland, Michigan, Minnesota, Nevada, New Jersey, New Mexico, and New York.

105. *Monthly Energy Review*, U.S. Energy Info. Admin., 109 tbl.7.2a (2013), https://perma.cc/45QS-2R4L.

106. IREC, Trends Shaping Our Clean Energy Future, *supra* note 5, at 25–26.

107. Solar Energy Indus. Ass'n, Solar Market Insight Report 2014 Q4, https://perma.cc/82K4-3YMW.

policies have almost certainly induced the rate and direction of advancement in both the short- and long-term.[108]

C. Net Metering Policies

The most common tool to track electrical output from distributed solar generators and to compensate distributed generation owners for this output is a billing arrangement known as "net metering."[109] While net metering has recently emerged as a hot-button issue, it dates back to the 1980s when Idaho, Arizona, and Massachusetts adopted the policy.[110] Since 2001, net metering has been available to utility customers in a majority of states,[111] though relatively few customers took advantage of it until 2005.[112] The passage of the 2005 Energy Policy Act, however, catalyzed distributed generation under net metering by offering favorable tax treatment to individuals installing solar generators and by encouraging state adoption of net metering policies.[113] While PURPA regulated federal wholesale markets and encouraged development among "qualifying facility" producers, the 2005 Energy Policy Act encouraged state policies to allow individual utility customers to produce and sell energy in state-regulated

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108. *See, e.g.*, THE WHITE HOUSE, A RETROSPECTIVE ASSESSMENT OF CLEAN ENERGY INVESTMENT IN THE RECOVERY ACT 18–19 (2016), https://perma.cc/886F-FEEQ (correlating declining capital costs in renewable energy with American Recovery and Reinvestment Act's investment programs).

109. U.S. ENERGY INFO. ADMIN., STATE ENERGY DATA SYSTEM, TABLE 4.10, NET METERING CUSTOMERS AND CAPACITY BY TECHNOLOGY TYPE, BY END USE SECTOR, 2004 THROUGH 2014 (2013), https://perma.cc/4C44-9JDK (noting a 53% annual growth rate in NEM customers); *see also* J. HEETER ET AL., NAT'L RENEWABLE ENERGY LAB., NREL/TP-6A20-61858, STATUS OF NET METERING: ASSESSING THE POTENTIAL TO REACH PROGRAM CAPS 12 (2014), https://perma.cc/2KPV-KC2M (noting net metering is a statistically significant driver of solar growth).

110. YIH-HUEI WAN, NAT'L RENEWABLE ENERGY LAB., NREL/SP-460-21651, NET METERING PROGRAMS 3 (1996), https://perma.cc/8TAW-5ZHB.

111. *See* James W. Stoutenborough & Matthew Beverlin, *Encouraging Pollution-Free Energy: The Diffusion of State Net Metering Policies*, 89 SOC. SCI. Q. 1230, 1232 (2008). Under the Energy Policy Act of 2005, every electric utility is required to at least consider making a net metering service available to any electric customer. Energy Policy Act of 2005 § 1251, 16 U.S.C. § 2621(d) (2012).

112. HEETER ET AL., *supra* note 109, at 1.

113. For a more in-depth discussion of the 2005 Energy Policy Act, see Jim Rossi, *Federalism and the Net Metering Alternative,* THE ELEC. J. (forthcoming) (on file with author). The 2005 Act included a list of eighteen retail policies for state consideration, including net metering, "time of day" rates, seasonal rates, and integrated resource planning initiatives. 16 U.S.C. § 2621(d). Specifically, the act defined "net metering" as "electric energy generated by [an] electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities . . . to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period." *See id.*

retail markets.[114] Moreover, though PURPA required purchases of qualifying facility output at avoided cost rates, the 2005 Energy Policy Act did not endorse or reject any specific compensation methodology. Notably, the 2005 Energy Policy Act left untouched net metering policies that were already operational in several states and that used retail rates.[115] The 2005 Energy Policy Act thus established net metering as a retail market alternative to the "intrusive"[116] qualifying facility and mandatory purchase obligations of PURPA. As a result, net metering has grown significantly in the wake of the 2005 Act. Furthermore, increased affordability has helped solidify solar generation as an attractive and feasible option for homeowners.[117] Residential solar installations have grown at a rate of 50% annually since 2012.[118] By the end of 2015, the residential solar market represented 29.5% of the U.S. solar market.[119] However, despite near ubiquitous adoption of net metering by states, the policies themselves differ, often substantially, between jurisdictions.[120] A few distinctions are particularly important.

First, and perhaps most significantly, state net metering programs differ in how they compensate customer-sited generation. Currently, thirty-four net metering jurisdictions credit customers for generation at the retail rate.[121] In contrast to PURPA's avoided costs rates, which reflect the cost to a utility generating equivalent power or purchasing it from a non-qualifying facility third-party, retail rates exactly mirror the price charged by utilities to end-use consumers for electricity, including delivery costs, administrative expenses, state

114. According to the "net sales" test, retail market transactions include transactions between a utility customer and the utility as long as the customer does *not* consistently produce sufficient excess energy (beyond their own energy consumption) during a given time period to be considered a "net seller" of electricity. *See* 16 U.S.C. § 824(a).

115. *See* 16 U.S.C. § 2621(d); *see also* Wan, *supra* note 110, at 3 (noting that Idaho, Minnesota, and Wisconsin all used retail rates in their net metering policies).

116. Fed. Energy Regulatory Comm'n v. Mississippi, 456 U.S. 742, 759 (1982). The Supreme Court distinguished between PURPA's "most intrusive" and legally enforceable requirement of mandatory purchases at avoided cost rates and the less intrusive requirements of PURPA, like the instruction that states consider adopting various regulatory tools. *Id.* at 764. Later, in the 2005 Energy Policy Act, Congress would amend the list of required considerations to include net metering. *Id.*

117. In addition to declining manufacturing and installation costs, favorable tax policy has also contributed to distributed generation's attractiveness. Notably, a 30% federal Investment Tax Credit is provided for solar systems on residential properties. Energy Policy Act of 2005 § 1335, 26 U.S.C. § 25D (2012); *see also* Photovoltaic Power Systems Programme, Annual Report 2014, at 108 (2014), https://perma.cc/WD28-XLPJ.

118. Solar Market Insight: 2015 Year in Review Executive Summary 6 (2016), https://perma.cc/QC6J-KPRV.

119. Mike Munsell, *US Solar Market Sets New Record, Installing 7.3GW of Solar PV in 2015*, GreenTech Media (Feb. 22, 2016), https://perma.cc/Q8E2-E866.

120. *See* Best Practices, *supra* note 21.

121. *Id.*

and local taxes, and utility profits.[122] Though only seven jurisdictions exclusively credit net excess generation at the avoided cost rates,[123] many states offer a combination of rates.[124] This combination typically credits monthly excess generation that is "carried-over" to future billing cycles at a retail rate, but credits annual net excess, when utilities and net-metered customers "zero-out" generation and consumption from the past twelve months, at a PURPA avoided-cost rate.[125] The difference between the retail and avoided-cost rates may be substantial, as much as $0.10 per kWh.[126] In Wisconsin, for example, utility avoided costs rates in 2015 were $0.03 to $0.04 per kWh, while retail rates ranged between $0.11 and $0.14 per kWh.[127] Retail rates in Kansas, which are some of the nation's highest, can reach $0.19 per kWh, while utility buy-back rates for excess generation can be as low as $0.013 per kWh, or just 7% of the retail price in 2015.[128] Fourteen states and the District of Columbia credit customer excess generation at the retail rate without expiration.[129] The Public Utilities Commission of Ohio recently decided that customers with distributed generation systems are entitled to the "full value" of electricity they sent to the grid, which they define as generation and capacity charges.[130] Finally, Hawaii's new "grid-supply" option credits customers at the avoided-cost rate for generation that is fed into the grid.[131]

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122. YIH-HUEI WAN & H. JAMES GREEN, CURRENT EXPERIENCE WITH NET METERING PROGRAMS 1–2 (1998), https://perma.cc/5CRH-D5AL.

123. As of 2014, Mississippi, Missouri, Nebraska, Nevada, New Mexico, North Dakota, and Rhode Island compensate excess net-metered generation at avoided cost rates. BEST PRACTICES, *supra* note 21.

124. LAURENCE D. KIRSCH & MATHEW J. MOREY, PRICING RETAIL ELECTRICITY IN A DISTRIBUTED ENERGY RESOURCES WORLD, CHRISTENSEN ASS'N ENERGY CONSULTING, LLC 9 (2015), https://perma.cc/U5CN-R9SJ.

125. *See, e.g.*, BEST PRACTICES, *supra* note 21 (noting states like New Jersey and Virginia, among others, adopt this combination scheme).

126. WAN & GREEN, *supra* note 122, at 1.

127. Kari Lydersen, *In Wisconsin, Solar 'New Math' Could Equal Big Impacts*, MIDWEST ENERGY NEWS (Jan. 16, 2015), https://perma.cc/3EH5-DPZZ.

128. *Net Metering & Related Utility Issues Frequently Asked Questions*, BERGEY WINDPOWER, https://perma.cc/G7VU-7V8D; *see also Net Energy Metering (NEM)*, CAL. PUB. UTILS. COMM'N, https://perma.cc/SDY4-RB6M (noting utility avoided cost rates may be as little as half of the retail rate).

129. KIRSCH & MOREY, *supra* note 124, at 9.

130. Kathiann M. Kowalski, *Ohio Utilities Take Net Metering Fight to State Supreme Court*, MIDWEST ENERGY NEWS (Aug. 4, 2014), https://perma.cc/ZXM6-KQKH.

131. Herman K. Trabish, *What Comes After Net Metering: Hawaii's Latest Postcard from the Future*, UTIL. DIVE (Oct. 22, 2015), https://perma.cc/SSV6-899H. Across the United States, policies also vary with regard to ownership of lucrative "renewable energy credits" that are (1) produced by renewable generators, (2) function as liquid commodities independent of the underlying produced energy, and (3) can be used by utilities to satisfy state renewable portfolio standards. BEST PRACTICES, *supra* note 21. Twenty-five states vest default ownership of these credits with the owner of a net-metered generator. *See, e.g.*, BEST PRACTICES, *supra*

A second variation among net metering policies is how long a customer's monthly excess generation may be "carried-over" to future billing cycles and used to offset electricity consumption. As of October 2016, net generation may be "carried over" month-to-month and applied in subsequent billing periods to offset later usage in all but two jurisdictions—Minnesota and North Dakota.[132] At least eleven jurisdictions offer customers a variation of indefinite carry-over, in which excess generation is perpetually credited toward the customer's bill in a subsequent month, though most state policies limit how long excess generation may be applied toward subsequent billing periods.[133] At least twenty-three states limit the available carry-over to twelve months.[134] Enabling the carryover of excess generation, even if limited to twelve months, leads to very low electricity bills for customers that own large photovoltaic systems.[135] For example, schools in California use the credits they earn during the summer months to offset their consumption during the school year, resulting in very low bills and, correspondingly, a significant financial impact for the utilities.[136]

Third, nearly all jurisdictions place a cap on the maximum permissible size of any individual net-metered generator.[137] These limits can range from relatively restrictive, like the 10 kW ceiling in Georgia, to more generous limits like the 80 MW cap in New Mexico.[138] The most common size limit is 25 kW, found in eleven states, while twenty-three jurisdictions restrict the size of individual net-metered generators below 100 kW.[139] To give these limits context, the capacity of existing net-metered generators range, nationally, from 3 kW, common among residential systems, to 10 MW or larger, common among generators installed on retail businesses.[140] Nationally, the average residential solar photovoltaic system has capacity of 6.1 kW,[141] and the average size of non-residential distributed solar is 109 kW.[142] On average, jurisdictions with individual capacity limits of 1 MW or greater have 3.4 kW of installed solar capac-

note 21 (noting states like Arkansas and Nebraska, among others, vest ownership of renewable energy credits with the owners of net-metered generators).

132. Best Practices, *supra* note 21.

133. *Id.*

134. *Id.*

135. Cherrelle Eid et al., *The Economic Effect of Electricity Net-Metering with Solar PV*, 75 Energy Pol'y 244, 247 (2014).

136. *Id.*

137. Best Practices, *supra* note 21.

138. Ga. Code Ann. § 46-3-52 (2002); *New Mexico Net Metering Program Overview*, Database of State Incentives for Renewables & Efficiency, https://perma.cc/JJE6-SUWR.

139. Best Practices, *supra* note 21.

140. Am. Pub. Power Ass'n, *supra* note 2, at 3.

141. Larry Sherwood, Interstate Renewable Energy Council, U.S. Solar Market Trends 2013, 15 (2014), https://perma.cc/FKQ3-7PXR.

142. *Id.* at 16.

ity per person, while states with individual capacity limits *below* 1 MW have just 0.740 watts of installed capacity per person.[143] Individual system caps may also exclude more cost-effective projects, such as multi-family residential systems, which benefit from economies of scale.[144]

Fourth, twenty-four jurisdictions set aggregate capacity limits that constrain the total amount of net-metered generation permissibly installed within a state or utility service area.[145] Typically expressed as a percentage of the yearly or historical peak demand for electricity,[146] aggregate limits commonly fall between 0.2%[147] and 9.0%.[148] Some jurisdictions have substantially higher aggregate limits. For example, Vermont has an aggregate capacity limit at 15% of the state's peak demand, and Utah imposes a limit at 20% of the state's peak demand.[149] Many states, however, do not have an aggregate capacity limit at all.[150]

The differences among net metering policies can significantly affect the attractiveness of distributed generation to utility customers. Over 76% of net-metered distributed generation systems are located in states with favorable net metering policies—states that offer greater individual or aggregate capacity limits, longer carry-over provisions, broader eligibility of community solar projects,

143. Elizabeth Doris et al., Nat'l Renewable Energy Lab., NREL/TP-6A246670, Net Metering Policy Development in Minnesota 11 (2009).

144. *Id.* at 13.

145. *See Net Metering State Database*, Database of State Incentives for Renewables & Efficiency, https://perma.cc/NA52-4BMV.

146. Aggregate capacity limits have varied widely. Best Practices, *supra* note 21. For example, Georgia caps permissible aggregate net metering at only 0.2% of a utility's peak demand. *Id.* Illinois and Indiana have caps of 1% of peak demand, and California and Delaware have caps of 5%. *Id.* Rather than expressing an aggregate capacity limit as a percentage, Maryland's aggregate capacity limit is fixed at 1,500 MW. *Id.* at 54. Similarly, New Hampshire's aggregate capacity limit is 50 MW. *Id.*

147. Ga. Code Ann. § 46-3-5650 (2002).

148. Mass. Gen. Laws Ann. ch. 164, § 1G(g) (West 1998).

149. Vt. Stat. Ann. tit. 30, § 219a(h)(1)(A) (West 1998); Best Practices, *supra* note 21.

150. For example, Arizona, Colorado, and New Jersey, have no limit on total program capacity. Best Practices, *supra* note 21. At least eleven states and the District of Columbia include "shared" renewable projects, which permit joint ownership of distributed generation and offer access to environmental and net metering benefits of distributed generation to utility customers that live in multi-family housing or who may be unable to finance their own generator. David Feldman et al., Nat'l Renewable Energy Lab., NREL/TP-6A20-63892, Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation app. at 41–44 (2015), https://perma.cc/Y57R-WNQC; Edgar Meza, *New York Backs Community Solar Initiatives*, PV Magazine (Apr. 15, 2015), https://perma.cc/L3FD-HN86. At least twenty-six states and the District of Columbia and Puerto Rico permit "third-party ownership" for distributed generation systems—a policy that allows utility customers to contract out the installation and maintenance costs in exchange for a promise to purchase the generated electricity. *3rd Party Solar PV Power Purchase Agreement (PPA)*, Database of State Incentives for Renewables & Efficiency (2016), https://perma.cc/X5RG-U9TK.

and higher reimbursement rates.[151] New Jersey provides a powerful illustration of the influence that favorable net metering policies can have on distributed solar installations. New Jersey imposes no limit on the aggregate capacity of net-metered generators statewide,[152] permits unlimited carry-over of excess generation during a twelve-month period,[153] has a renewable portfolio standard with a specific solar-energy requirement,[154] and offers rebates to individuals that install solar generators.[155] Although New Jersey ranks thirty-ninth among U.S. states in annual sunlight hours—and is thus an unlikely home for widespread development of distributed generation—it accounts for nearly 10% of *all* national net-metered capacity.[156]

D. Current State Reconsideration of Net Metering Policies

In response to the growth of distributed generation, and the subsequent alarm by utilities over shrinking electricity demand and declining revenues,[157] states and utilities are reconsidering the design of net metering programs.[158] During the first quarter of 2016 alone, over thirty changes to existing programs were considered across twenty-two states.[159] While many proposed reforms impose additional charges on net metering customers or reduce the rate of compensation on-site generation may receive,[160] some reforms are attempting to encourage additional distributed generation development.[161]

151. *See* Best Practices, *supra* note 21 (noting states with favorable net metering policies). *Cf. Electric Power Sales, Revenue, and Energy Efficiency Form EIA-861 Detailed Data Files*, U.S. Energy Info. Admin. (Oct. 6, 2015), https://perma.cc/SA6F-8ZXU (noting capacity and location of net-metered distributed generation).

