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Time of Renewables

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ARTICLE

TIME OF RENEWABLES

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ABSTRACT

100% renewable energy is increasingly becoming a goal in the United States, and it makes sense for both climate and cost reasons. First, generating electricity from renewable resources, instead of fossil fuels, avoids climate-changing carbon and methane emissions. Second, solar and wind power involve technologies that now represent the lowest cost options for new electricity generation in many parts of the country.

Transitioning from a 19th century fossil-fuel grid to 100% renewables involves technical and economic challenges, but some of the greatest challenges are due to policy. In 2005, Congress enacted policies to encourage the more efficient use of electricity and the deployment of renewable energy generation sources. Ironically, these policies are now perpetuating the use of electricity from fossil fuel, especially at the expense of expanded solar development. Switching from current time-of-use rates to rates that reflect the time-of-renewables will give solar energy its day in the sun.

CONTENTS

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INTRODUCTION

Several states and other entities now have 100% renewable energy mandates or goals.[1] The 100% renewable energy goal makes sense for both climate and economic reasons. First, generating electricity from renewable resources avoids climate-changing carbon or methane emissions. Second, because solar and wind generation involves improving technologies, their price has dropped precipitously over the years.[2] Unlike coal or natural gas-fired power plants that require fuels that are becoming scarcer and requiring more expensive extraction techniques, solar and wind are frequently now the lowest-cost option for new electricity generation.[3]

Although the definition of what qualifies as a renewable energy resource may vary, wind and solar power typically play a leading role. Because wind and solar are variable resources, scientists debate the feasibility of reaching 100%

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1 *See, e.g.*, Miriam Makhyoun, *100% Clean and Renewable Electricity Standards Proliferate Across States*, EQ RSCH. BLOG (Apr. 16, 2020), https://eq-research.com/blog/eq-research-100-clean-energy-infographics/ [https://perma.cc/SNR7-WFXW]. In 2021, the Biden administration incorporated a 24/7 renewable energy goal into the American Jobs Plan (the "Plan"). The Plan states a promise to purchase "24/7 clean power for federal buildings," which account for around 300,000 buildings in the United States. Fact Sheet from The White House on The American Jobs Plan (Mar. 31, 2021) (available at https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/ [https://perma.cc/VUV7-DH2S]).

2 *How Falling Costs Make Renewables a Cost-Effective Investment*, INT'L RENEWABLE ENERGY AGENCY (June 2, 2020), https://www.irena.org/newsroom/articles/2020/Jun/How-Falling-Costs-Make-Renewables-a-Cost-effective-Investment [https://perma.cc/4QNK-5Y3Q].

3 *Id.*

renewables due to the technical and economic challenges.[4] Yet, some of the greatest challenges come from outdated policies that perpetuate the construction and use of fossil fuel-generated electricity.

In 2005, Congress introduced time-of-use rates as a mechanism to encourage the more efficient use of electricity and the deployment of renewable energy generation sources.[5] Ironically, as discussed later in this paper, time-of-use is now perpetuating the consumption of electricity generated from fossil fuels, especially at the expense of expanded solar development. Switching from time-of-use rates that propel us in the wrong direction toward more fossil fuels, energy policy should drive utilities and their consumers to transition to an electric grid that runs on renewables.[6]

I. ON-DEMAND POWER THROUGH THE FOSSIL-FUEL GRID

The United States has a tradition of on-demand electric service—*i.e.*, consumers can expect to receive as much electricity as they want upon the flip of a switch. This model evolved over decades. In the late 1800s, electricity was a luxury item provided by small neighborhood utility companies such as Thomas Edison's Pearl Street Station in New York City, initially serving just 82 customers through a generator fired by coal.[7] Samuel Insull, who worked with Edison and took over operations of Chicago-Edison in 1892, lobbied for the concept of "regulated monopolies" for electric utilities. By the early 1900s, thirty state legislatures had expanded state utility commissions to include electricity regulation of the monopolies that consolidated most of the initially small utility

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[4] *See, e.g.*, Mark Z. Jacobson, Mark A. Delucchi, Mary A. Cameron & Bethany A. Frew, *Low-Cost Solution to the Grid Reliability Problem with 100% Penetration of Intermittent Wind, Water, and Solar for All Purposes*, 112 PROC. NAT'L. ACAD. SCI. U.S. 15060, 15060 (2015); Christopher T.M. Clack, Staffan A. Qvist, Jay Apt, Morgan Bazilian, Adam R. Brandt, Ken Caldeira, Steven J. Davis, Victor Diakov, Mark A. Handschy, Paul D.H. Hines, Paulina Jaramillo, Daniel M. Kammen, Jane C.S. Long, M. Granger Morgan, Adam Reed, Varun Sivaram, James Sweeney, George R. Tynan, David G. Victor, John P. Weyant & Jay F. Whitacre, *Evaluation of a Proposal for Reliable Low-Cost Grid Power with 100% Wind, Water, and Solar*, 114 PROC. NATL. ACAD. SCI. U.S. 6722, 6723–27 (2017); B.P. Heard, B.W. Brook, T.M.L. Wigley & C.J.A. Bradshaw, *Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems*, 76 RENEWABLE & SUSTAINABLE ENERGY REV. 1122, 1122–30 (2017); Mark Diesendorf & Ben Elliston, *The Feasibility of 100% Renewable Electricity Systems: A Response to Critics*, 93 RENEWABLE & SUSTAINABLE ENERGY REV. 318, 318–27 (2018); T.W. Brown, T. Bischof-Niemz, K. Blok, C. Breyer, H. Lund & B.V. Mathiesen, *Response to* Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems, 92 RENEWABLE & SUSTAINABLE ENERGY REV. 834, 834–42 (2018).

[5] Energy Policy Act of 2005, Pub. L. No. 109–58, 119 Stat. 964.

[6] *See generally* Sanya Carley, *Decarbonization of the U.S. Electricity Sector: Are State Energy Policy Portfolios the Solution?*, 33 ENERGY ECON. 1004, 1004–23 (2011).

[7] KELD NIELSEN, HENRY NIELSEN & HANS SIGGAARD JENSEN, SKRUEN UDEN ENDE 253 (3d ed. 2005).

companies.[8] The traditional on-demand grid of the 1900s created at least two major problems for today's power markets: (A) the overbuilding of inflexible fossil fuel electricity generation sources and (B) a lack of transparent price signals to customers about the true cost of the electrons they were consuming at any particular time of day.

A. Overbuilding of Inflexible Fossil-Fuel Generation Sources and "Waste" of Renewable Resources

The electric grid requires a balance of real-time supply and demand at all times.[9] Traditionally, utilities focused on the supply side. The "cost-of-service" rate structure established by state public utility commissions (PUCs) encouraged utilities to invest in expensive large-scale infrastructure to provide supply.[10] The formula used by PUCs allowed utilities to use the cost of these investments as their "rate base" upon which the utilities were guaranteed a set rate of return on equity.[11] Consequently, the higher the rate base, dependent on investments in large infrastructure, the greater the guaranteed rate of return for the utility.[12] Consequently, for a vertically-integrated, investor-owned electric utility, the only thing better for profit than one expensive generator was two expensive generators.

Historically, the highest cost electricity generation infrastructure has been large-scale coal-fired and nuclear power plants.[13] The problem with these generation sources is that they are extremely inflexible. They are designed to run at maximum power at all times, and they cannot easily be turned down without

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[8] Richard D. Cudahy & William D. Henderson, *From Insull to Enron: Corporate (Re)Regulation After the Rise and Fall of Two Energy Icons*, 26 ENERGY L.J. 35, 50, 104, 110 (2005); *see also* RICHARD RUDOLPH & SCOTT RIDLEY, POWER STRUGGLE: THE HUNDRED YEAR WAR OVER ELECTRICITY 34 (1986).

[9] Robin Whitlock, *The Future of Demand Response: An Interview with Cisco DeVries of OhmConnect*, RENEWABLE ENERGY MAG. (July 22, 2020), https://www.renewableenergymagazine.com/interviews/scanreach-awarded-financing-to-make-operations-at-20200722-1 [https://perma.cc/DFW4-AVMA].

[10] Inara Scott, *Incentive Regulation, New Business Models, and the Transformation of the Electric Power Industry*, 5 MICH. J. ENV'T. & ADMIN. L. 319, 328–29 (2016).

[11] K.K. DUVIVIER, ENERGY LAW BASICS 102 (2017) [hereinafter ENERGY LAW].