152. Best Practices, *supra* note 21.

153. N.J. Admin. Code § 14:8-4.3 (2008).

154. New Jersey's RPS required that statewide utilities provide, collectively, 305 GWh of solar energy in 2011, and will require statewide utilities provide, collectively, over 5,316 GWh of solar energy by 2026. Sherwood, *supra* note 141, at 20.

155. Rebates for New Jersey customers peaked in 2006 at $78 million in rebate expenditures distributed. However, rebates have tapered downward since that time. Sherwood, *supra* note 141, at 15.

156. *Average Annual Sunshine by State*, Current Results, https://perma.cc/Q7SJ-EDUM.

157. *See* Jaquelin Cochran et al., Nat'l Renewable Energy Lab., NREL/TP-6A00-53732, Integrating Variable Renewable Energy in Electric Power Markets: Best practices from Int'l Experience 1 (2012), https://perma.cc/V7MD-EYHL; Kind, *supra* note 32, at 1.

158. Kind, *supra* note 32, at 3, 17.

159. 50 States, Q1 2016, *supra* note 24, at 11.

160. *See, e.g.*, 50 States, Q1 2016, *supra* note 24, at 11–23 (discussing policy proposals that would impose charges on net metering customers or reduce the rate of compensation for net-metered generation).

161. Heeter et al., *supra* note 109, at 8.

One impetus driving many net metering reform efforts is the recovery of utility "fixed costs"—costs of grid investment and maintenance that remain constant even when fewer customers purchase electricity because of self-generation.[162] Traditionally, utilities have recovered a substantial share of these fixed costs through volumetric rates based on the total kWh of electricity a customer purchased.[163] Yet, as a growing number of utility customers turn to on-site solar generation in order to satisfy or supplement their electricity usage, these fixed costs have to be recovered in fewer kWh sales.[164] Utilities and their allies, notably the American Legislative Exchange Council ("ALEC"), have made significant efforts to curtail net metering through state legislative action.[165] In late 2013, ALEC published model legislation, which was sent to nearly 2,000 state legislators across the country, calling for "a fixed grid charge or other rate mechanisms" to "recover grid costs from [distributed generation] systems."[166] Legislation that would bar net metering entirely or make it more costly to customers has been introduced in at least two-dozen state legislatures since 2013.[167] In addition, some utilities have chosen to concentrate anti-net metering efforts in appeals to state public utility commissions.[168]

One common strategy proposed by utilities to limit the financial consequences of net metering has been to adjust the price customers with on-site generation receive for their output. In 2014, utilities in Arizona, Hawaii, and Colorado—all states with large solar markets and traditionally pro-solar regulation—filed proposals with state regulatory commissions seeking to alter the compensation new distributed generation customers would stand to receive.[169] Colorado regulators ultimately chose to retain the retail rate for net metering customers,[170] though the state's largest utility cooperative, Intermountain Rural

162. Steve Mitnick, Build Energy Am., Changing Uses of the Electric Grid xvi (2015), https://perma.cc/NX4K-J6PD.

163. *Id.*

164. *Id.*

165. *See* Joby Warrick, *Utilities Wage Campaign Against Rooftop Solar*, Wash. Post (Mar. 7, 2015), https://perma.cc/7E4S-GG8M.

166. *Updating Net Metering Policies Resolution*, Am. Legis. Exchange Council (2014), https://perma.cc/JL9S-4GK8.

167. Warrick, *supra* note 165.

168. For a list of proposals pending before state regulatory commissions as of April 2016, see 50 States, Q1 2016 *supra* note 24, at 11–23.

169. *See generally* Proposal of Tucson Electric Power Co., No. E-01933A-15-0322 (Ariz. Corp. Comm'n Nov. 2015), https://perma.cc/WA68-4TFL; Proposal of USNS Electric, Inc., No. E-04204A-15-0099 (Ariz. Corp. Comm'n Mar. 25, 2015) *proposal withdrawn* Apr. 28, 2015, https://perma.cc/4XFL-WTZQ; Instituting a Proceeding to Investigate Distributed Energy Resource Policies, No. 2014-0192, Order No. 33258 (Haw. P.U.C. 2015); Krysti Shallenberger, *Colorado Utility Wades into Net-metering Debate*, Energy Wire (June 16, 2015), https://perma.cc/2YD5-YWTL.

170. *See* Shay Castle, *PUC Ruling: No Changes on Net Metering in Colorado*, Daily Camera (Aug. 26, 2015), https://perma.cc/ARP9-GQBN.

Electric Association, independently adopted a new "demand charge" policy that could add between $20 and $24 to net-metered customers' bills.[171] Arizona regulators were still considering the bulk of utility proposals in October 2016.[172]

In November 2015, Hawaii, however, adopted new tariffs and lowered compensation for new customers, which had been at the $0.299 per kWh retail rate, to between $0.150–0.280 per kWh, the "avoided cost" rate.[173] Hawaii's new policy, which replaces net metering, offers distributed generation owners a choice between a "grid-supply tariff," which reduces compensation to avoided cost rates, and a "self-supply tariff," in which a customer does not export any energy they generate.[174] Under the latter option, customers will not receive compensation for energy they generate but do not consume.[175] Also in 2014, the Arkansas legislature enacted a change that replaced retail rate compensation with compensation at the utility's avoided-cost rate.[176] In Wisconsin, a similar decision by state regulators that would have reduced net metering credit to avoided-cost levels was vacated by a state trial court.[177]

In January 2015, Nevada's state utility commission upheld a change to state net metering that decreases the credit offered for energy sold back to the grid from the retail rate of $0.11 per kWh to $0.026 per kWh over the next four years.[178] Over the same period, fixed charges for customers with rooftop

171. Cathy Proctor, *Colorado Power Co-op OK's New Charge Aimed at Solar Power Customers*, DENVER BUS. J. (Oct. 6, 2015), https://perma.cc/V7Y6-F6J2.

172. Arizona regulators are considering petitions from two Arizona utilities related to net metering. In one proceeding, regulators approved a $1.58 monthly charge on net metering customers for fixed costs associated with installation and servicing second meters, required to track customer consumption and generation. Regulators held off on a decision whether to allow the utility to change the rate of compensation customers receive for generation, awaiting the completion of a value of solar study due out in October 2016. Opinion and Order, No. E-04204A-15-0142, (Ariz. Corp. Comm'n 2016), https://perma.cc/TV67-6U5J. A decision in the second proceeding is still pending, and it appears regulators may await the results of the same value of solar study before issuing a final order. Recommendation of Administrative Law Judge Jane Rodda, Opinion and Order, Nos. E- 01933A-15-0239 and E- 01933A-15-0322, (Ariz. Corp. Comm'n Oct. 2016), https://perma.cc/H786-JFLP.

173. *Compare* Mark Dyson & Jesse Morris, *Hawaii Just Ended Net Metering for Solar. Now What?*, ROCKY MOUNTAIN INST. (Oct. 16, 2015), https://perma.cc/S2NN-PC3D, *with Table 5.6.A. Average Price of Electricity to Ultimate Customers by End-Use Sector*, U.S. ENERGY INFO. ADMIN. (2016), https://perma.cc/UCZ9-K8CP.

174. Dyson & Morris, *supra* note 173; *see also Customer Grid Supply and Self Supply Programs*, HAWAIIAN ELEC., https://perma.cc/6GF7-KBC3.

175. *See* Dyson & Morris, *supra* note 173.

176. The proposal would also charge customers an additional transmission fee for electricity they feed into the grid. H.B. 1004, 90th Gen. Assemb., Reg. Sess. (Ark. 2015), https://perma.cc/9T5H-J33S.

177. Renew Wisconsin v. Pub. Serv. Comm'n, Case No. 15-CV-153, Decision and Order (Dane Co. Cir. Ct. Nov. 2, 2015), https://perma.cc/2M6L-QDQY.

178. Krysti Shallenberger & Gavin Bade, *Nevada Regulators Approve NV Energy, SolarCity Grandfathering Proposal*, UTIL. DIVE (Sept. 16, 2016), https://perma.cc/DXB4-NJYY.

solar will increase from $12.75 per month to $38.51 per month.[179] In California, following state utilities' proposal to cut net metering rates and back-and-forth discussions, utility regulators recently adopted "time-of-use" retail rates for net-metered customers.[180] Under the new rates, net-metered customers will receive different prices at different times of the day for the electricity they generate.[181] Utility customers, including net-metered customers, will pay the time-of-use rate when they purchase electricity from the grid. This effort is intended to match the real-time costs of generating and transmitting electricity to the credit net-metered customers receive. The new rates in California, which are part of a broad set of changes to residential rates, will be proposed by utilities though ultimately set by state regulators, and will take effect by July 1, 2017 for net-metered customers.[182]

In addition, a number of states have considered or introduced comprehensive changes in how they credit distributed generation. One alternative to net metering, known as a feed-in tariff, is offered in twenty-one states,[183] and is the most widely used policy for renewable energy outside of the United States.[184] Feed-in tariff programs in the United States are typically offered in combination with other incentives or as an alternative to net metering, leaving individual utility customers the final choice whether to receive credit under net metering or a feed-in tariff.[185]

Functionally, feed-in tariff programs bifurcate a utility customer's on-site production from their electricity usage, creating two parallel transactions that are measured by two separate meters. Utility customers participating in feed-in tariff programs purchase *all* of their electricity from utilities at normal retail rates, and simultaneously sell (or "feed") *all* of their output to utilities at the offered "feed-in tariff" rate.[186] The rate, established by state regulators, is de-

179. Julia Pyper, *Nevada PUC to Reconsider Grandfathering Rooftop Solar Customers into New Net-Metering Policy*, GREENTECH MEDIA (Jan. 26, 2016), https://perma.cc/B4LY-LBCX.

180. Jeff St. John, *California's NEM 2.0 Decision Keeps Retail Rate for Rooftop Solar, Adds Time-of-Use*, GREENTECH MEDIA (Jan. 28, 2016), https://perma.cc/U35X-LNJ6.

181. *Id.*

182. Order Instituting Rulemaking to Develop a Successor to Existing Net Energy Metering Tariffs Pursuant to Public Utilities Code Section 2827.1, and to Address Other Issues Related to Net Energy Metering 170-21, No. 14-07-002, CAL. P.U.C. 17 (July 10, 2014), https://perma.cc/6BF7-2Q53. The CPUC has a goal that all residential customers, including non-net-metered customers, will be subject to time-of-use rates beginning in 2019. *See id.* at 19.

183. *See* EIA, *Feed-in Tariffs & Similar Programs*, *supra* note 21.

184. *See* RENEWABLE ENERGY POLICY NETWORK FOR THE 21ST CENTURY, RENEWABLES 2016 GLOBAL STATUS REPORT 20, 20 (2016), https://perma.cc/E7EG-S3P9.

185. *See* EIA, *Feed-in Tariffs & Similar Programs*, *supra* note 21; *Feed-in Tariff: A Policy Tool Encouraging Deployment of Renewable Electricity Technologies*, U.S. ENERGY INFO. ADMIN., (2013), https://perma.cc/6TWX-FVYQ (noting each state offering feed-in tariff programs also offer net metering).

186. *Id.* at 6.

signed to cover costs of installing and maintaining an eligible generator plus ensure a modest profit on the generated output.[187] Unlike net metering, feed-in-tariffs are structured as long-term contracts, lasting as long as twenty years with a fixed tariff rate,[188] offering an advantage of a guaranteed, long-term return on investment.[189] However, rates offered under feed-in tariff programs may fall below the level required to encourage distributed generation development, as illustrated by the recent experience of Palo Alto's feed-in tariff program, which has failed to attract a single program participant since its adoption in 2012.[190] Exceptionally high rates may be equally harmful, as they could encourage over-development by promising windfall payments at the expense of taxpayers and other utility ratepayers.[191]

While the vast majority of proposed reforms are intended to *limit* the attractiveness of distributed generation, primarily by cutting compensation owners might receive, a few jurisdictions have attempted to reform net metering in order to *encourage* distributed generation development. One such reform, known as a "value-of-solar" tariff, has been adopted in just two jurisdictions, but is currently pending in a third. In 2014, Minnesota became the first state, and joined the city of Austin, Texas as the second jurisdiction, to offer such a scheme.[192] Like feed-in tariff policies, value-of-solar programs require customers to purchase all of their electricity from utilities and sell all of their output at a specified rate—the "value-of-solar" rate.[193] However, in contrast to traditional feed-in tariff programs, which attempt to estimate the value of solar energy to the generator (in the case of rooftop solar, the residential or commercial cus-

187. *Id.*; *see generally* 18 C.F.R. § 292.303(a) (1985).

188. *See* EIA, *Feed-in Tariffs & Similar Programs*, *supra* note 21.

189. Toby Couture & Karlynn Cory, Nat'l Renewable Energy Lab., NREL/TP-6A2-45551, State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-In Tariffs in the United States (2009), https://perma.cc/JVU9-7VWZ.

190. *See* Felix Mormann, *Clean Energy Federalism*, Fla. L. Rev. 1621, 1644, 1661 (2015); *Utilities CLEAN (FIT) Program*, City of Palo Alto (July 13, 2016), https://perma.cc/A9BJ-W7FH (indicating "[f]ive applications are in process" for tariff program). Internationally, feed-in tariff programs have been more successful at incentivizing new distributed generation. *See* Int'l Energy Agency, Deploying Renewables: Principles for Effective Policies 12328 (2008), https://perma.cc/D9S8-76PT.

191. *See* Mormann, *supra* note 190; *Utilities CLEAN (FIT) Program*, *supra* note 190; Int'l Energy Agency, *supra* note 190.

192. H.F. 729, 88th Leg., 4th Engrossment (Minn. 2013); John Farrell, *Could Minnesota's "Value of Solar" Make Everyone a Winner?*, Inst. for Loc. Self-Reliance (Mar. 13, 2014), https://perma.cc/Z4ZK-HLSY; *Residential Solar Energy Rate*, Austin Energy, https://perma.cc/SP28-3K2S.

193. Mike Taylor et al., Nat'l Renewable Energy Lab., NREL/TP-6A20-6236, Value of Solar: Program Design and Implementation Considerations, at v (2015), https://perma.cc/L5NY-86QJ.

tomer) by basing rates on the costs of generation plus a "reasonable" return,[194] value-of-solar programs try to estimate the value of solar generation to the entire electrical system and to wider society, by taking into account benefits from avoided fuel purchases, avoided generation costs, mitigated transmission and distribution costs, benefits to the grid, and some external benefits such as avoided carbon emissions.[195]

Value of solar rates take into account costs related to environmental benefits and mitigated distribution costs—such as costs incurred because of 'leaky' grid transmission lines—that may come with distributed generation.[196] These costs can be sizeable, and value of solar rates may, in certain instances, promise distributed solar customers a greater return than net metering programs. For example, Minnesota's preliminary value of solar rate was $0.135 per kWh in 2014.[197] In contrast, the rate for residential retail sales in Minnesota in 2016 was $0.131 per kWh.[198] At the moment, Minnesota's value-of-solar program is voluntary, meaning utilities may choose whether to credit customers at the value-of-solar rate or through traditional net metering.[199]

On June 30, 2015, Maine lawmakers passed value-of-solar legislation over the Governor's veto.[200] Like Minnesota, the proposed value-of-solar rate in Maine incorporates a value for "avoided environmental costs,"[201] defined as avoided carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrous oxides (NO_x)

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194. *Id.* at 6.

195. *Id.* at 1–3, 11.

196. EIA, *Feed-in Tariffs & Similar Programs*, *supra* note 21. Specifically, environmental and distribution components can represent a significant percent of the higher value-of-solar rate. *See also* MINN. VOST, *supra* note 21, at 42 (indicating avoided transmission and transmission costs, and avoided environmental costs amount to $0.039, out of a total value-of-solar rate of $0.135); TAYLOR ET AL., *supra* note 193, at 22 (indicating environmental, transmission and distribution deferral, and avoided transmission losses amount to $0.0281, in a high case rate of 0.11, and $0.003 in a low case of .049, where environmental and transmission and distribution loses are valued at zero).

197. *See* MINN. VOST, *supra* note 21, at 42. In 2014, Minnesota utility regulators established a methodology for determining the value-of-solar rate. Minnesota utilities that wish to adopt a value-of-solar rate as an alternative to net metering are required to use the methodology, but rates calculated using the methodology in 2016 may well be different than they were using the same methodology, but in 2014. *See generally id.* (noting the various considerations that go into the value-of-solar rate calculation.)