[12] *Id.*

[13] 'Most expensive' translates to 'highest investment' for the utility to up its rate base. *See* INT'L ENERGY ASS'N, PROJECTED COSTS OF GENERATING ELECTRICITY 2020 19 (Dec. 2020), https://www.iea.org/reports/projected-costs-of-generating-electricity-2020 [https://perma.cc/KP7U-EC97] ("Technologies with high variable costs (such as high-flexibility open-cycle gas turbines), that produce only during a few hours with very high prices, provide on average a higher value (per unit of generation) to the system. Baseload plants, typically CCGTs (an exception is Europe, where they are mostly operating during hours with high residual load), coal and nuclear, that produce reliably over a high number of hours provide a value similar to the system average.").

damage to the generator or even the risk of explosions.[14] Consequently, these types of power plants are used for "baseload," or the minimum demand the utility might expect on its system during a day.[15] Dips below this minimum demand mean that the utility is generating too much power from a source that it cannot turn off and, consequently, it might have to find some way of redirecting or disposing of this power.[16] In addition, utilities have convinced public utility commissions that the construction of these types of baseload power plants is most cost-effective.[17] That cost-effective assumption is based on running the baseload plant at or close to maximum capacity most of the time. However, the supposedly cheap power they might have generated at 90% capacity is no longer cheap at 80% or less.

As can be expected with an on-demand system, the amount of electricity that customers consume varies throughout the day.[18] Consequently, utilities need to have other power generation sources to meet this demand. While much of this variable demand is predictable, the most challenging times for utilities to balance supply and demand are during "peak" loads.[19] These peak loads vary by customer type—i.e., business vs. residential—and by time of day or year.[20] For example, pre-COVID-19, the peak load for residences was in the evening when consumers returned from work and used electricity for cooking, washing, videogaming, etc. With respect to seasonal demand, many parts of the United States have summer peaks on hot days when electrical air conditioning demand is high.[21]

Two of the most common mechanisms used to meet peak load are (1) storage or (2) natural gas "peaker" plants.

1. Storage

The focus of this article is the overbuild of fossil-fuel sources to meet supply-side efforts to balance the grid. Consequently, this section on storage will be brief. While battery storage is still a relatively new and as yet untapped

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14 JEFFREY LOGAN, CARA MARCY, JAMES MCCALL, FRANCISCO FLORES-ESPINO, AARON BLOOM, JORN AABAKKEN, WESLEY COLE, THOMAS JENKIN, GIAN PORRO & CHANG LIU, ELECTRICITY GENERATION BASELINE REPORT 20 (2017).

15 INT'L ATOMIC ENERGY AGENCY, NON-BASELOAD OPERATION IN NUCLEAR POWER PLANTS: LOAD FOLLOWING AND FREQUENCY CONTROL MODES OF FLEXIBLE OPERATION 1 (2018).

16 *Id.* at 11.

17 *See* INT'L ENERGY ASS'N, *supra* note 13.

18 Jonathan Susser, *Why is Peak Demand a Concern for Utilities?*, ADVANCED ENERGY (Mar. 13, 2018), https://www.advancedenergy.org/2018/03/13/why-is-peak-demand-a-concern-for-utilities/ [https://perma.cc/N8EF-Y24V].

19 *Id.*

20 *Id.*

21 *Id.*

technology, there is a lot of current discussion about its advantages.[22] Battery use is growing exponentially, and batteries furnish dual benefits of (A) providing a way to capture electricity that is being generated beyond the current demand and that otherwise might be wasted, as well as (B) being able to "dispatch" electricity immediately and flexibly when and where it is needed.[23]

Currently, pumped hydro storage is the primary mechanism that U.S. utilities use to meet peaks in customer demand for electricity above baseloads. Water creates electricity through gravity when it flows downstream through a turbine.[24] While the amount of electricity generated by a hydropower dam can vary with how much water is in the reservoirs,[25] pumped storage is a special use of hydropower to meet peak demands. A pumped storage project involves two bodies of water, one at an upper reservoir and one at a lower elevation. During times of low customer demand, the utility can pump water uphill so that it is available later for release into the turbines at the lower elevation to generate electricity at times of higher demand.[26]

Pumped hydroelectric storage was introduced in the United States and Europe in the 1920s, and, as of 2017, the United States had forty-three pumped hydro projects representing around twenty-three gigawatts of potential power, two percent of U.S. electricity generation capacity.[27] Most pumped hydro storage in the

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[22] *See, e.g.*, *Supplying Clean Power is Easier than Storing It*, THE ECONOMIST (Nov. 28, 2019), https://www.economist.com/business/2019/11/28/supplying-clean-power-is-easier-than-storing-it; *Battery Storage Paves Way for a Renewable-Powered Future,* INT'L RENEWABLE ENERGY AGENCY (Mar. 26, 2020), https://www.irena.org/newsroom/articles/2020/Mar/Battery-storage-paves-way-for-a-renewable-powered-future [https://perma.cc/95JA-MTG7].