198. *Average Price of Electricity to Ultimate Customers by End-Use Sector*, U.S. ENERGY INFO. ADMIN. (2016), https://perma.cc/XF25-X4C3.

199. H.F. 729, Art. 9, subd. 10, 88th Leg., 4th Engrossment (Minn. 2013); *see also* Dan Haugen, *Minnesota Becomes First State to Set 'Value of Solar' Tariff*, MIDWEST ENERGY NEWS (Mar. 12, 2014), https://perma.cc/89EC-KD3S.

200. H.P. 863, 127th Leg., 1st Reg. Sess. (Me. 2015); *Maine – LD 1263 – 2015*, ADVANCED ENERGY LEGIS. TRACKER, https://perma.cc/Z7T2-8UBD.

201. ME. PUB. UTILS. COMM'N, MAINE DISTRIBUTED SOLAR VALUATION STUDY 34 (2015), https://perma.cc/FF6P-CQPQ.

emissions.[202] Maine determined that external benefits were equal to $0.093 per kWh in 2016 compared to $0.092 per kWh of avoided energy supply, transmission, and delivery costs. Retail rates averaged just $0.133 for Maine's largest two utilities in 2014, the most recent year for which data is available.[203] Currently, however, the state's public utility commission is reviewing its net metering policy because of a state law that is triggered when 1% solar generation is reached,[204] with the governor proposing to end net metering altogether.[205]

The only other value-of-solar tariff program in the United States was adopted by Texas utility Austin Energy in 2012.[206] Since its inception, the value-of-solar rate offered by Austin Energy has been readjusted downward twice, reflecting declining generation costs for natural gas power plants. Nevertheless, value of solar rates in 2015 still exceed retail rates by $0.036 per kWh.[207] Moreover, under the value-of-solar program, Austin has experienced remarkable growth among residential solar installations, jumping from approximately 6,000 kWh in annual generation from distributed generators in 2011 to over 20,000 kWh by year-end 2014.[208]

Individual and aggregate capacity limits have also been frequent targets for change.[209] While no state had an aggregate net metering cap greater than 1% before 2005, the average cap as of 2015 is near 4%.[210] Fourteen jurisdictions have raised aggregate caps at least once since 2004,[211] and at least three states—Illinois, Maryland, and Georgia—may reach their current aggregate caps by 2018.[212]

Since 2014 alone, at least four jurisdictions have adopted measures to increase aggregate caps; Rhode Island notably eliminated its aggregate cap alto-

202. *Id.* at 34.

203. *2014 Utility Bundled Retail Sales-Residential*, U.S. ENERGY INFO. ADMIN. (2016), https://perma.cc/6B7J-5BA7.

204. Marina Villeneuve, *LePage, Environmental Lobbyists Weigh Future of Solar Policy*, BOS. GLOBE (Aug. 9, 2016), https://perma.cc/6VRN-EH9K.

205. Fred Bever, *LePage Proposes End to Solar Net Metering Program*, ME. PUB. RADIO (Jul. 25, 2016), https://perma.cc/8R7F-HRD2.

206. *See Residential Solar Energy Rate*, AUSTIN ENERGY, https://perma.cc/2F8R-9WRF.

207. *Compare id.* ("residential solar rate schedule" showing solar tariffs between $0.10 and $0.12 per KWh), *with Residential Electric Rates & Line Items*, AUSTIN ENERGY, https://perma.cc/LV6S-PR6Z (showing residential energy rates ranging from $0.018/KWh to $0.11/KWh).

208. *See* TAYLOR ET AL., *supra* note 193, at 14.

209. *See* HEETER ET AL., *supra* note 109, at 8.

210. *Id.*

211. *Id.*

212. *Id.* at 25. Some states are already contending with caps that are too low. For example, New York's Public Service Commission suspended aggregate caps for all investor owned utilities in October 2015 until Reforming the Energy Vision proceedings are completed. Herman K. Trabish, *NY Regulators Lift Solar Net Metering Caps Until REV Docket Sets DER Values*, UTIL. DIVE (Oct. 21, 2015), https://perma.cc/ACY3-2K2B.

gether.[213] Among other states we reviewed to implement higher aggregate caps, Vermont's eleven percentage point cap increase was the largest, while Massachusetts increased its cap the least, a least at a three percentage point escalation.[214] In addition, three jurisdictions have increased individual capacity limits,[215] while only one state, Kansas, reduced its limit.[216]

II. Evaluating Current Pricing Approaches

Before outlining the socially optimal distributed generation policy, it is important to analyze the current pricing approaches. In this Part, we review the characteristics of the most common pricing methods and discuss the limitations of each approach.

A. Net Metering

At its core, the argument that a kWh of electricity produced and sent to the grid by a distributed generator should be compensated at the retail rate is grounded in the basic principles of perfectly competitive markets. In a perfectly competitive market with no market failures, buyers and sellers, none of whom have any market power, buy or sell the product at the same market-clearing price. So, if a new entrant wants to sell a unit of the product in this market, the price that it would get would be that prevailing market-clearing price. In such a market, the clearing price also equals the marginal cost—the production cost of the last unit sold in the market. In perfectly competitive markets, the prevailing

213. Celia B. O'Brien, Assistant General Counsel and Director, National Grid, Comment Letter on Docket No. 4549—Tariff Advice Filing to Amend RIPUC No. 2099, Net Metering Provision (Feb. 19, 2015) (removing the cap for all utilities except for Block Island Power Company and Pascoag Utility District). Other individual caps include: Order Raising Net Metering Minimum Caps, Requiring Tariff Revisions, Making Other Findings, and Establishing Further Procedures, Case Nos. 14-E-0422 & 14-E-0151 (N.Y. Pub. Serv. Comm'n Dec. 15, 2014); H.B. 4385, 188th Leg. (Mass. 2014); H.B. 702, Gen. Assemb. (Vt. 2014).

214. H.B. 702, Gen. Assemb., Reg. Sess. (Vt. 2014); Heeter et al., *supra* note 109, at 3–4 (noting Vermont's aggregate cap raised from 4% to 15%); *Mass. Bumps Net Metering Cap to Spur Solar Projects*, Law 360 (Apr. 11, 2016), https://perma.cc/CBU6-Q7VH.

215. H.B. 1004, 90th Gen. Assemb., Reg. Sess. (Ark. 2015) (increasing capacity limit from 25 kW to the greater of 25 kW or 100% of the net metering customer's highest monthly usage); S.B. 182, 64th Leg. (Mont. 2015) (increasing net metering cap from 50 kw to 1 MW); Second Entry on Rehearing, Case No. 12-2050-EL-ORD (Ohio P.U.C. May 28, 2014) (allowing customers to size their systems to generate 120% of their electricity needs instead of 100%).

216. H.B. 2101, 2014 Leg. (Kan. 2014) (reducing limit from 25 kW to 15 kW for systems built after July 1, 2014, retaining existing levels for current net metering customers). Arkansas bill H.B. 1004 imposed a "limit" on residential NEM customers of 100% of the highest monthly usage in the previous twelve months. H.B. 1004, 90th Gen. Assemb., Reg. Sess. (Ark. 2015).

retail price is also the "avoided cost." In other words, if the electricity market was a competitive market with no externalities, net metering—the practice of reimbursing a producer at the prevailing retail price—would be the right policy in the absence of any market failure.

However, while the market-determined retail rate in perfectly competitive markets is actually the marginal cost of production, this is not the case for retail electricity rates. Many retail electricity tariffs use inefficiently designed, flat volumetric per kWh rates as determined by state public utility commissions. These rates are intended to cover not only the variable costs of the generation of electricity itself, but also other costs including transmission and distribution expenses, most of which are fixed, as well as a reasonable rate of return for the utilities.[217]

1. Shortcomings of a Bundled, Flat Volumetric Rate

A typical tariff for residential customers has two parts, a fixed monthly service charge and a flat, volumetric energy-consumption charge. Even though transmission, distribution, ancillary services and capacity-based non-energy fixed costs amount to about 55% of an average electricity bill,[218] fixed charges represent about only 7% of the average electric bill. The rest of the fixed non-energy costs are recovered through a bundled, flat volumetric rate. Consequently, utilities' ability to recover their costs depends on the volume of electricity sold.

The retail electricity price is essentially the bundled average cost of providing retail electricity to a customer. The final electricity consumed by the end-user requires other services in addition to the generation of electricity, such as transmission, balancing, and local distribution. Hence the electricity sent to the grid by a distributed generator, which lacks those additional services, is not a perfect substitute for the final good—the retail electricity—consumed by the end-user. As the services provided by distributed generation are different from retail electricity, compensating it using retail electricity rates would lead to economic inefficiency.

If there were separate, competitive retail markets for generation, distribution, transmission, and other necessary services in which end-users could shop individually for each component of electricity delivery, the resulting prices could be used to reimburse distributed generation separately for the benefits it provides or the costs it avoids in each market, if any. In such a setting, net metering could be used, and would be socially optimal. Unfortunately, due to the complex nature of electricity provision, and the associated high fixed costs

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217. *See* Tanton, *supra* note 38, at 1–5.

218. Lisa Wood & Robert Borlick, Edison Elec. Inst., Value of the Grid to DG Customers 3 tbl.1 (2013), https://perma.cc/5QGC-NGXC.

of providing essential services such as transmission and distribution, pricing of this sort is not possible.

Given the absence of unbundled pricing, when net-metered customers are compensated using retail rates, they avoid paying for the costs already incurred for their reliance on grid-delivered electricity and for the demands they place on the grid and grid-related services.[219]

2. *Temporal and Locational Variations, and Production and Transmission Constraints*

Another source of inefficiency in electricity pricing stems from the way in which energy charges are calculated for retail customers. Almost all retail customers are charged on the basis of the average cost of electricity generation during a set billing period.[220] Thus, the energy price that these consumers face is a flat rate regardless of when or where they consume their electricity. However, the cost of generating energy varies significantly by time and location.[221] As the demand for electricity is higher at certain "peak" demand times during the day, utilities use more expensive generators during these periods to be able to meet the demand. Similarly, when the transmission lines serving a particular location are congested due to high demand, the lowest priced energy might not be able to flow freely and hence the demand at that location would have to be met by more expensive electricity.[222] Even though electricity generated during peak periods, or electricity transmitted and delivered to congested areas, is costlier to provide, it is still sold to every end-user at the same lower average rate.

As a result of flat volumetric rates that are uniform across a utility's service territory, consumers do not receive the correct price signals about the true cost of providing electricity and therefore do not adjust their usage patterns accordingly. Electricity is then over-consumed during the more costly peak periods and under-consumed during the "off-peak" periods. The cost of peak energy generation is averaged into the retail rate that is paid by all the customers, creating a cross-subsidy between off-peak users and peak users.

When this variation in costs is not reflected in retail rates, net metering compensates distributed generation using the same flat volumetric rate at all times and locations. As a consequence, net metering policies lead to overcompensating distributed generation exports during off-peak times and undercompensating it during peak times. Net-metered customers who export energy during the peak times and draw on grid power in the evening when utility costs of production are lower effectively exchange a high-value product for a low-

219. TANTON, *supra* note 38, at 1.

220. *See* GLICK ET AL., *supra* note 10, at 12.

221. *Id.*

222. *Locational Marginal Pricing*, PJM (2016), https://perma.cc/AGP8-KN2C.

value one.[223] Thus, by passing electricity into the utility grid for a lower price than utilities would otherwise pay, distributed generators are being undercompensated for their contribution of electricity and subsidizing non-net-metered customers.[224]

3. Demand Variations and Distribution Constraints

A consumer's contribution to the fixed costs of local distribution networks is also dependent on the time and location of the consumption. The maximum demand during peak periods is the main driver of any new distribution system capacity investment.[225] A customer's maximum demand at the moment of highest usage among all customers in a particular location—"coincident peak demand"—is more important as a driver of infrastructure investments than the customer's individual peak demand—"non-coincident peak demand."[226] For example, a customer may be using the most electricity early in the morning, but if the circuits at that location are not already loaded at that time her consumption would not prompt new investment. However, if the peak demand on the circuit at that location occurs in the early afternoon, her early afternoon demand might prompt new investment even if it is actually less than her morning demand. If however, the same customer moves to a different area with a higher network capacity, even her coincident peak demand may not require new capacity investment.

When distributed generation lowers the coincident peak demand at a location which is close to the peak network capacity, it lowers the need for future distributed capacity investment. This value varies significantly with location. For example, while the capacity deferral value of distributed solar panels is $6/kW-yr when averaged over Pacific Gas & Electric's service territory, the capacity value can be as much as $60/kW-yr when analyzed at a more granular feeder level.[227] As this variation is not reflected in the flat volumetric retail rates, common net metering policies cannot sufficiently capture the full value of distributed generation. On the other hand, if distributed generators can avoid only minimal usage during peak periods, and hence cannot significantly help defer

223. Anderson Hoke & Paul Komor, *Maximizing the Benefits of Distributed Photovoltaics*, 35 ELEC. J. 55, 58 (2012).

224. GIDEON WEISSMAN, SHINING REWARDS THE VALUE OF ROOFTOP SOLAR POWER FOR CONSUMERS AND SOCIETY 4–6 (2015), https://perma.cc/9PQX-DDQC.

225. Paul Simshauser, *Distribution Network Prices and Solar PV: Resolving Rate Instability and Wealth Transfers Through Demand Tariffs*, 54 ENERGY ECON. 108, 108–09 (2016).

226. Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Staff White Paper on Ratemaking and Utility Business Models, Case No. 14-M-0101, N.Y. PSC, Filing No. 416 at 80 n.81 (July 28, 2015).

227. Michael A. Cohen, Paul A. Kauzmann & Duncan S. Callaway, Economic Effects of Distributed PV Generation on California's Distribution System 16 (Energy Inst. at Haas, Working Paper No. 260, 2015), https://perma.cc/RK2R-E67W.

capacity investments, then the implicit subsidy they get by avoiding paying for the distribution network upgrade might be substantial.[228]

4. Equity Considerations

Cost recovery using flat, volumetric rates with low fixed charges creates a mismatch between the way in which costs are incurred and how they are recovered. This mismatch gives rise to the possibility of cost shifting among different customer groups when one group lowers their consumption for any reason, whether it is a result of distributed generation, energy efficiency, or personal preference. If a group of customers decide to conserve energy by running their air conditioners less often, for example, they reduce their volumetric consumption. The revenue generated by volumetric charges is no longer high enough to recover that the utility already incurred. If such costs can no longer be recovered from this group of consumers, the utility ends up having to raise the volumetric rate for all the customers to make up for the shortfall of revenue during the next rate case. Thus, with net metering, while customers who own solar panels essentially get credited for the output they produce at the retail rate by being billed for a lower "net" volume of electricity, customers without distributed generation systems end up having to make up the difference with higher rates.[229]

Presently, distributed wind and solar penetration across much of the United States is sufficiently limited that any cost shifts are relatively small. However, in states where distributed generation is already substantial, these transfers may be significant. One Arizona utility alleged cost shifts among residential ratepayers in Arizona totaling $1,000 a year for every net metering customer,[230] and California's net metering policy could shift as much as $370 million in fixed service costs to non-net-metered consumers by 2020.[231] In New York, utility companies suggested that cost shifts might be a little more than $300 million annually if all the projects that are waiting for the interconnection queue are realized.[232] Although Arizona and California may encounter a greater degree of cost shifting than other states due to higher solar penetrations, a 2014 white paper published by the American Public Power Association predicted

228. Simshauser, *supra* note 225, at 119–121.

229. *See* TANTON, *supra* note 38, at 9–11.

230. Application, In the Matter of the Application of Arizona Public Service Company for Approval of Net Metering Cost Shift Solution, Docket No. E-01345A-13-0248, at 9-10 (Ariz. Corp. Comm'n July 12, 2013).

231. CAL. PUB. UTILS. COMM'N, CALIFORNIA NET ENERGY METERING RATEPAYER IMPACTS EVALUATION 6 (2013), https://perma.cc/ER9R-Y3F5.