[23] THE ECONOMIST, *supra* note 22.

[24] *Pumped Hydropower*, ENERGY STORAGE ASS'N, https://energystorage.org/why-energy-storage/technologies/pumped-hydropower/ [https://perma.cc/DUQ4-WKV4].

[25] *See, e.g.*, Lindsay Aramayo, *California's Hydroelectric Generation Affected by Historic Drought*, U.S. ENERGY INFO. ADMIN. (July 7, 2021), https://www.eia.gov/todayinenergy/detail.php?id=48616 [https://perma.cc/9DD4-VCZ5] (California hydropower generation declined significantly between 2012 and 2016, and again between 2020 and 2021 due to drought); Paul Rogers, *Lake Oroville Reaches All-Time Low Level; Hydroelectric Plant Shuts Down for First Time Ever*, THE MERCURY NEWS (Aug. 5, 2021), https://www.mercurynews.com/2021/08/05/lake-oroville-reaches-all-time-low-level-hydroelectric-plant-will-shut-down-for-first-time-ever/ [https://perma.cc/L226-MASJ] (reporting shut down on August 5, 2021 of one of California's hydropower dams due to lack of water).

[26] ENERGY STORAGE ASS'N, *supra* note 24.

[27] *Id.*

United States was installed in the 1970s,[28] motivated by the inflexibility of nuclear power plants.[29]

2. Natural Gas Peaker Plants

The most common fossil-fuel mechanism for meeting varying electricity demands in the United States are natural-gas-fired power plants. Natural gas plants accounted for nearly 45% of total electricity generation in the United States in 2016.[30] As concerns about the greenhouse gases emitted from coal-fired power plants grew, many jurisdictions required utilities to convert their generation fleets to natural gas,[31] which produces less carbon dioxide upon burning, but may be offsetting those gains with more climate-damaging methane emissions while drilling and transporting the natural gas to the power plants.[32]

Most "peaker" plants in the United States are natural-gas fired. There were around 1,000 natural gas- and oil-fired peaker plants across the United States in

[28] Fred Mayes, *Most Pumped Storage Electricity Generators in the U.S. Were Built in the 1970s*, U.S. ENERGY INFO. ADMIN. (Oct. 31, 2019), https://www.eia.gov/todayinenergy/detail.php?id=41833 [https://www.eia.gov/todayinenergy/detail.php?id=41833].

[29] "Ironically, what originally motivated pumped storage installations was the inflexibility of nuclear power. Nuclear plants' large steam turbines run best at full power. Pumped storage can defer surplus nuclear power generated overnight (when consumption is low) to help meet the next day's demand peak." Peter Fairley, *A Pumped Hydro Energy-Storage Renaissance*, INST. OF ELEC. & ELECS. ENG'RS: IEEE SPECTRUM (Mar. 18, 2015), https://spectrum.ieee.org/a-pumped-hydro-energystorage-renaissance [https://perma.cc/YWP3-LKVN].

[30] Augustine Kwon, *Natural Gas Generators Make Up the Largest Share of Overall U.S. Generation Capacity*, U.S. ENERGY INFO. ADMIN. (Dec. 18, 2017), https://www.eia.gov/todayinenergy/detail.php?id=34172 [https://perma.cc/CKE2-PWN8]. Combined-cycle natural-gas-fired power plants can produce up to fifty percent more electricity from the same fuel as a single-cycle power plant because they utilize a gas combustion turbine and then use the waste heat from that process to generate electricity through a separate steam turbine. *Combined Cycle Power Plant,* GE GAS POWER, https://www.ge.com/gas-power/resources/education/combined-cycle-power-plants [https://perma.cc/BBQ5-P7X2].

[31] *See, e.g.*, Clean Air—Clean Jobs Act, COLO. REV. STAT. § 40–3.2–202(1) (2019).

[32] *See, e.g.*, *A Dirty Little Secret*, THE ECONOMIST (July 23, 2016), https://www.economist.com/business/2016/07/23/a-dirty-little-secret [https://perma.cc/E68D-FYQT]; Jeff Tollefson, *Methane Leaks Erode Green Credentials of Natural Gas*, 493 NATURE 12, 12 (2013). *But cf. Despite Pandemic Shutdowns, Carbon Dioxide and Methane Surged In 2020*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Apr. 7, 2021), https://research.noaa.gov/article/ArtMID/587/ArticleID/2742/Despite-pandemic-shutdowns-carbon-dioxide-and-methane-surged-in-2020 [https://perma.cc/3M6W-XA7J] (suggesting that all-time high methane emissions in 2020 came from wetlands or livestock). In fact, according to the International Energy Agency, methane emission from oil and natural gas decreased ten percent in 2020 because of lower output. *Methane Tracker*, INT'L ENERGY AGENCY (Jan. 2021), https://www.iea.org/reports/methane-tracker-2021 [https://perma.cc/XJM8-VSGW].

2020.[33] Peaker plants are designed to turn on and off when needed to supply electricity at any time and fill in supply when primary generation sources are inadequate.

The main issue with peaker plants is that, on average, peaker plants in the United States are only used around 4% of the time, amounting to less than 300 hours every year.[34] In addition to releasing carbon dioxide while burning the gas and emitting fugitive methane in transporting the gas, peaker plants also emit nitrous oxide and particulate matter that are associated with an increased risk of asthma and other respiratory conditions.[35] Because these peaker plants are almost exclusively relied upon in times of immediate need for electricity, they are often located near heavily populated and residential areas, which makes their harmful emissions an even greater risk to public health, especially to vulnerable low-income populations.[36]

B. Variable Prices and the Lack of Transparency

In addition to air pollution and greenhouse gas concerns, the traditional methods of meeting peak demand result in widely varying costs to the utility to procure electrons in times of need. When demand is low and generation high, then prices are low or sometimes "negative," meaning the utility must pay a third party to take the power that otherwise would throw off the balance of the grid. Looking at the other side of the coin, when demand is high and generation low, a utility must quickly find generation sources, and thus pay a premium.

Texas provides a recent example of the high variations in price for electricity depending on demand. During the unprecedented storm in February of 2021, some customers saw their utility bills burgeon to thousands of dollars as the wholesale market price of electricity rose 7,400%—from twelve cents per kilowatt-hour to nine dollars per kilowatt hour.[37] This was due to the added cost to

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[33] *Energy Storage Peaker Plant Replacement Project*, PHYSICIANS, SCIENTISTS, & ENG'RS FOR HEALTHY ENERGY, https://www.psehealthyenergy.org/our-work/energy-storage-peaker-plant-replacement-project/ [https://perma.cc/XE2T-P4DV].

[34] *What is a Peaker Power Plant?*, CLEAN ENERGY GRP., https://www.cleanegroup.org/ceg-resources/resource/what-is-a-peaker-power-plant/ [https://perma.cc/GZ74-6CE9]. Most peaker plants are simple cycle. These means that peaker plants, unlike combined cycle plants, do not take advantage of efficiencies of using the hot exhaust gases emitted as a biproduct of combustion of the natural gas in the single cycle to generate electricity from steam in the combined cycle. Bethel Afework, Jordan Hanania, James Jenden, Kailyn Stenhouse & Jason Donev, *Natural Gas Power Plant*, ENERGY EDUC. (Feb. 24, 2019), https://energyeducation.ca/encyclopedia/Natural_gas_power_plant [https://perma.cc/A66B-JV5D].

[35] *Phase Out Peakers*, CLEAN ENERGY GRP., https://www.cleanegroup.org/ceg-projects/phase-out-peakers/ [https://perma.cc/QB4U-8NSP].

[36] CLEAN ENERGY GRP., *supra* note 34.