232. Joint Utilities Response to Staff's Information Request, Case 15-E-0751, at 1 (N.Y. Pub. Serv. Comm'n, In the Matter of the Value of Distributed Energy Resources June 10, 2016), https://perma.cc/3CSD-VUHM.

that if net metering accounted for 5% of total electricity load, it would lead to a 2% rise in the average utility rates for non-net metering customers.[233]

Net metering supporters have been quick to respond that some amount of cross-subsidization is inevitable—consumers who conserve power and minimize utility overhead effectively offset, and therefore subsidize, customers who waste electricity during periods of peak demand.[234] However, because of the expenses associated with owning or leasing solar panels and a greater incentive among high-consumption households to pursue distributed generation as a means of lowering utility bills, net metering is often disproportionately concentrated among wealthier customers. In 2013, the median household income of California net metering households was 68% higher than that of the state.[235] Thus, many fear that net metering acts as a socially regressive subsidy for utility customers with distributed generation, who are traditionally more affluent, by placing additional costs on moderate- and low-income utility customers without the resources to afford distributed generators themselves.[236]

The cost shifting impacts of net metering also vary with the underlying rate design in a particular jurisdiction. For example, in California where the retail electricity rates use an increasing block pricing design, utility interests claim that the consequences of cost shifting are exacerbated by the fact that many net-metered customers are also high-usage consumers subject to higher utility rates and, prior to installing on-site generation, accounted for a sizeable portion of utility revenue.[237] In 2013, the top one-quarter of households by energy consumption accounted for one-half of utility billings.[238] The financial vacuum created by the reduction in the grid-supplied electricity consumption of these customers as a result of net metering was substantial. In California, prior to installing solar or wind units, metered customers were charged rates equivalent to 154% of the basic cost-of-service, but paid rates equivalent to 88% of this cost afterward.[239]

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233. Am. Pub. Power Ass'n, Solar Photovoltaic Power: Assessing the Benefits & Costs 5 (2014), https://perma.cc/7UAN-WJ29.

234. *See, e.g.*, David Schmitt, *Net Metering: Getting Beyond the Controversy*, 2011 A.B.A. Recent Dev. Pub. Util. Comm. & Transp. 417, 425 ("[Utility] customers already cross-subsidize each other.")

235. Ashley Brown, *Valuation of Distributed Solar*, 27 Elec. J. 27, 47 (2014), https://perma.cc/C35M-G2QV.

236. *Id.* at 27 ("Retail net metering . . . is socially regressive because it effectively transfers wealth from less affluent to more affluent consumers.")

237. Borenstein & Bushnell, *supra* note 90, at 458–59.

238. Mitnick, *supra* note 162, at xvi.

239. John V. Barraco, *Distributed Energy and Net Metering: Adopting Rules to Promote a Bright Future*, 29 J. Land Use & Envtl. L. 365, 383 (2014).

B. Fixed Charges

To allay cost recovery issues associated with net metering, utilities across thirteen states proposed or adopted over twenty types of measures. Nearly all of these states considered establishing or increasing fixed service, demand, or capacity charges; though only half considered raising rates specifically for net metered customers.[240] On average, proposed measures would increase monthly rates for net-metered customers by approximately twelve dollars. Idaho and Hawaii were the most aggressive states, each proposing price hikes equivalent to sixteen dollars per month.[241] Ultimately, neither Idaho's nor Hawaii's proposed hikes were approved: Idaho's was denied by the state commission outright[242] and Hawaii's was superseded by the new "grid-supply" and "self-supply" options that replaced net metering in the state in late 2015.[243] In Arizona, the state's largest electric utility requested approval to raise its rates to include a forty or fifty dollar monthly charge for net-metered customers,[244] but received approval only for a monthly charge of approximately five dollars for an average household system.[245]

It is important to distinguish an arbitrary increase in fixed charges from possible bill increases that would occur as a result of a properly designed tariff. An increase in fixed charges that applies only to distributed generators would hurt efficiency if it does not reflect the costs that they actually impose on the

240. *Distributed Generation Rate Reform Around the U.S.*, LEWIS & CLARK L. SCH. (Oct. 1, 2014), https://perma.cc/R9AR-85SP.

241. *Id.* In addition to a fixed service fee of sixteen dollars per month for distributed generation customers, Hawaii proposed a fifty-five dollars per month service fee for all ratepayers. *HECO Companies Propose Significant Charges for DG Customers*, LEWIS & CLARK L. SCH. (Sept. 24, 2014), https://perma.cc/X9F6-WEXR.

242. Press Release, Idaho Power Utility Company, *Most of Idaho Power's Net Metering Proposals Denied* (July 3, 2013), https://perma.cc/V594-7ELD.

243. Instituting a Proceeding to Investigate Distributed Energy Resource Policies 14, No. 2014-0192, Order No. 33258 (Haw. P.U.C. Oct. 12, 2015) ("The HECO Companies subsequently filed their [Distributed Generation Interconnection Plan, which included the proposed fixed charge] in Docket No. 2011-0206, and by 'Order No. 32292 Transferring Distributed Generation Interconnection Plan to Docket No. 2014-0192' ('Order No. 32292'), the commission transferred the DGIP from Docket No. 2011-0206, into the instant proceeding for review."). The instant proceeding culminated in Decision and Order 33258, issued on October 12, 2015, that installed the "self-supply" and "grid-supply" options. *Id.*

244. Diane Cardwell, *Compromise in Arizona Defers a Solar Power Fight*, N.Y. TIMES (Nov. 15, 2013), https://perma.cc/4MCB-P6LG.

245. In a 3-to-2 vote, the commission decided to levy a fixed charge for net-metered customers equal to $0.70 per kW of system capacity. The utility saw a silver lining in this decision, despite the substantial reduction in additional charges, because the commission found that there indeed was a cost shift to non-solar customers. *Id.*

grid.[246] Converting distribution expenses into flat service fees also ignores actual variation in delivery costs, which decline when customers are located near generators or are geographically concentrated,[247] and undervalues the savings that can be achieved by the *distributed* nature of distributed generation. Simply increasing fixed service charges can therefore transfer cost burdens from rural, higher-use ratepayers, who require greater delivery costs, to urban and low-use ratepayers, for whom these costs are lower.[248]

C. *Net Metering Caps*

As discussed earlier, state policies on net metering caps as well as on how credits are carried forward vary significantly.[249] Utilities in four states have already reached their cap, while utilities in four additional states are projected to reach their caps by 2018.[250]

An arbitrary cap, however, tries to fix the inefficiencies caused by net metering by enacting another inefficient policy. While it is true that net metering policies increase a utility's risk concerning the recovery of its costs, the proper way to solve that problem is to address the underlying reasons for this increased risk rather than to suppress the symptom itself. To the extent that a utility cannot recover its costs with the prevailing retail rates, a cap could be necessary to ensure that the grid can be maintained. However, given that a proper tariff design would alleviate any cost recovery concerns, an arbitrary net metering cap would only lead to further inefficiency and under-deployment of distributed generation.

III. Evaluating the Contributions of Distributed Generation to the Electric Grid

Economic efficiency defines the socially optimal outcome of a policy as the point at which its marginal social benefits—which includes both private and external benefits—of a good equals it marginal social cost—which, similarly, includes both private and external costs. Therefore, it is important to first understand how interconnection of distributed generation systems affects the overall electric grid as well as society as a whole before discussing what a socially optimal pricing policy might look like. In this Part, we review the private marginal benefits and private marginal costs of distributed generation—benefits

246. Darghouth et al., *supra* note 19, at 6–8.
247. Carl Linvill, Reg. Assistance Project, Designing Distributed Generation Tariffs Well 36 (2013).
248. Jim Lazar, Reg. Assistance Project, Rate Design Where Advanced Metering Infrastructure Has Not Been Fully Deployed 59 (2013).
249. Heeter et al., *supra* note 109, at v.
250. *Id.*

and costs that accrue to the parties involved in the transactions that take place in the electricity market. Then, in Part IV, we discuss the external benefits and external costs—those that accrue to the third parties.

A. Benefits of Distributed Generation to the Electric Grid

The clearest benefit of distributed generation to the overall electrical system is that it "avoids" the cost of the energy that would have had to be generated by a bulk system generator to meet customer demand. Installing a distributed generation system reduces the amount of energy that a customer needs from the grid, and this reduced demand leads to savings in the amount of what it would have cost the bulk system to produce this energy. These avoided costs are driven by the variable costs of the marginal resource that is being displaced, which depend on that resource's fuel prices, variable operation and maintenance costs, and efficiency.[251] Avoided energy benefits can be especially significant if distributed energy resources help avoid generation from costlier peak plants. Although some utilities question the ability of intermittent distributed generators to cover customer demand reliably enough to produce meaningful reductions in fuel costs,[252] a study by Arizona Public Service estimated the utility's savings from avoided fuel purchases due to distributed generation were equivalent to $0.08 per kWh.[253] As the national average residential retail rate is $0.125 per kWh, the reduced fuel expenses resulting from distributed generation are extremely significant.[254]

Distributed energy resources also provide value to the transmission system and the distribution system. Identifying and understanding these values is crucial for achieving efficiency in grid investment.[255] For example, distributed generation provides certain benefits due to its "distributed" nature, such as lower line losses, because electricity travels shorter distances between the generator and the end-user. Up to 8% of a utility's total generated output may be lost in-transit because of inefficient power lines.[256] Distributed generators stationed

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251. Devi Glick et al., Rocky Mountain Inst., A Review of Solar PV Benefit & Cost Studies 14 (2013), https://perma.cc/7EK8-HDEY.

252. Navigant Consulting, Distributed Generation Study for NV Energy (2010), https://perma.cc/FP3Q-XAS2.

253. R.W. Beck, Inc., Distributed Renewable Energy Operating Impacts & Valuation Study for Arizona Public Service, at xxii (2009).

254. *Table 9.8. Average Retail Prices of Electricity*, U.S. Energy Info. Admin. (Jan. 26, 2016), https://perma.cc/VH7M-SDWJ.

255. *See generally* Susan Tierney, Analysis Grp., The Value of "DER" to "D" (2016), https://perma.cc/SC9S-GDW6 (discussing the value of distributed energy resources to the distribution system).

256. U.S. Dep't of Energy, The Potential Benefits Of Distributed Generation and Rate-Related Issues That May Impede Their Expansion 3–18 (2007), https://perma.cc/XQ75-LNEC.

physically closer to end-users—at precisely the location of end-users for residential solar generators—directly curtail these energy losses.[257] Therefore, to the extent that locally placed distributed generators can satisfy nearby demand, the expenditures of utilities transmitting electricity,[258] and maintaining grid capacity and reliability can be avoided.[259] Further, the rate of distribution losses increases during peak times, making resources that help avoid the use of distribution network during those times even more valuable. As a result, they may save utilities from spending on distribution system improvements that can run as high as ninety-six dollars for every kW of line capacity added.[260]

In addition to these immediate benefits, distributed renewables offer long-term cost savings by enabling utility and state entities to defer, or altogether avoid, large capital investments in new fossil-fuel generators, transmission, and distribution infrastructure.[261] By decreasing the demand for power generation from traditional plants, distributed generation reduces the need for investments to provide additional generating capacity. Further, it reduces the strain on the current capacity when solar generation occurs in times of high demand. While estimates of long-term cost savings place the estimates within the $0.01 per kWh to $0.02 per kWh,[262] distributed generation systems must be integrated into the grid planning process before these benefits can be realized.[263]

Finally, distributed generation also has resiliency benefits. Resiliency is defined as the characteristics of utility infrastructure that "avoid or minimize interruption of service during an extraordinary and hazardous event."[264] Major weather-related power outages have increased dramatically in the last decades,[265] and the cost estimates of these power outages range from $18 billion to $70 billion per year.[266] As such, there is an increasing need and interest in building systems that are resilient. Distributed generation can indeed be invaluable to provide power supply during extreme weather events such as storms or other emergency situations, in combination with smart inverters, microgrids and energy storage units. Further, as distributed generation units are located

257. R.W. Beck, Inc., *supra* note 253.
258. U.S. Dep't of Energy, *supra* note 256.
259. Hoke & Komor, *supra* note 223, at 55–61.
260. Jim Lazar, Reg. Assistance Project, Recognizing the Full Value of Energy Efficiency 39 (2013), https://perma.cc/74TZ-X6GF.
261. Hoke & Komor, *supra* note 223, at 57.
262. L. Bird et al., Nat'l Renewable Energy Lab., NREL/TP-6A20-60613, Regulatory Considerations Associated with the Expanded Adoption of Distributed Solar 10 (2013), https://perma.cc/C6LX-R98X.
263. U.S. Dep't of Energy, *supra* note 256.
264. Miles Keogh & Christina Cody, Nat'l Ass'n of Reg. Util. Comm'rs, Resilience in Regulated Utilities 1 (2013), https://perma.cc/XE7H-CPR9.
265. Nat'l Renewable Energy Lab., Distributed Solar PV For Electricity System Resiliency 1 (2014), https://perma.cc/7XSH-MLRH.
266. *Id.*

closer to consumers, they also reduce the risk of outages due to failures in transmission and distribution systems.[267] While there is no single widely accepted metric or methodology to measure resiliency benefits of distributed generation, the existing monetary estimates range from $0.010 per kWh to $0.025 per kWh.[268]

B. Costs of Distributed Generation to the Grid

The costs of distributed generation go beyond the costs of installing new meters that can measure the flow of electricity in both directions and ensuring safe grid interconnection standards. While most distributed generators are connected to the grid, and therefore are free to draw electricity or feed in excess generation, they are not integrated into the operation or long-term planning of the grid's infrastructure.[269] As electricity cannot be stored on a large scale, customer usage must be met in real time by utility generation.[270] This dynamic requirement places significant responsibility on utilities and grid operators to ensure supply and demand are instantaneously balanced throughout the day as the distributed generation output changes.[271] Significant mismatches between consumer demand and available power supply can cause grid frequency levels to drop,[272] which may damage generator turbines, or, if left unchecked, can even lead to blackouts.[273] Accommodating non-synchronous generation and the variable and intermittent nature of distributed solar generation output presents challenges and expenses.

The dependence of most distributed generation on weather conditions inescapably means that its output is variable and patterned. Solar generation is greater seasonally in summer months and diurnally in the early afternoon, but dips in winter and the evening.[274] The intrinsically variable output of distributed wind or solar generators can hamper the grid's reliability and interfere with its

267. ALISON SEEL & TOM BEACH, NON-ENERGY BENEFITS OF DISTRIBUTED GENERATION 7 (2015), https://perma.cc/6S62-ZSKA.

268. *Id.* at 7; MICHAEL SULLIVAN ET AL., VALUE-BASED RELIABILITY PLANNING FOR GRID MODERNIZATION INVESTMENTS 3 (2014), https://perma.cc/S54L-U248.

269. ELEC. POWER RESEARCH INST., THE INTEGRATED GRID 8 (2014), https://perma.cc/U77P-W893.

270. *See* Timothy P. Duane, *Legal, Technical, and Economic Challenges in Integrating Renewable Power Generation into the Electricity Grid*, 4 SAN DIEGO J. CLIMATE & ENERGY L. 1, 7–9 (2013).

271. *See id.* at 8–9.

272. ERIK ELA ET AL., NAT'L RENEWABLE ENERGY LAB., ACTIVE POWER CONTROLS FROM WIND POWER: BRIDGING THE GAPS 40 (2014), https://perma.cc/XA7K-GRDP.

273. *Id.* at 1.

274. N. AM. ELEC. RELIABILITY CORP., ACCOMMODATING HIGH LEVELS OF VARIABLE GENERATION 24 (2009), https://perma.cc/NL4X-XNU4 [HEREINAFTER NERC REPORT].

efficient operation.[275] Even if the total electricity production by a distributed generator in a month is comparable to the monthly usage of the owner, the actual need at a particular time may not correspond with the level of electricity production at that time.[276] Because storage options for electricity are not adequate, this mismatch leads to bi-directional energy flows as customers draw energy from the grid at certain times and export energy to the grid at other times.[277]

As electricity supply and demand must be balanced in real time, electricity suppliers need to react quickly to changes in the net electricity load they need to serve, and hence they require resources with ramping flexibility[278] and the ability to start and stop multiple times per day.[279] Not having flexible resources that can ramp generation up or down quickly can pose significant challenges to the utilities, especially in states that have higher renewable integration such as California.[280] Although frequency-control mechanisms, known as "smart inverters," can mimic the response of a traditional generator by curtailing or increasing (if possible) photovoltaic output, most residential distributed solar units lack this feature.[281] In the absence of such a technological modification, grid managers must ensure that traditional bulk generators remain capable of providing the response necessary to prevent negative consequences.[282] Increases in the average operating costs of conventional plants resulting from frequent cycling are expected to be higher as the degree of distributed solar generation penetration increases.[283]

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275. TANTON, *supra* note 38, at 4.

276. David Raskin, *Getting Distributed Generation Right: A Response to "Does Disruptive Competition Mean a Death Spiral for Electric Utilities?"*, 35 ENERGY L.J. 263, 266 (2014).

277. TANTON, *supra* note 38, at 2.

278. *See id.*

279. *See id.* at 4.

280. *See* CAL. INDEP. SYS. OPERATOR, FAST FACTS: WHAT THE DUCK CURVE TELLS US ABOUT MANAGING A GREEN GRID 3 (2013), https://perma.cc/GDU6-NAYP.

281. *See* Borenstein & Bushnell, *supra* note 90, at 455 n.20 (2015). California stands as a notable exception to this rule, with updated interconnection requirements for distributed PV units that require installation of smart inverters to provide local voltage and frequency support. *See* Decision 14-12-035, Interim Decision Adopting Revisions to Electric Tariff Rule 21 for Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company to Require 'Smart' Inverters, CAL. P.U.C. 7 (Dec. 22, 2014).