[37] Shannon Najmabadi, *Texans Blindsided by Massive Electric Bills Await Details of Gov. Greg Abbott's Promised Relief*, TEX. TRIBUNE (Feb. 22, 2021), https://www.texastribune.org/2021/02/22/texas-pauses-electric-bills/ [https://perma.cc/7AKY-FUP2].

the utility to purchase that power when there was a shortage.[38] Natural-gas peaker plants are an example of an especially expensive source of peak power. One peaker plant in New Jersey cost Public Service Enterprise Group (PSEG), the energy company that operated that plant, $3 million over the year to run and maintain the facility when the plant was only used five days in 2010.[39]

At times, utility balancing authorities throw away or "curtail" electricity production to ensure that the load on the grid does not exceed demand.[40] Curtailment is an intentional reduction in energy output and is mostly done by shutting off the generating resources.[41] Traditional, inflexible power sources, such as coal and nuclear, have resulted in a great deal of electricity being wasted as utilities must curtail electricity that is capable of being generated by other sources.

Curtailment occurs for all sources of electricity generation. As the total capacity of renewable generation increases, it will become increasingly common for renewables to be curtailed because they are some of the least expensive sources of electricity production (no fuel costs), but also because renewables are dependent on the weather, and therefore, more variable. Studies from the National Renewable Energy Laboratory have analyzed how energy production from renewables, namely wind and solar, is not consistent throughout the day.[42] Spikes in renewable electricity generation typically occur when weather conditions are ideal, which can result in a surplus of electricity.

The renewables curtailment issue is growing as more utilities build solar and wind generation facilities. For example, Texas's grid operator, ERCOT,

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[38] Some of the price-gouging was also due to speculation in the electricity and gas market. *See* Minyvonne Burke, *$29 Million of Electric Bills from Texas Winter Storm Will Be Forgiven, AG Says*, NBC NEWS (Mar. 17, 2021), https://www.nbcnews.com/news/us-news/29-million-electric-bills-texas-winter-storm-will-be-forgiven-n1261310 [https://perma.cc/4P84-SELF].

[39] Now PSEG is taking steps to replace some of its peaker plants with renewables and battery storage. *See, e.g.*, PHYSICIANS, SCIENTISTS, & ENG'RS FOR HEALTHY ENERGY, NEW JERSEY PEAKER POWER PLANTS 1 (2020), https://www.psehealthyenergy.org/wp-content/uploads/2020/05/New-Jersey.pdf [https://perma.cc/B9P3-DG69].

[40] *Reverse Demand Response?*, ENERGYWATCH, https://energywatch-inc.com/reverse-demand-response/ [https://perma.cc/DY3T-KN98].

[41] Rarely is curtailment done by shutting off transmission, but this is only the case when the grid is in crisis—to reduce load, not generation. Major parts of the Texas transmission gird were shut down in February 2021 because there was insufficient generation to match the load. *See* Mark Specht, *Renewable Energy Curtailment 101: The Problem That's Actually Not a Problem At All*, UNION OF CONCERNED SCIENTISTS BLOG (June 25, 2019), https://blog.ucsusa.org/mark-specht/renewable-energy-curtailment-101 [https://perma.cc/9AL6-L5JR].

[42] *See, e.g.*, TRIEU MAI, YINONG SUN, JADUN PAIGE, CAITLIN MURPHY, JEFFREY LOGAN, MATTEO MURATORI & BRENT NELSON, U.S. DEP'T OF ENERGY, OFF. OF SCI. & TECH. INFO., ELECTRIFICATION FUTURES STUDY: METHODOLOGICAL APPROACHES FOR ASSESSING LONG-TERM POWER SYSTEM IMPACTS OF END-USE ELECTRIFICATION, https://www.nrel.gov/docs/fy20osti/73336.pdf [https://perma.cc/SRD9-55CL].

curtailed over 8% of its solar photovoltaic (PV) generation in 2018.[43] Similarly, the California Integrated System Operator (CAISO) saw an increase in solar PV curtailment from 0.6% of total electricity generated in 2015 to 3.3% in 2020.[44]

While the volume of curtailed electricity does not amount to a huge percentage of total energy production, the upwards trend in curtailment correlates with the increase in installed renewable energy capacity. The more renewables that utilities and developers build, the more surplus electricity there will be for certain times of the day or year. Based on their traditional fossil-fuel generation and consumption patterns, some utilities model their renewable generation sources assuming that they will need to curtail them. For example, Xcel Energy Colorado by its own analysis, anticipates curtailing 950,756 MWhs of wind in 2021.[45] This is enough to charge roughly 300,000 EVs for 30 miles per day for an entire year.[46]

Some states have viewed renewable energy curtailment as a waste of electricity and enacted statutes that aim to reduce it. For example, the Hawai'i Revised Statutes contain a provision which requires the Hawai'i PUC to consider programs to mitigate renewable energy curtailment.[47] Prior to this provision, Hawai'i utilities had taken steps to analyze curtailment of renewable electricity within the state, which included studies that modeled future grid impacts of

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[43] *Id.* at 8.