282. *See* NERC REPORT, *supra* note 274, at 47.

283. *See* MASS. INST. OF TECH., THE FUTURE OF THE ELECTRIC GRID 64 (2011), https://perma.cc/UKE4-SM36; *see also* BRUCE TSUCHIDA ET AL., BRATTLE GRP., COMPARATIVE GENERATION COSTS OF UTILITY-SCALE AND RESIDENTIAL-SCALE PV IN XCEL ENERGY COLORADO'S SERVICE AREA 35–36 (2015).

Bi-directional energy flow introduced by net-metered customers also imposes additional strains on the physical electric grid,[284] leading to increased flow management and voltage regulation costs.[285] The electric grid was originally intended to accommodate one-way delivery of electricity from large-scale power plants to end-use consumers. When unregulated, bi-directional flows may overload the circuits close to the distributed generator, which might not be able to handle the temporary high flow volume.[286] Furthermore, an unexpected reverse energy flow may jeopardize the safety of utility workers.[287]

Another related challenge is that distributed solar units, in contrast to centralized fossil fuel power plants, are almost completely weather-dependent, and cannot be intentionally fueled or dispatched with certainty to meet consumer demand at a particular time.[288] As a result, utilities must provide adequate back-up power. In fact, distributed solar customers may depend on utility-supplied power to supplement or meet their usage sixteen hours a day, including evening hours when consumption is low.[289] Output from distributed solar units can fluctuate as much as 50% within a thirty- to ninety-second time frame and 70% within a five- to ten-minute time frame.[290] Erratic changes in output make matching electric generation and customer usage difficult,[291] and can require other power plants to remain online simply to ensure that adequate power is available to meet demand.[292] Placing primary or back-up responsibility for energy coverage on fossil-fuel power plants can prompt their sustained use even with environmentally preferable sources available, thereby forgoing the environmental benefits of distributed generation and doing little to reduce the operational costs of utilities.[293]

However, it should also be noted that the costs associated with bi-directional energy flows, as well as with the intermittency and variability of solar power can be significantly lowered or even eliminated as technology and fore-

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284. *See* AM. PUB. POWER ASS'N, *supra* note 2, at 11 (potential safety issues involving distributed generation include "islanding," high-voltage spikes, out-of-phase reclosing, and system-wide blackouts).

285. *See* MASS. INST. OF TECH., *supra* note 283, at 17; *see also* ELEC. POWER RESEARCH INST., *supra* note 269, at 14.

286. *See* AM. PUB. POWER ASS'N, *supra* note 2, at 11.

287. *See* Rebuttal Testimony of Ashley C. Brown on Behalf of Wisconsin Electric Power Company, Wis. P.S.C. Docket No. 05-UR-107 at 33 (Sept. 12, 2014); AM. PUB. POWER ASS'N, *supra* note 2, at 11.

288. *See* Borenstein & Bushnell, *supra* note 90, at 455.

289. *See* TANTON, *supra* note 38, at 10.

290. NERC REPORT, *supra* note 274, at 27.

291. *Id.* at ii.

292. *See* Borenstein & Bushnell, *supra* note 90, at 455.

293. L. BIRD ET AL., NAT'L RENEWABLE ENERGY LAB., NREL/TP-6A20-60451, INTEGRATING VARIABLE RENEWABLE ENERGY: CHALLENGES AND SOLUTIONS 3–4 (2013), https://perma.cc/28B5-XK8Y.

casting methods become more advanced. Because factors relevant to solar generation (like sunrise, sunset, and solar noon times) can be identified with certainty, theoretical production levels can already be reasonably predicted.[294] Further, improving energy storage, increasing transmission line capacity, coordinating energy distribution across jurisdictions, incorporating advanced forecasting techniques into grid management, installing smart inverters on distributed solar units, and improving ramping capability of conventional generators are all likely to mitigate certain negative consequences of distributed generation systems.[295]

IV. Considering the Social Benefits of Distributed Generation

An externality is the uncompensated benefit or cost imposed on third parties by an activity. As its effect is not borne by the parties carrying out the transaction, a market failure arises.[296] When externalities are present, economic efficiency can be achieved only when the externalities are fully "internalized"—when parties to the market transaction are made to bear these external costs and benefits. Therefore, an economically sound distributed generation price policy should ensure that any social benefits of cleaner energy provided by distributed generation are reflected in the price it is paid.

The primary external benefit of distributed generation is arguably the reduced CO_2 emissions from fossil fuel sources that are displaced by distributed generators. However, distributed solar generation offers many other benefits for the general public,[297] including public health and welfare improvements, water conservation, land preservation, and reductions in physical infrastructure necessary to support fossil-fuel electricity generation.[298]

As these external benefits are not fully reflected in current retail tariffs, if at all, the existing net metering policies are not sufficient to capture the true value of distributed generation to the society, and will thus lead to less distributed generation than is socially optimal.

A. Incorporating Climate Change Benefits

As carbon pollution is a classic example of a negative externality, which the market would overproduce without intervention, the simplest policy solution would be to tax all polluters by exactly the amount of the marginal external

294. Idaho Power, Solar Integration Study Report 16–17 (2014), https://perma.cc/J5N7-F2W3.

295. *See* Cochran et al., *supra* note 157, at 2; *see also* Elec. Power Research Inst., *supra* note 269, at 14.

296. Jonathan Gruber, Public Finance and Public Policy 123 (4th ed. 2013).

297. Glick et al., *supra* note 251, at 13.

298. Lazar, *supra* note 260, at 50.

damage caused by one more unit of emissions. However, this approach would require a comprehensive overhaul of federal and state energy policies, and is not feasible in the near future given the current legislative gridlock in U.S. Congress.

If power plants do not fully internalize the external costs of their carbon emissions, then these costs are not reflected in the cost of generating electricity, and therefore are not reflected in retail electricity rates. As a result, standard net metering policies underpay distributed generation for the environmental benefits it provides. Thus, net metering policies falls short of inducing the socially optimal level of distributed generation. To transmit the right incentives, the remuneration for distributed generation should reflect the benefits associated with the net avoided emissions that distributed generation provides. Calculating these benefits requires three distinct steps: quantifying the amount of net avoided emissions, monetizing those emissions using the monetary value of the marginal external damage, and ensuring that this approach does not under- or over-value distributed generation as a result of other regulatory policies.

1. Quantifying Net Avoided Emissions

The first step in valuing the climate change benefits of distributed generation is to calculate the amount of net avoided emissions—the amount that would have been emitted in the absence of the distributed generator. In this calculation, it is crucial to note that avoided emissions from distributed generation depend on the type of generator that the distributed generation is displacing—the marginal generator—and thus heavily depend on the time and location of the energy generated.[299] If solar generation is displacing a generator with low or zero carbon emissions, such as a nuclear plant, the avoided carbon emissions would be low. If solar generation is displacing a coal-fired plant, the avoided carbon emissions would be high. Similarly, the external health benefits of distributed generation that result from lowering emissions also vary with generator being displaced.[300]

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299. For example, as natural gas is the dominant marginal fuel in California, the average carbon dioxide displacement by a solar panel there is lower than in more coal-intensive states, such as Kansas. *See* Kyle Siler-Evans et al., *Regional Variations in the Health, Environmental, and Climate Benefits of Wind and Solar Generation*, 110 PNAS 11768, 11770 (2013). The environmental and health benefits depend, in part, on the location and timing of distributed generation. "[T]he average solar panel in Nebraska displaces 20% more CO_2 than a panel in Arizona, although energy output from the Nebraska panel is 20% less." *Id.* at 11770; *see also generally* Jonathan J. Buonocore et al., *Health and Climate Benefits of Different Energy-Efficiency and Renewable Energy Choices*, 6 NATURE CLIMATE CHANGE 100 (2016) (discussing the site-specific impacts on climate and public health benefits).

300. Erik P. Johnson & Juan B. Moreno-Cruz, *Air-Quality and Health Impacts of Electricity Congestion* (Georgia Inst. of Tech., Working Paper, 2015), https://perma.cc/5DRT-X24M.

Consequently, the quantity of greenhouse gas emissions avoided by distributed generation should be calculated by looking at the quantity of emissions that the marginal generator at that location would have emitted at the time of the distributed generation production. This feature is a missing quality in current net metering or "value-of-solar" policies. Unless the pricing is granular enough, emission benefits of distributed generation systems cannot be valued accurately.

Accurately valuing emission benefits is vital to ensure the efficient allocation of resources among different investment alternatives, whether it is for distributed solar generation, other distributed energy resources, energy efficiency, or utility-scale investments. For example, an energy efficiency program is likely to reduce the bulk demand on average, though this is not always the case.[301] Thus, calculating the quantity of avoided emissions using an average value would likely to lead to accurate estimates when calculating the environmental benefits of such energy efficiency programs. However, the same is not true when distributed solar generation is considered. If the distributed solar generation is replacing dirtier-than-average production, for example a "peaker" plant, the avoided emissions at that particular time will be higher than average. If the temporal dimensions are not taken into account in pricing, and all distributed energy resources are rewarded based on the same average quantity of avoided emissions, then the market incentives will lead to more investment in whichever resource is the cheapest to build and operate, regardless of whether they are the most beneficial for the society when externalities are taken into account. This pathology would lead to under-deployment of the type of distributed generation that is most needed for the society at a particular location.

Further, it is important to note that not all distributed generation is clean. While the focus of this Article is distributed solar generation, which is emissions-free, the proposed approach here can also be applied to other distributed generation resources with a small modification. If the distributed generation resource produces emissions, the quantity of "net" avoided emissions should be calculated by looking at the difference in emissions of the displaced generator and the distributed generator.

2. *Valuing Avoided Carbon Dioxide Emissions*

The second step in valuing climate change benefits is to monetize the quantity of avoided emissions based on estimates of the monetary value of the external damage they impose on society. Currently, the best estimate of the marginal damage caused by carbon emissions is the Social Cost of Carbon ("SCC"), which was developed by a high-level federal Interagency Working

301. An energy efficiency program that automatically turns off lights at night in commercial buildings, for example, would reduce demand only during night times.

Group ("IWG"). The SCC is "the monetized damages associated with an incremental increase in carbon emissions in a given year,"[302] and should be used to monetize the climate change benefits of distributed generation.

"The IWG's members included economic and scientific experts from the White House and multiple federal agencies, who met regularly to review the technical literature, consider public comments, and discuss relevant inputs and assumptions."[303] The SCC values were calculated using three widely cited climate economic impact models, known as integrated assessment models. These models were each developed by outside experts, and published and extensively discussed in peer-reviewed literature.[304] The IWG's Technical Support Document discussed the models, their inputs, and the assumptions, including discount rates, used in generating the SCC estimates.[305] The SCC was first released in 2010 and it was revised in 2013.

Both the 2010 and 2013 Technical Support Documents are comprehensive and rigorous in explaining the IWG's sources of data, assumptions, and analytic methods. The Government Accountability Office recently examined the IWG's process, and found that it was consensus-based, relied on academic literature and modeling, disclosed relevant limitations, and incorporated new information through public comments and updated research.[306] While additional research has found that the SCC is likely too low because it currently omits a number of types of damages from the analysis, it is still the best estimate of climate effects that is currently available.[307] As the SCC will continue to be regularly updated over time to account for changing information and evolving climate effects, using the SCC to monetize the climate change benefits of distributed generation is currently the most desirable approach for this endeavor.[308]

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302. Interagency Working Grp. on Soc. Cost of Carbon, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Exec. Order 12866 (2013), https://perma.cc/K8U8-JHUJ.

303. Interagency Working Grp. on Soc. Cost of Carbon, Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Exec. Order 12866, at 2–3 (2010), https://perma.cc/G7XH-E6J3.

304. *Id.* at 5.

305. *Id.* at 5–23.

306. *See generally* U.S. Gov't Accountability Office, GAO-14-663, Regulatory Impact Analysis: Development of Social Cost of Carbon Estimates (2014), https://perma.cc/9LRH-ZED7 (describing the participating entities and the processes and methods they used to develop the 2010 and 2013 social cost of carbon estimates).

307. Peter Howard, Inst. for Policy Integrity, Omitted Damages: What's Missing from the Social Cost of Carbon 1 (2014), https://perma.cc/B2AJ-LB6U.

308. Interagency Working Grp. on Soc. Cost of Carbon, Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, at 2 (2015), https://perma.cc/Y4V6-KAM2.

Further, the SCC is a standardized number used across multiple regulatory agencies in the federal government, ensuring that all agencies account for climate benefits in a rational and consistent manner.[309] Leading states and municipalities, including New York,[310] Minnesota,[311] and Maine,[312] have also begun using the SCC in their energy-related benefit-cost analysis, recognizing that the SCC is the best available estimate of the marginal economic impact of carbon emission reductions. Using the SCC, Minnesota, Maine, and the city of Austin calculated the avoided emissions benefits of distributed solar generation as $0.030,[313] $0.090,[314] and $0.020[315] per kWh respectively.

3. Interaction with Other Regulatory Approaches

The variation in state policies regarding distributed generation is not limited to the specifics of net metering policies. As previously mentioned in this Article, states provide a variety of different incentives for renewable energy resources, and specifically for solar panels. North Carolina, for example, gives a 35% tax credit for installation of solar panels in addition to the federal tax credit of 30%, while Louisiana gives a 50% tax credit.[316] California, on the other hand, gives direct cash rebates to customers who install solar panels based on the generating capacity of these panels.[317]

These disparities further highlight the need for analyzing all other incentive programs for distributed generation, including net metering, to ensure that the combination of policy programs is providing appropriate incentives for distributed generation without either over- or under-compensating producers.

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309. *See* Richard L. Revesz, *Quantifying Regulatory Benefits*, 102 CAL. L. REV. 1423, 1439–41, 1454–55 (2014).

310. *See generally* Order Establishing the Benefit Cost Analysis Framework, Case No. 14-M-0101 (N.Y. Pub. Serv. Comm'n Jan. 21, 2016).

311. MINN. VOST, *supra* note 21.

312. ME. PUB. UTILS. COMM'N, *supra* note 201, at 35 n.26.

313. *See* JOHN FARRELL, INST. FOR LOC. SELF-RELIANCE, MINNESOTA'S VALUE OF SOLAR: CAN A NORTHERN STATE'S NEW SOLAR POLICY DEFUSE DISTRIBUTED GENERATION BATTLES? 11 (2014), http://perma.cc/BL5K-TVNP.

314. ME. PUB. UTILS. COMM'N, *supra* note 201, at 5.

315. Kaiba White, *Austin's Solar Tool Box*, SOLAR AUSTIN 4, https://perma.cc/GQS8-9DUQ.

316. Craig Morris, *Solar Twice as Expensive in U.S. as in Germany*, ENERGY TRANSITION (May 11, 2015), https://perma.cc/9L2F-ZBYX.

317. Severin Borenstein, *Private Net Benefits of Residential Solar PV: The Role of Electricity Tariffs, Tax Incentives and Rebates* (Energy Inst. at Haas, Working Paper No. 259R, July 2015), https://perma.cc/NSA8-7T3L.

a. Valuing Emissions in the Presence of Other Policies

It is crucial to understand that the existence of other policies aimed at reducing emissions does not change the marginal external cost of carbon emissions. This value is simply the monetary value of all the damages caused by one additional unit of emission. Thus, the marginal external damage associated with each additional unit of emissions is exogenously determined, and is independent of any other environmental policies that are in effect. Economic efficiency requires that this full value of the marginal damage be internalized at the socially optimal outcome, not more and not less.

If, however, there are other policies in effect that cause fossil-fuel generators to internalize some of the external damage they are causing, then the environmental benefit adjustment in remuneration of distributed generation should only include the "uninternalized" damages. For example, a socially optimal distributed generation policy in a state that is a part of the Regional Greenhouse Gas Initiative ("RGGI"), a regional cap-and-trade program,[318] should start by subtracting the per-ton allowance price from the SCC to derive the value of external damage of one ton of additional carbon emission that has not yet been internalized.[319] But, to be accurate, this calculation would need to reflect *all* existing policies affecting the market. In addition to policies like a cap-and-trade program and Environmental Protection Agency's ("EPA") Clean Power Plan, which might reduce the magnitude of the optimal environmental adder needed in a distributed generation pricing policy, the analysis would also need to include policies that might increase the magnitude of the optimal adder, such as federal subsidies for fossil fuels.[320]

b. Quantifying Net Avoided Emissions in the Presence of Other Policies

The existence of a cap-and-trade program also complicates the calculation of the quantity of net avoided emissions. A cap-and-trade program sets a cap for emission allowances for a given year and allocates allowances to meet that cap. These allowances can be either used for meeting the compliance obligations of emitting entities or can be traded in a secondary market.

318. *Program Overview*, REGIONAL GREENHOUSE GAS INITIATIVE, https://perma.cc/TB8P-CQ7J.

319. *See* Comments of the N.Y. Dep't of Envtl. Conservation, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Case No. 14-M-0101, N.Y. P.S.C., Filing No. 365 (May 1, 2015); *see generally* RICK HORNBY ET AL., SYNAPSE ENERGY ECON., INC., AVOIDED ENERGY SUPPLY COSTS IN NEW ENGLAND: 2013 REPORT 4-1-4-60 (2013), https://perma.cc/Q6M3-YPRQ.

320. *See* U.S. ENERGY INFO. ADMIN., DIRECT FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY IN FISCAL YEAR 2013, at 11–14 (2015), https://perma.cc/3P47-K6WK.

If the program's cap is not binding, as was the case for RGGI until 2014,[321] any carbon-free distributed generation would displace bulk electricity and lead to a reduction in the number of traded allowances and to a consequent reduction in carbon dioxide emissions. However, complications arise when the allowance cap is binding. If the demand for allowances is high enough, all available allowances are sold, limiting the level of emissions to the initially set cap. In this case, if a generator wants to emit more, it would have to buy an already existing allowance from another generator. Therefore, in theory, if the allowance cap is binding, a distributed generator that displaces a fossil-fuel generator cannot immediately reduce overall emissions. Any allowance that would have been used to meet the obligations resulting from the displaced energy generation of the fossil-fuel source would be immediately sold to be used by the next source that was not able to initially buy allowances, keeping the emissions level the same level as the initial cap. So, the composition of the fuel mix might change but emissions are not immediately lowered.

To be able to quantify avoided emissions that result from distributed generation given a cap-and-trade program with a binding cap, it is necessary to analyze the individual dynamics of these programs. If a distributed generator is reducing the amount of electricity the bulk system needs to generate, then it is stopping a dirtier generator from emitting more carbon dioxide at that instant, and hence, creating an "unused" allowance at that moment, regardless of whether the cap is binding. Thus, the relevant questions for the purposes of calculating the socially optimal distributed generation compensation are what happens to the allowances that are unused as a result of more distributed generation, and how these unused allowances affect the long-term level of the cap. [322]

Two short-term scenarios are possible. Under one, the unused allowance is purchased by an entity that intends to use it right away. In that case, the carbon dioxide emissions displaced by the distributed generation are replaced by other carbon dioxide emissions and the distributed generation does not lead to an immediate reduction in such emissions. The price of the allowances, however, will have fallen as a result of the distributed generation. Because more clean electricity will now be produced, the demand for such allowances will be lower.

In the second scenario, the allowances are not used in the short term. They could be banked for future use by the existing holders of these permits, or they could be purchased by other actors seeking to bank them. In this scenario, the distributed generation will reduce the current carbon dioxide emissions, and this reduction will remain in effect until the banked allowances begin to be used. Here, too, the distributed generation will have depressed the demand for future allowances and lowered the price at which they trade.

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321. Potomac Econ., Annual Report on the Market for RGGI CO_2 Allowances: 2014, at 7–11 (2015), https://perma.cc/3PDJ-T5L7.

322. *See* Rick Hornby et al., *supra* note 319, at 4–11 (2013).

Over the longer run, the greater use of banked allowances and the lower price at which they are traded might lead a regulator to reduce the cap, as was the case in RGGI,[323] thereby permitting a lower level of emissions. A high amount of banked permits not only caused RGGI states to adjust the actual cap downward, but it also caused them to further decrease the number of available allowances by the exact number of allowances that were banked to date to eliminate the surplus.[324] As a result, distributed generation can have beneficial climate change properties by leading to the long-term reductions in the caps of cap-and-trade schemes.

Consequently, even under a cap-and-trade program, there are benefits from the avoided emissions resulting from distributed generation. A precise calculation of the quantity of net avoided emissions in the presence of a cap-and-trade program requires an in-depth study of how distributed generation affects the number of unused allowances and how fast those unused allowances in turn affect the long-term level of the cap. An alternative approach would be to use the quantity of emissions displaced by the distributed generator as an approximation. The main difference between the two approaches to estimating the quantity of avoided emissions would stem from the time delay between the "creation" of the unused allowance and the eventual reduction of the allowance cap.

Crediting distributed generation for avoided emissions using a metric based on a possible future reduction in the cap would undervalue the benefits of distributed generation, as the avoided emissions technically occur at the moment when a distributed generator displaces a fossil-fuel source. Using, instead, the reduction in emissions resulting from the displaced generators as an approximation, may potentially overestimate the quantity of avoided emissions if the cap is binding and the unused allowances are traded and used by another source right away. The latter approach, of course, is much simpler. In any event, once the quantity of avoided emissions is calculated, it can be then multiplied by the SCC to monetize the environmental benefits of distributed generation.

B. Other Social Benefits

In addition to environmental benefits, reductions in carbon emissions and local pollutants such as SO_2, NO_x, and fine particulate matter also provide external health benefits such as improved morbidity and reduced risk of premature mortality.[325] The public health benefits associated with reduced operating

323. RGGI 2012 Program Review: Summary of Recommendations to Accompany Model Rule Amendments, Regional Greenhouse Gas Initiative (2012), https://perma.cc/9383-PV4T.

324. Potomac Econ., *supra* note 321, at 11–12.

325. Dallas Burtraw et al., *Costs and Benefits of Reducing Air Pollutants Related to Acid Rain*, 16 Contemporary Econ. Pol'y 379, 397–99 (1998); Nicholas Z. Muller & Robert Mendel-

time of fossil-fuel generators can exceed $300,000 for each reduced ton of fine particulate emissions.[326] According to the National Research Council, the average cost of adverse health effects attributed specifically to coal-fired power plant emissions is $0.032 for every kWh of electricity generated.[327] Other studies calculate total health or environmental expenses that stem from coal extraction and subsequent electricity generation, finding average expenses as high as $0.270 per kWh, with total costs as high as $500 billion annually.[328]

Just as for carbon emissions, a socially optimal approach to compensating distributed generation should include the value of these external health benefits. The net avoided emissions should be calculated by looking at the displaced generator, and then monetized using the estimates of the marginal damages of these pollutants. EPA has calculated regional values of the marginal damage estimates for SO_2 and NO_x.[329] Unlike the marginal damage estimate of CO_2, the marginal damage estimates of these pollutants depend on the region where they are emitted (health impacts from these pollutants vary based on the demographic and geographic characteristics of a particular area, as well as of the density of the area).[330] Thus, if there is a strong reason to believe that the state-specific values for these pollutants are significantly different than EPA regional values, each state should conduct its own study to calculate these values, and use those values to compensate distributed generation.

Distributed solar generation can also help improve water quality and address land degradation issues exacerbated by fossil fuel power plants.[331] Water is integral to hydroelectric generation, cooling systems for thermoelectric plants, and systems that scrub pollutants from flue gases.[332] Therefore, reducing the need for steam-electric or coal-fired power plants can conserve significant amounts of water.[333] This benefit is estimated to be $0.0007 per kWh.[334] Siting conventional generators and transmission and distribution lines necessary to deliver electricity can also involve significant degradation of natural lands.[335] In

sohn, *Measuring the Damages of Air Pollution in the US*, 54 J. Envtl. Econ. Mgmt. 1, 8–13 (2007).

326. Office of Air & Radiation, EPA, Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors, 13 tbl.5 (2013), https://perma.cc/3M7B-5V67.

327. Jared L. Cohon et al., Hidden Costs of Energy Unpriced Consequences of Energy Production & Use, Nat'l Acad. of Sci., 91 (2010), https://perma.cc/3K2Y-5BPB.

328. Paul R. Epstein, *Full Cost Accounting for the Life Cycle of Coal*, 1219 Ann. N.Y. Acad. Sci. 73, 73 (2011).

329. *See* Office of Air & Radiation, *supra* note 326.

330. *Id.* at 25.

331. Hoke & Komor, *supra* note 223, at 57.

332. Lazar, *supra* note 260, at 56.

333. *See id.* at 58.

334. Seel & Beach, *supra* note 267, at 3.

335. Hoke & Komor, *supra* note 223, at 57.

contrast, distributed solar is generally installed on existing rooftops and thus does not consume additional land space.[336] One estimate puts the monetized value of land use benefits of distributed generation at $0.002 per kWh.[337]

Distributed generation can also reduce the number and/or severity of power outages, leading to other social benefits including reduced financial and security risks, improved economic development,[338] and other social resiliency benefits such as reduced crime during outages. All of these benefits should ideally be quantified and incorporated into the optimal distributed generation tariff. The fact that some of these benefits may be difficult to quantify and monetize does not provide a justification for counting these values as zero without any discussion.[339] At the very least, they should be considered in a non-monetized form.

V. Toward an "Avoided Cost Plus Social Benefit" Approach

As discussed earlier, the efficient price for distributed generation should reflect all of its costs and benefits, both private and external. While net metering partially accomplishes this goal by compensating distributed generation using the prevailing retail prices, it falls short because the current retail electricity rates do not fully reflect either the true marginal cost of electricity generation or the associated externalities. Therefore, a new approach is needed until comprehensive retail rate reform corrects such inefficiencies. In this Part, we discuss an alternative "Avoided Cost Plus Social Benefit" methodology and provide legal support for such an approach.

A. Identifying the Socially Optimal Approach

As state efforts to evaluate and reform net metering become increasingly common, it is important to establish a socially desirable framework that can be used consistently in different states and for different types of distributed energy resources, not simply distributed solar generation. Further, as the available resource options to viably balance demand and supply increase with advancing technology, and utility scale renewables become more common, a consistent formulation that could provide an accurate value comparison among different alternatives is needed.

The discussion in Parts III and IV points to an "Avoided Cost Plus Social Benefit" approach that compensates distributed generation for all the net avoided costs that the bulk system no longer has to incur as a result of lower demand, and for the net social benefits that distributed generation provides by

336. U.S. Dep't of Energy, *supra* note 256, at 6–3 n.43.

337. Seel & Beach, *supra* note 267, at 3.

338. Glick et al., *supra* note 251, at 13.

339. Richard L. Revesz, *Quantifying Regulatory Benefits*, 102 Cal. L. Rev. 1423, 1436 (2014).

replacing dirtier generation. This approach would catalogue all the benefits and costs of distributed generation, and reward distributed generation according to these categories. Thus distributed generation would be compensated for all the system benefits it provides, such as avoided energy costs, avoided distribution and generation capacity costs, and avoided line losses, as well as for social benefits such as environmental and health benefits. As this approach takes into account the additional costs imposed by distributed generation and rewards distributed generation only for costs it avoids, it eliminates utilities' concerns about recovering costs of existing infrastructure. Even if this approach may not be as easy to implement as common net metering policies, especially at the level of granularity that we support, such an approach is necessary to avoid further inefficiencies caused by the use of retail rates as distributed generation continues to grow.

This approach is supported by economic theory, though theoretical guidance on distributed generation policy design under current regulatory and market structures is sparse in the economics literature.[340] A recent article shows that if regulators lack the ability to set a different rate for distributed generation than the retail rate and, thus, are required to use net metering, the result would be suboptimal.[341] The authors show that a socially optimal distributed generation price (when the regulators are not restricted to traditional net metering) should account for externalities, and that the environmental adder should depend on the net avoided emissions, which can vary substantially with the prevailing generation mix.[342] Compared to net metering, this approach leads to higher social welfare and better distributional consequences.

Another recent article shows that the socially optimal distributed generation policy depends on a variety of parameters that may vary significantly from state to state, such as the regulators' ability to set all prices—including capacity prices—efficiently, and the nature of the distributed generation technologies. [343] Thus, a "one-size-fits-all" policy such as net metering, which does not allow for any variation based on prevalent technologies, is not economically desirable. Our "Avoided Cost Plus Social Benefits" approach provides a flexible framework that would lead to different outcomes based on state-specific generation mix and regulatory policies.

340. For a review of relevant economic literature, see David P. Brown & David E. M. Sappington, *On the Design of Distributed Generation Policies: Are Common Net Metering Policies Optimal?* (U.S. Ass'n Energy Econ. Working Paper No. 16-234, Oct. 2015), https://perma.cc/QE3W-ACFH.

341. *Id.* at 26.

342. *Id.* at 22.

343. David P. Brown & David E. M. Sappington, *Optimal Policies to Promote Efficient Distributed Generation of Electricity* 27 (U.S. Ass'n Energy Econ. Working Paper No. 16-236, Dec. 2015), https://perma.cc/PV4B-U6A5.

The value of solar tariff is an example of a design that is consistent with the "Avoided Cost Plus Social Benefit" concept. As it incorporates external value components such as avoided greenhouse gas emissions, it already is better than current net metering policies in valuing distributed generation systems. However, it is important to note that value-of-solar tariffs provide compensation based on system averages, and hence fail to provide price signals that are granular enough to drive efficient investment for distributed energy resources. Further, it is a value-of-*solar* tariff, and hence cannot be used for compensating other types of distributed energy resources. This limitation creates a structural difference between how distributed solar resources are compensated and how other distributed energy resources are compensated, distorting investment incentives for different types of resources. Instead, it is important to devise a framework than can be used for all types of distributed energy resources instead of having to formulate a new tariff every time a new type of distributed energy resource becomes widely available.

B. Legal Basis and State Practice

1. FERC Regulation and Decisions

Traditionally, FERC regulation has been limited to wholesale and interstate transactions among utilities.[344] In contrast to FERC, individual state public utility commissions have traditionally monitored the retail rates charged by utilities of end-use consumers, intrastate utility activity, and avoided cost rates. They also have determined whether to include the environmental and social benefits of distributed generation in avoided cost calculations.[345] In practice, however, the division of regulation is not so definite, and FERC policy has proven a significant determinant of state regulatory action.[346]

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344. Federal Power Act, 16 U.S.C. § 824(a) (2012).

345. *See* Public Utility Regulatory Policies Act, 16 U.S.C. § 824a-3(f) (2012) (placing ultimate responsibility for establishing avoided cost rates for qualifying facility power with state public utility commissions); Sun Edison LLC, 129 FERC ¶ 61,146, 61,620 (2009) ("[T]he Commission does not assert jurisdiction when the end-use customer . . . receives a credit against its retail power purchases from the selling utility."). *But see id.* ("Only if the end-use customer participating in the net metering program produces more energy than it needs over the applicable billing period, and thus is considered to have made a net sale of energy to a utility over the applicable billing period, has the Commission asserted jurisdiction."); 16 U.S.C. § 824d (granting FERC jurisdiction to set *wholesale* rates that are "just and reasonable" and "not unduly discriminatory").

346. Amy Abel & Jon Shimabukuro, Cong. Research Serv., RS20146, Electricity Restructuring Bills: A Comparison of PURPA Provisions 2 (1999).

Notably, until recently FERC explicitly prohibited the inclusion of "externality" adders in avoided-cost rates in the wholesale markets.[347] Externality adders are monetary sums intended to capture non-market consequences of electric generation, such as reduced environmental degradation, improved public health from pollution reductions, or improved national energy security due to greater diversity of electricity generators.[348]

In *Southern California Edison Co.*, decided in 1995,[349] FERC reasoned that because environmental externalities were not "real costs that would be incurred by utilities," they did not count as "avoided" costs.[350] However, FERC made clear that once non-market benefits are "monetized" by state or federal policy initiatives and internalized in utility costs, previously off-limit considerations like the environmental consequences of generation could be incorporated into avoided cost rates.[351] Environmental benefits may be "monetized" in a number of ways, such as through state policies that require pollutant filtration or mitigation devices, renewable fuel mandates, and emission tax regimes that impose additional compliance costs on traditional fossil-fuel generators.[352] For example, even though *Southern California Edison* excluded the consideration of external benefits in avoided-cost rates, FERC noted that states may choose to "account for environmental costs" of electricity generation by "imposing a tax on fossil generators."[353] In other words, state policy makers could, by levying a tax on fossil-fuel generators, increase the costs fossil-fuel generators incur from generating electricity, and therefore might "avoid" costs by purchasing energy from cleaner facilities.

Likewise, statutory or regulatory directives that impose equipment compliance costs on fossil-fuel generators may be incorporated into avoided cost rates.[354] Ultimately, in its 1995 *Southern California Edison* Order, FERC declared that states wishing to include non-market benefits in avoided cost rates could do so through broad policy measures, like changes to state tax code laws

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347. S. Cal. Edison Co., 70 FERC ¶ 61,215 (1995), *aff'd on rehearing*, 71 FERC ¶ 61,269 (1995).

348. *See* S. Cal. Edison Co., 71 FERC ¶ 61,269, 62,080 (1995); *see also* Rudy Perkins, Note, *Electricity Deregulation, Environmental Externalities, and the Limitations of Price*, 39 B.C. L. Rev. 993, 994 (1998) (discussing environmental externalities).