[44] Andrew D. Mills, Joachim Seel, Dev Millstein, James Hyungkwan Kim, Seongeun Jeong, Cody Warner & Will Gorman, Lawrence Berkeley Nat'l Lab'y, SOLAR TO GRID — TRENDS IN SYSTEM IMPACTS, RELIABILITY, AND MARKET VALUE IN THE UNITED STATES 24–25 (2021), https://emp.lbl.gov/sites/default/files/solar-to-grid_2020_final.pdf [https://perma.cc/N5WP-ALWE]; *cf.* Yinong Sun, Sadanand Wachche, Andrew Mills & Ookie Ma, 2018 Renewable Energy Grid Integration Data Book 9 (Mike Meshek ed., 2018), https://www.nrel.gov/docs/fy20osti/74823.pdf [https://perma.cc/6QWM-RAY9] (finding CAISO average annual solar PV curtailment increased from 0.8% of total electricity generated in 2015 to 1.5% in 2018).

[45] *See Public Service Company of Colo.—Trans. Electrification Plan: Hearing Before the Pub. Utils. Comm'n,* Proc. No. 20A–0204E (Colo. 2020) [hereinafter *Trans. Electrification Plan*] (statement of Joseph C. McCabe, Staff, Pub. Utils. Comm'n).

[46] *See Public Service Company of Colo.—AL 1814—Tariff 8—TOU: Hearing Before the Pub. Utils. Comm'n,* Proc. No. 19AL–0687E (Colo. 2020) (testimony of Dan Regelson & Ken Regelson, at 4) (950,756 MWh x 1000 kWh/MWh / (365 days/year x 30 miles per day) / 3.5 miles per kWh = 303,000 cars per year). While this analysis is helpful to understand the amount of wind energy that Xcel predicts it will generate and be unable to sell, Xcel anticipates the curtailment period will be short—approximately ten days per year—so that electricity could not be distributed to 300,000 vehicles for daily use throughout a year. *See Trans. Electrification Plan, supra* note 45, and accompanying text.

[47] HAW. REV. STAT. § 269–6(e)(2) (2021) ("The establishment of a renewable energy curtailment mitigation incentive mechanism to encourage public utilities to implement curtailment mitigation practices when lower cost renewable energy is available but not utilized through the sharing of energy cost savings between the public utility, ratepayer, and affected renewable energy projects . . . .").

higher levels of renewables.[48] While studies of this nature are still underway, they are providing utilities with the information they need to initiate programs to reduce renewable electricity curtailment as renewables become a prominent generating source on the grid.[49] Without efforts to redirect demand to a time of renewables as recommended here, solar PV generation may be capped at a maximum of just 25% of total generation when it has the potential to play a much greater role in the energy mix.[50]

Furthermore, while the variability of renewable resources may be seen as a negative by some, it is increasingly seen as an asset. In contrast to inflexible base loads from coal or nuclear power plants, renewable resources can be turned on and off easily. "Dispatchable" resources, or those that can be made available with little lead time, are in high demand for a renewables-based grid, and therefore, able to fetch higher prices on the market when more customers flip the switch and demand is higher. Curtailed renewable energy might increasing play a role as a dispatchable resource.[51]

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48 *See generally* HAW. NAT. ENERGY INST., CURTAILMENT AND GRID SERVICES WITH HIGH PENETRATION SOLAR & STORAGE (Nov. 2020), https://www.hnei.hawaii.edu/wp-content/uploads/Curtailment-and-Grid-Services.pdf [https://perma.cc/AS6H-CAND].