349. *S. Cal. Edison Co.*, 71 FERC ¶ 61,269 (1995).

350. *Id.* at ¶ 62,080.

351. *See id.*

352. *See* Scott Hempling et al., Nat'l Renewable Energy Lab., NREL/TP-6A2-47408, Renewable Energy Prices in State-Level Feed-in Tariffs: Federal Law Constraints and Possible Solutions 9 (2010), https://perma.cc/ZRC5-J8YW.

353. S. Cal. Edison Co., 71 FERC at ¶ 62,080.

354. Cal. Pub. Utils. Comm'n, 134 FERC ¶ 61,044, 61,160 (2011) ("Just as, for example, an avoided cost rate may reflect a state requirement that utilities must 'scrub' pollutants from coal plant emissions, so an avoided cost rate may also reflect a state requirement that utilities purchase their energy needs from, for example, renewable resources.").

or equipment compliance costs, but could *not* do so merely by selecting an avoided cost rate-setting methodology that favored environmentally preferable fuel sources.[355]

Yet, in 2010 FERC reversed course and substantially overruled *Southern California Edison*'s broad prohibition against the inclusion of environmental benefits in avoided cost rates.[356] In *California Public Utilities Commission*, FERC ruled that avoided cost rates could permissibly differentiate between "various [qualifying facility] technologies on the basis of the supply characteristics of the different technologies."[357] FERC reasoned that state utility commissions should have discretion under PURPA's "avoided cost" mandate to tailor avoided cost rates for power generated in compliance with certain policies, such as mandates requiring that a portion of utility electricity come from solar photovoltaic generators.[358] Since utilities are required to meet procurement mandates, they cannot "avoid" the costs resulting from compliance with these mandates.[359]

However, FERC stopped shy of mandating technology-specific rates reflecting the actual environmental benefits of renewable generation. Instead, FERC deferred to state policies imposing such rates, stating that "states have the authority to dictate the generation resources from which utilities may procure electric energy."[360] Nevertheless, the decision in *California Public Utilities Commission* has opened the door to avoided cost rates that reflect the characteristics of a qualifying facility.

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355. *S. Cal. Edison Co.*, 71 FERC at ¶ 62,080 ("[A] state may impose a tax or other charge on all generation produced by a particular fuel. . . . A state, however, may not set avoided cost rates . . . by imposing environmental adders or subtractors that are not based on real costs that would be incurred by utilities."); Michael J. Zucchet, *Renewable Resource Electricity in a Changing Regulatory Environment*, *in* Renewable Energy Annual 1995 xxv, xxviii (1995).

356. *See* Cal. Pub. Utils. Comm'n, 133 FERC ¶ 61,059, 61,628 (2010).

357. *Id.* at ¶ 61,263. The same 2010 FERC order also noted the physical location of a qualifying facility could offer savings by decreasing costs of electricity transmission. Savings are primarily achieved by qualifying facilities, located near end-use consumers, could cut down on energy losses due to inherently inefficient transmission grid, or displace utility need for additional transmission line construction, avoided cost rates could incorporate the associated savings. *Id.* at ¶ 61,267–68.

358. Kaylie E. Klein, *Bypassing Roadblocks to Renewable Energy: Understanding Electricity Law and the Legal Tools Available to Advance Clean Energy*, 92 Or. L. Rev. 235, 258 (2013).

359. Carolyn Elefant, Reviving PURPA's Purpose: The Limits of Existing State Avoided Cost Ratemaking Methodologies in Supporting Alternative Energy Development and a Proposed Path for Reform 9 (2011), https://perma.cc/5KL2-QXNW.

360. Cal. Pub. Utils. Comm'n, 134 FERC ¶ 61,044, 61,160 (2011). *See also* Cal. Pub. Utils. Comm'n, 133 FERC at ¶ 61,268 ("[I]f the environmental costs 'are real costs that would be incurred by utilities,' then they 'may be accounted for in a determination of avoided cost rates.'") (quoting S. Cal. Edison Co., 71 FERC at ¶ 62,080).

2. *State Approaches to Avoided Cost Rates*

Between PURPA's qualifying facility rates, net metering, feed-in tariffs, and renewable energy credits, every state provides some means of compensating distributed generators for electrical output.[361] Although some state net metering programs are based on avoided cost rates, PURPA's qualifying facility rates are the only compensation method based *entirely* on avoided costs.[362]

Under PURPA's mandatory purchase obligation, the rate paid for distributed generation output may not exceed a utility's avoided cost. Although FERC continues to define the parameters of what attributes may be included as "avoided" costs—most recently in the *California Public Utilities Commission* decision discussed above[363]—under PURPA, determining the avoided cost rate is otherwise left to individual state utility commissions.[364] Perhaps unsurprisingly, since 1978 states have developed a wide variety of idiosyncratic methods to calculate these rates.[365] Generally, however, the methodologies may be loosely grouped under two approaches.[366]

The first and most common approach compares the generation cost of a non-renewable "proxy" generator with the generation cost of a qualifying facility attempting to sell its output.[367] Here, the avoided cost rate is merely the difference in generation cost between the qualifying facility and the "proxy"

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361. *See* NET METERING, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (2015), https://perma.cc/UJ5V-FVEZ; DSIRE, *RPS Policies*, *supra* note 93; EIA, *Feed-in Tariffs & Similar Programs*, *supra* note 21.

362. *See* 18 C.F.R. §§ 292.101(b)(6) (2015). Feed-in tariffs are governed by the Federal Power Act and subject only to a general dictate that they be "just and reasonable" and not "unduly discriminatory" against any particular source of generation. Federal Power Act §§ 205–06, 16 U.S.C. §§ 824d, 824e. Renewable energy credits are priced according to market-driven spot rates. *Renewable Energy Certificates (RECs)* U.S. DEP'T OF ENERGY (2012), https://perma.cc/YHJ8-FYQL. Because RPSs impose compliance costs on utilities, the price of renewable energy credits do indirectly track a utility's avoided cost of compliance and typically demand a higher price in so-called "compliance markets," those states with portfolio standards. *Id.*

363. *See supra* Part V.B.1.

364. ELEFANT, *supra* note 359, at 11.

365. *Id.*

366. A rarely used third approach is employed in a few jurisdictions where the aggregate supply of electricity from qualifying facilities consistently outstrips aggregate ability of utilities to absorb qualifying facility power. This approach pits qualifying facilities against one another in competitive bidding wars, whereby the state utility commission awards a purchase contract to the qualifying facility willing to accept the lowest bid. FRANK GRAVES ET AL., EDISON ELEC. INST., PURPA: MAKING THE SEQUEL BETTER THAN THE ORIGINAL 13 (2006), https://perma.cc/U58A-ZBC2.

367. ELEFANT, *supra* note 359, at 17. *See also* HEETER ET AL., *supra* note 109, at 5–7. A variation of the "proxy" approach is the "peaker" method, which compares the generation costs of a qualifying facility with the marginal or most expensive generation source available for dispatch during the life of the purchase contract. ELEFANT, *supra* note 359, at 18.

generator.[368] Because distributed or qualifying facility generation may offset different utility proxies—depending on a utility's generation portfolio, time of year, and even time of day—the proxy method will produce rates that reflect peak and off-peak costs, and will be largely driven by a utility's choice of "proxy."[369] While some states have sought to address this variance by establishing a "hypothetical proxy," utilities have complained that generation costs associated with hypothetical proxies exceed the cost of a utility's actual proxy unit.[370]

A second approach models a given utility's "revenue requirement"—the revenue necessary to cover a utility's total generation costs, including energy and capacity costs, as well as other factors like taxes.[371] Under this approach, a utility's revenue requirement is calculated twice, once with the qualifying facility output and once without it.[372] Avoided costs, then, are the difference in revenue requirement between the two models.[373]

3. *State Approaches to Incorporating Social and Environmental Benefits*

Although avoided cost rates largely do not account for non-market benefits, a number of state utility commissions as well as utilities have undertaken efforts to include social and environmental benefits in other compensation structures.[374] As of 2006, fifteen states either set forth a commitment or gave state utility commissions specific authority to account for environmental considerations in the oversight of in-state utilities.[375] In Maryland, for example, the state public utility code broadly directs the state utility commission to "consider

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368. ELEFANT, *supra* note 359, at 17. *See also* HEETER ET AL., *supra* note 109, at 5–7.

369. A utility's proxy unit is usually defined as the next generating unit in the utility's integrated resource plan. ELEFANT, *supra* note 359, at 17.

370. *Id.* at 17.

371. *Id.* at 10–11.

372. *Id.* at 19.

373. GRAVES ET AL., *supra* note 366, at 10–11.

374. ELEFANT, *supra* note 359, at 32 ("Over 20 years ago, Florida approved inclusion of a standard offer contract language that recognizes emissions cost savings of renewables.").

375. *See* Michael Dworkin et al., *Revisiting the Environmental Duties of Public Utility Commissions*, 7 VT. J. ENVTL. L. 1, 2, app. (2006) (collecting statutes for Alaska: Public Utilities Commissions Act, ALASKA STAT. § 42.05.141(7)(c) (2004); Connecticut: Public Utility Environmental Standards Act, CONN. GEN. STAT. ANN. §§ 16-50g to 16-50aa (West 1998); Florida: FLA. STAT. ANN. § 366.81 (West 1999); Illinois: 220 ILL. COMP. STAT. ANN. 5/1-102(b) (West 1997); Iowa, IOWA CODE ANN. § 476.41 (West 1999); Maine: ME. REV. STAT. ANN. tit. 35-A, § 3302 (1988 & Supp. 2005); Maryland: MD. CODE ANN., PUB. UTIL. COS. § 2-113 (LexisNexis 2000); Mississippi: MISS. CODE ANN. 77-3-2(1)(d)(e) (West 2005); New Jersey: N.J. STAT. ANN. 48:2-23 (West 1998); New York: N.Y. PUB. SERV. LAW § 5(2) (McKinney 2000); North Carolina: N.C. GEN. STAT. § 62-2(5) (2000); Rhode Island: R.I. GEN. LAWS § 39-1-1(a)(3), (c) (1997); Utah: UTAH CODE ANN. 54-1-1(3)(b)(ix) (2000); West Virginia: W. VA. CODE ANN. § 24-1-1(a), (a)(5) (LexisNexis 2004); and Wisconsin: WIS. STAT. ANN. § 196.025(1) (West 2004)).

the public safety, the economy of the State, *the conservation of natural resources*, and *the preservation of environmental quality*" in all aspects of utility oversight.[376] In New Hampshire[377] and Iowa,[378] state codes provide more rate-specific direction. Both explicitly command the state public utility commission to consider environmental consequences when setting rates. Similarly, the California state code directs the state's public utility commission to incorporate pricing elements that reflect state policies intended to curtail pollutant emissions.[379] Bolstered by the so-called "greenhouse gas adder," rates in California are $0.016 higher per kWh of renewable electricity purchased by a utility, a 16.6% increase in the rate when compared to the price without the adder.[380] In addition, and as noted above, three jurisdictions—Austin, Texas,[381] Minnesota,[382] and Maine[383]—have implemented a "value-of-solar" tariff that account for external benefits such as positive environmental consequences and increased reliability of electricity supply.[384]

Finally, environmental benefits are included with some regularity in state energy efficiency studies. Nationwide, forty-four states and the District of Columbia have formal energy efficiency programs.[385] According to a 2012 survey

376. MD. CODE ANN., PUB. UTIL. COS. § 2-113(a)(2) (LexisNexis 2000) (emphasis added).

377. N.H. REV. STAT. ANN. § 362-A:8(b)(4) (2016) (A state statute entitled "Payment Obligation; Public Utilities" dictates "[t]he commission shall, in all decisions affecting [rates for] qualifying small power producers and qualifying cogenerators, consider . . . [p]otential environmental and health-related impacts.").

378. IOWA CODE ANN. § 476.43.3(a)–(e) (West 2016) ("The board may adopt individual utility or uniform statewide facility rates. The board shall consider . . . [e]xternal factors, including but not limited to, environmental and economic factors."). Section 476.44(a) exempts utilities form the rate structure when purchasing, "at any one time, more than . . . one hundred five megawatts of power from alternative energy production facilities." IOWA CODE ANN. § 476.44.2(a) (West 2016).

379. CAL. PUB. UTILS. CODE § 399.20(d)(1), (2) (West 2016) ("The tariff shall provide for payment for every kilowatthour of electricity purchased from an electric generation facility . . . shall include all current and anticipated environmental compliance costs [including] mitigation of emissions of greenhouse gases and air pollution offsets associated with the operation of new generating facilities in the local air pollution control or air quality management district where the electric generation facility is located.").

380. *Market Price Referent (MPR)*, CAL. PUB. UTILS. COMM'N., https://perma.cc/P76C-D7YM (Click on "2011 MPR Model" which loads an excel data sheet. Next, click on the "Control" tab, and set "Project Start Date" to year 2015. Relevant data is found in cell G7 and G11).

381. *See Residential Solar Energy Rate*, AUSTIN ENERGY, https://perma.cc/N26X-MTYG.

382. H.R. 729, 88th Leg., 4th Engrossment (Minn. 2013).

383. H.P. 863, 127th Leg., 1st Reg. Sess. (Me. 2015).

384. MIKE TAYLOR ET AL., NAT'L RENEWABLE ENERGY LAB., NREL/TP-6A20-6236, VALUE OF SOLAR: PROGRAM DESIGN AND IMPLEMENTATION CONSIDERATIONS 62 (2015), https://perma.cc/L5NY-86QJ.

385. MARTIN KUSHLER ET AL., A NATIONAL SURVEY OF STATE POLICIES & PRACTICES FOR THE EVALUATION OF RATEPAYER-FUNDED ENERGY EFFICIENCY PROGRAMS 3 (2012), https://perma.cc/E58Z-UGHQ.

conducted by the American Council for an Energy-Efficient Economy, of these forty-five jurisdictions, at least fourteen states and the District of Columbia determine the cost-effectiveness of an active or proposed energy efficiency program using a "Societal Cost Test" that incorporates environmental benefits that flow from greater energy efficiency.[386] Eight of these jurisdictions calculate a specific value for reduced emissions, while the rest use a more general "environmental adder" to reflect environmental benefits.[387] Rhode Island, for example, monetizes various externalities, including health and safety benefits, improved comfort (thermal and noise reduction), property value benefits, and other societal impacts in its project assessments.[388]

VI. The Promise of Time-, Location-, and Demand-Variant Pricing

The current debate on net metering, however it is resolved, can patch only one hole in energy policy unless it considers the bigger picture. Similar debates on how to value a particular resource have pitted environmentalists against utility companies in the past with regard to energy efficiency and demand response.[389] These debates will likely reemerge in the near future when other behind-the-meter technologies such as battery storage systems become more affordable and more widespread. We should, instead, begin to move away from this limited, one-step-at-a-time approach and embrace a proactive policy approach that can prepare us for the future of the grid.

The energy crisis in 1970s sparked broad efforts to encourage energy conservation by promoting energy efficiency and demand-side measures.[390] The

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386. *Id.* at 59. The Societal Cost Test "includes the costs and benefits experienced by all members of society," including externalities and reduced emissions. Tim Woolf et al., Synapse Energy Econ., Inc., Energy Efficiency Cost-Effectiveness Screening in the Northeast and Mid-Atlantic States 22 (2013), https://perma.cc/252G-66H3.

387. Kushler et al., *supra* note 385, at 32.

388. Woolf et al., *supra* note 386, at 46, 57–58.

389. *Compare* Reply Affidavit of Alfred Kahn, Attachment A to Reply Comments of Demand Response Supporters, FERC Docket No. RM10-17-000 (Aug. 26, 2010), https://perma.cc/K2HX-EZ7C (arguing that demand response is economically equivalent to supply response in the wholesale market and thus, must be paid the same market-clearing price as all the other generators in the wholesale market, i.e. the Locational Market Price), *with* Brief Of Robert L. Borlick, Joseph Bowring, James Bushnell, and 19 Other Leading Economists as Amici Curiae, Elec. Power Supply Ass'n v. Fed. Energy Regulatory Comm'n, 753 F.3d 216 (Sept. 8, 2015); William Hogan, *Demand Response Compensation, Net Benefits and Cost Allocation: Preliminary Comments*, FERC Docket No. RM10-17-000 (Sept. 13, 2010); Robert Borlick, *Prepared Remarks for FERC Technical Conference*, FERC Docket No. AD08-8-000 (May 21, 2008) (arguing that LMP overestimates the social benefit of demand response).

390. *See* David N. Carvalho, *Energy Conservation Through the State Public Utility Commissions*, 3 Harv. Envtl. L. Rev. 160, 172–85 (1979) (describing early efforts to promote conservation at the federal and state levels); All. to Save Energy, Utility Promotion of

central point of debate during this period, just like in net metering now, concerned the "price" that utilities should pay for energy conservation, given benefits such as deferred capacity investments, and how much conservation should be "purchased." This debate, like the current net metering controversy, dealt with possibility of cost shifting among customers and of overinvesting in cost-ineffective programs.[391] And, again, as in the net metering debate, environmental groups advocated for energy efficiency based on non-system benefits such as reduced emissions.[392]

The "Avoided Cost Plus Social Benefit" approach to compensating distributed generation advocated in this Article is only a stop-gap measure until comprehensive retail electricity reform can take place. Cost recovery and cost-shifting problems are unintended consequences of the current, inefficient retail rate designs, and should not be blamed on net metering polices. The first-best solution to the problems caused by net metering is to simply correct the inefficiencies of the retail rates. As distributed generation and other similar resources are becoming a key component of the nation's energy policy, and utility business models are changing as a result, reforming the retail tariff structures is becoming a policy imperative. These reforms are necessary to achieve efficiency gains both in the retail electricity markets and in the distributed energy resources markets.

Current tariff designs almost universally use one flat volumetric price per kWh to recover costs that are incurred in non-volumetric ways. This economically inefficient practice is leading to perverse incentives when it comes to renewable energy resources, and hurting the successful integration of distributed generation when and where it is most valued. Originally, volumetric rates were adopted in part because existing technology could not easily measure and record time-variant consumption. But such technological barriers are falling as advanced metering infrastructure becomes cheaper and more prevalent across the United States.[393]

Using a cost-reflective tariff that is properly unbundled and granular would not only improve overall system efficiency, but it would also improve the value of distributed generation for several reasons. First, a bundled, flat volu-

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INVESTMENT IN ENERGY EFFICIENCY: ENGINEERING, LEGAL, AND ECONOMIC ANALYSIS 331 (1983).

391. Mark Cherniack & Margaret Gardner, *A Review Of Conservation Experience In The Pacific Northwest And Some Policy Issues Raised*, 8 AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON. 26, 36 (1988); ALL. TO SAVE ENERGY, *supra* note 390, at 350; John Plunkett & Paul Chernick, *Role of Revenue Losses in Evaluating Demand-Side Resources—An Economic Reappraisal*, 8 AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON. 197, 204–209 (1985).

392. *See* ALL. TO SAVE ENERGY, *supra* note 390, at 351–52; Proceeding to Adopt a Comprehensive Energy Plan, 1989 ILL. P.U.C. LEXIS 366, at *61–62; Ralph C. Cavanagh, *Least-Cost Planning Imperatives for Electric Utilities and Their Regulators*, 10 HARV. ENVTL. L. REV. 299, 334–35 n.106 (1986).

393. FED. ENERGY REGULATORY COMM'N, ASSESSMENT OF DEMAND RESPONSE AND ADVANCED METERING (2014), https://perma.cc/9MNA-ZDZB.

metric rate insulates both the consumers and producers from receiving the correct price signals about the true social cost of generating energy. As a result, consumers have no incentive to adjust their usage based on the actual cost of electricity. More importantly, a flat rate prevents prices from being interpreted as efficient investment signals. If distributed generators are getting low compensation for the energy they export to the grid at peak times as a result of the averaging the cost of all generation into flat volumetric rates, incentives to invest in distributed generation will not be high enough to induce the socially optimal level of distributed generation. If, on the other hand, the retail prices reflected such variations, and consequently net metering policies compensated distributed generators at a higher price when it is costlier to generate electricity, more distributed generation would be installed to take advantage of these higher returns, leading to a more socially optimal level of distributed generation penetration.

Second, using a flat volumetric rate that is uniform across the service territory of a utility undercompensates distributed generation for other benefits it provides, such as reducing grid congestion when the system is close to capacity during peak hours. Consumers' maximum demand during system peak periods is the main driver of any new system capacity investment.[394] Hence distributed generation systems that help customers reduce their maximum demand during these times periods, and therefore reduce congestion, have value to society that cannot be captured by flat volumetric rates.

Third, a flat volumetric rate creates perverse incentives for customers during the installation phase. As net-metered customers are compensated using the same flat rate regardless of what time they send energy to the grid, their inherent incentive is to install solar panels with the goal of maximizing their total production rather than overall power system benefits. These incentives lead to most solar panels being installed facing south to maximize production.[395] If, instead, the rates reflected overall systems benefits, and customers were incentivized to install solar panels facing west, production could be maximized during the peak demand period between 2:00 p.m. and 8:00 p.m., providing more value to the overall power system by curbing the need to dispatch more expensive peaker plants.[396]

Finally, the amount of greenhouse gas emissions displaced by distributed generation also depends on time and location. The level of this change is a

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394. Paul Simshauser, *Network Tariffs: Resolving Rate Instability and Hidden Subsidies* 6 (AGL Applied Economics & Policy Research Working Paper No. 45, 2014), https://perma.cc/9T7D-MDW4.

395. Barry Fischer & Ben Harack, *9% of Solar Homes Are Doing Something Utilities Love. Will Others Follow?*, OPOWER (Dec. 1, 2014), https://perma.cc/U9JR-WZFQ.

396. Herman K. Trabish, *How California is Incentivizing Solar to Solve the Duck Curve*, UTIL. DIVE (Oct. 13, 2014), https://perma.cc/F6VT-YNLT. *See generally* NAÏM R. DARGHOUTH ET AL., LAWRENCE BERKELEY NAT'L LAB., LBNL- 183185, NET METERING AND MARKET FEEDBACK LOOPS: EXPLORING THE IMPACT OF RETAIL RATE DESIGN ON DISTRIBUTED PV DEPLOYMENT (2015), https://perma.cc/Y7GK-69WW.

function of the emissions rate of the generator that is on the margin when the distributed generator sends electricity to the grid. A distributed generator that exports electricity in the mid-afternoon will have a different environmental impact than a distributed generator that exports electricity in the late evening. Further, especially at locations with dirty generation mixes, there is a societal benefit trade-off between inducing higher total production from distributed generation, which would lead to more reductions in avoided greenhouse gases, and inducing targeted but lower levels of total production that help avoid costlier peak periods. Once again, the use of a flat volumetric that does not granularly reflect changes in the external costs of electricity generation prevents the realization of the full value of distributed generation.

A. Valuing Distributed Generation with Time-, Location-, and Demand-Variant Pricing

The economic literature on tariff design is long and rich,[397] and an extensive review of this literature is beyond the scope of this Article. However, there is value to summarizing the well-accepted principles of public utility rate-making initially laid out by James Bonbright.[398] Ideally, tariffs should be effective in yielding the required revenues; they should be fair in allocating the costs among customers and avoid undue discrimination; they should promote static efficiency by discouraging wasteful use as well as dynamic efficiency by encouraging innovation and responding to changing demand and supply patterns; they should reflect all present, future, private, and social costs of providing electricity; they should provide revenue stability for the utilities and rate stability for the customers; and, finally, they should be simple, understandable, and free from controversies over proper interpretation.[399]

The efficiency problems created by the interaction of net metering policies and inadequate retail rate designs are preventable—regulators need only move towards more sophisticated rate designs that follow Bonbright's principles more closely. Such rate designs should be unbundled—with generation, distribution and transmission valued and priced separately—and more cost-reflective,[400] so that costs are recovered in a fashion similar to the way they are incurred based on the unit of their drivers. For example, energy generation costs that are based on the volume of energy sold should be recovered using volumetric charges. To avoid any cross-subsidization, volumetric energy charges should be designed to reflect the variation in locational and temporal changes in the cost of providing electricity.

397. *See* Simshauser, *supra* note 394, at 11–18.

398. James C. Bonbright, Principles of Public Utility Rates 383–84 (2d ed. 1988).

399. *Id.*

400. Ahmad Faruqui, Brattle Grp., The Global Movement Towards Cost-Reflective Tariffs 30–31 (2015), https://perma.cc/6QH4-GAB3.

Similarly, distribution network charges should be carefully designed.[401] If the highest electricity capacity a customer needs at a particular time period is driving the need for further infrastructure investment, charges that are specific to that time period based on the customer's maximum demand during that period—coincident peak demand charges—could be imposed. To ensure that existing network costs are recovered fairly, a charge based on connected load, similar to a network subscription charge, could be imposed.[402] Such tariff designs are already frequently used for cell phone subscriptions and internet/data access plans.

Cost-reflective retail tariff rate structures that provide customers proper price signals that reflect the actual costs underlying the provision of electricity, including the associated externalities, will improve economic efficiency in several ways. First, the new rate structures will ensure that when customers make their decisions about electricity consumption, they will be taking into account the true costs of providing electricity at that particular time and location. Hence, the observed market outcome will be a socially efficient one. Second, these new rate structures will ensure that the market price is actually signaling the true value of electricity to the society and guiding investments to where they would be most beneficial.[403] And finally, cost-reflective tariffs that allow for valuation of several different dimensions of benefits would provide versatile compensation tools that could reduce inefficiencies caused by attempting to integrate new and cleaner energy resources into the existing grid without favoring a particular type of technology ex-ante.

B. Equity Issues

The implementation of such a tariff structure would be easy if we were building a system and corresponding tariffs from scratch. However, while an ideal tariff structure has to be guided by economic theory, it also has to be adapted to the realities of the current system. Any significant tariff change should be implemented with regard for the stakeholders who stand to lose in the short term. For example, while such tariffs would decrease the need for capacity investments in the future, those benefits are accrued in the future whereas bill increases are borne immediately by today's customers. Or, a move from a low fixed charge, high volumetric charge rate structure to a higher fixed charge, lower volumetric charge structure would initially hurt users who consume relatively small amounts of electricity, who are presumably also lower-income customers.

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401. *See generally* Toby Brown et al., *Efficient Tariff Structures For Distribution Network Services*, 48 ECON. ANALYSIS & POL'Y 139 (2015).

402. AHMAD FARUQUI, BRATTLE GRP., THE CASE FOR INTRODUCING DEMAND CHARGES IN RESIDENTIAL TARIFFS (2015), https://perma.cc/8HQY-4Q5G.

403. Borenstein & Bushnell, *supra* note 90, 454–57.

The possibility of such transitional equity problems should be recognized, and policy solutions aimed at these problems should be discussed as part of any reform. However, keeping volumetric rates artificially low is not the solution to equity concerns regarding vulnerable low-income energy customers. After all, similar concerns exist for many other essential goods such as food and health insurance. Instead of distorting the prices of many basic food items, food stamps are provided to low-income customers to partially subsidize their food spending. Instead of regulating health insurance premiums, subsidies are given to lower-income consumers to defray the cost of health insurance. Such practices are not limited to large-scale federal policies; utilities themselves offer many programs to help low-income consumers.[404] Similarly, analyzing the evolution of tariffs in the telecommunications sector with an eye toward the various tariffs geared at customers with different profiles would provide valuable insights for the electricity sector.

It is important to keep in mind that social welfare is maximized when the market price reflects both private and external marginal costs.[405] Once such a price is established so that the maximum possible net benefits can be realized, distributing this net value among different groups of stakeholders is best done through direct transfer programs that have specific policy goals, such as crediting low-income customers with fixed amounts on their energy bills, or subsidizing programs that would allow low-income customers easier access to distributed energy resources. Distorting the prices for everyone with the sole goal of protecting low-income customers may indeed be hurting them because it impairs economic efficiency.

C. Incorporating Externalities into Dynamic Pricing

Internalizing externalities in retail rates is crucial to the success of clean energy policies, especially when dynamic tariffs are used. The environmental and health benefits of distributed generation systems are among the most important reasons that these systems are at the center of clean energy policy initiatives. Such benefits must therefore be recognized and internalized in any tariff design that is aimed at maximizing net social benefits.

Using time-, location-, and demand-variant pricing does not automatically resolve environmental or health concerns related to emissions. It is important to note that while dynamic tariffs provide more incentives for distributed generation deployment and thus result in a decrease in the energy demanded from the

404. Notice Seeking Comments, Proceeding on Motion of the Commission to Examine Programs to Address Energy Affordability for Low Income Utility Customers, Case 14-M-0565, N.Y. PUB. SERV. COMM'N (Jan. 16, 2015); *see also Energy Assistance Programs*, CONEDISON (2014), https://perma.cc/YZM8-Y7AZ.

405. *See* JONATHAN GRUBER, PUBLIC FINANCE AND PUBLIC POLICY 127, 138–42 (4th ed. 2013).

bulk system, dynamic rates may also cause consumers without distributed generation systems to shift their loads to periods where dirtier plants are on the margin, unless the externalities are fully internalized in retail rates. Understanding these two effects is crucial in preventing an unintended increase in overall emissions.

As peaker plants are often less efficient and dirtier,[406] overall emissions decrease when distributed generation reduces the need for the electricity generated from such plants. However, if time-varying rates shift consumption to other periods, calculating the net effects requires a more careful analysis. If the load is shifted from a period when an inefficient oil-fired plant is on the margin to a period when a more efficient gas-fired unit is on the margin, the overall greenhouse gas emissions would decrease. If, however, the load is shifted to a period when the cheaper coal-fired base load plants are on the margin, overall carbon emissions may increase even if this shift lowers overall energy generation costs. Thus, any tariff underlying net metering should include externalities at a granular enough level to be able to account for such temporal variation. If the temporal dimensions are not taken into account while calculating environmental and health benefits, and all distributed energy resources are rewarded based on the same average quantity of avoided emissions, then the market incentives will lead to more investment in cheaper distributed energy resources, regardless of whether they are the most beneficial for the society when externalities are taken into account.

Overall, having the right price signals would ensure an efficient allocation of resources by directing the right type of distributed energy resource investments to where they are needed most. It is important to realize that not all distributed energy resources are comparable, and they can be used to serve different purposes. Different technologies have different attributes and therefore they contribute differently to the electric system.[407] Encouraging solar panels to be installed in specific areas that are closer to requiring additional peak capacity can provide far more capacity value than installations averaged across a whole service territory.[408] While solar panels may be more valuable when installed near areas where demand peaks during the day, investing in wind turbines may be more valuable in areas where demand peaks later in the day, as that is when

406. Robin Bravender & Collin Sullivan, *Utility to Build First Power Plant with Greenhouse Gas Emissions Limits in California*, SCI. AM. (Feb. 5, 2010), https://perma.cc/Q4GW-TGWU; *see also Flexible Peaking Resource*, ENERGY STORAGE ASS'N, https://perma.cc/9YUH-5AXV; Janice Lin, *The Value of Energy Storage*, CAL. ENERGY STORAGE ALL. (Mar. 25, 2014), https://perma.cc/R2MM-M23G.

407. SUSAN TIERNEY, THE ANALYSIS GRP., THE VALUE OF "DER" TO "D," at ES-2 (2016), https://perma.cc/SC9S-GDW6.

408. *See* Michael A. Cohen et al., *Economic Effects of Distributed PV Generation on California's Distribution System* (Energy Inst. at Haas, Working Paper No. 260, 2015), https://perma.cc/4TNJ-K95U.

wind production also peaks.[409] Some distributed energy resources may not provide desired benefits in certain areas,[410] so reallocating funds to more effective resources in those areas may be necessary to achieve clean energy or reliability goals in the least-cost manner. Further, the granular and dynamic nature of this approach would allow it to be used consistently across all energy resources to provide the right signals for a socially desirable outcome, regardless of whether they are centralized or distributed; small scale or utility scale; or emitting or non-emitting. Only by using a comprehensive framework that can recognize such granular variations in valuation can we move beyond narrow and short-sighted debates that may inefficiently favor one low-carbon resource over another. Instead, we should start a debate on how to use all distributed energy resources to unlock their value to the fullest extent possible.

Conclusion

As many states are looking to integrate more distributed energy resources into the grid, current net metering policies are proving to be inadequate to properly value the clean energy produced by distributed generation, or the services provided by the electric grid and the utilities. The current literature has not comprehensively analyzed the benefits and costs of distributed generation to the electric grid or to society as a whole, which is the necessary first step before a socially optimal net metering policy can be designed. This Article fills the resulting current vacuum.

Our analysis identifies the sources of the inefficiencies of current policies and we propose a preferable protocol, which we refer to as the "Avoided Cost Plus Social Benefit" approach. This approach both rewards clean distributed energy for the environmental and health benefits it provides and ensures that utilities are compensated for the services they provide. This approach is the best that can be accomplished given the limitations of the current energy policy framework, which relies too heavily on fixed volumetric rates. Finally, this Article provides a roadmap for more comprehensive energy policy reform, which is necessary in order to properly value all energy resources, including distributed generation, and thereby ensure that states' clean energy and resiliency goals can be achieved as efficiently as possible.

409. *See generally* Joseph Cullen, *Measuring the Environmental Benefits of Wind-Generated Electricity*, 5 Am. Econ. J. Econ. Pol'y 107 (2013).

410. *See* Eduardo Porter, *Climate Change Calls for Science, Not Hope*, N.Y. Times (June 24, 2015), https://perma.cc/S9KP-ZD7V.