49 Minnesota state statutes stipulate that efforts to reduce renewable energy curtailment may be initiated by utilities through energy storage system pilot projects if it is economically feasible. *See, e.g.*, MINN. STAT. § 216B.16 subdiv. 7e(A)(6) ("[T]he goals the project proposes to achieve, which may include controlling frequency or voltage, mitigating transmission congestion, providing emergency power supplies during outages, reducing curtailment of existing renewable energy generators, and reducing peak power costs."). Spurred by this statute, previous studies indicated that it is cheaper for energy utilities and owners of renewable generation to curtail (rather than pay for tools like battery storage) to utilize the full potential of a renewable resource. MORGAN PUTNAM & MARC PEREZ, CLEAN POWER RSCH., SOLAR POTENTIAL ANALYSIS REPORT 7 (2018), http://mnsolarpathways.org/wp-content/uploads/2018/11/solar-potential-analysis-report-nov15.pdf [https://perma.cc/6QDN-RTEB]. However, battery prices are falling rapidly, and 2020 was a record year for battery deployment. *See New Energy Storage Deployment Topped Record 3,500 MWh in 2020, ESA Report Shows*, RENEWABLE ENERGY WORLD (Mar. 10, 2021), https://www.renewableenergyworld.com/storage/new-energy-storage-deployment-topped-record-3500-mwh-in-2020-esa-report-shows/ [https://perma.cc/PX57-2E5J].

50 E-mail from Ron Sinton, Founder/President, Sinton Instruments, to K.K. DuVivier, Professor of L., U. of Denv. Sturm Coll. of L. (May 3, 2021, 8:10 AM) (on file with author).

51 Paul Denholm, Douglas J. Arent, Samuel F. Baldwin, Daniel E. Bilello, Gregory L. Brinkman, Jaquelin M. Cochran, Wesley J. Cole, Bethany Frew, Vahan Gevorgian, Jenny Heeter, Bri-Mathias S. Hodge, Benjamin Kroposki, Trieu Mai, Mark J. O'Malley, Bryan Palmintier, Daniel Steinberg & Yingchen Zhang, *Perspective: The Challenges of Achieving a 100% Renewable Electricity System in the United States*, 5 JOULE 1331, 1339 (2021) (noting that a cost-competitive system may have a thirty-three percent curtailment rate, which would allow for use of maximum amount of cheap renewables). The authors also describe the challenge of moving from a system of rotating machines (with inherent stability) to inverter-based power. *Id.* at 1442–44.

II. THE RENEWABLE GRID AND TIME-OF-USE PRICING

Although there is much optimism that the Biden Administration's proposals for significant energy measures will pass Congress in some form, the last major bipartisan energy bill was the Energy Policy Act of 2005 ("2005 EPAct").[52] Among its 551 pages and many provisions,[53] the 2005 EPAct attempted to promote generation by solar photovoltaic panels and demand control by customers through rate mechanisms such as (A) net metering and (B) time-based rates including time-of-use.

A. Net Metering

Net metering has generated the most controversy. Through net metering, customers with grid-connected solar PV "offset electric energy provided by the electric utility" with the electricity that their solar panels generate[54]—in other words, their electric meter is essentially allowed to run backward and gain credit for kilowatt-hours when the solar panels on their roofs are generating electricity. The way net metering is implemented varies from utility to utility, but generally, customers who generate 800 kWh of electricity from their on-site solar panels over the course of a year and who consume 1,000 kWh during that same year, are only required to pay the utility for the net amount consumed, or 200 kWh, even if the customers consumed the power at times the solar panel was not generating, such as during the night.[55]

Net metering encouraged private investment in PV because it provided a positive cash flow to offset the up-front costs of installing the panels. Net metering also benefited utilities and other ratepayers because it encouraged private citizens to invest to fund two products that were at a premium in the early days of solar PV deployment—climate-friendly electricity generation sources and electricity during the higher-cost peak demand periods, such as hot summer days when air conditioning loads are at their highest.[56]

The problem is that after penetrations of about ten to fifteen percent of electricity generation from solar PV, the mid-day peak load advantage is offset and there is too much solar generation at that time. Without battery storage, this excess generation means that production outstrips the demand and turns the peak load value of solar generation into an overload liability.[57]

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[52] Energy Policy Act of 2005, Pub. L. No. 109–58, 119 Stat. 594.

[53] *Id.*

[54] *Id.* § 1251(a)(11).

[55] *See, e.g.*, ENERGY LAW, *supra* note 11, at 109.

[56] Nathaniel Bullard, *California's Solar Industry Is Getting Sunburned*, BLOOMBERG GREEN (Mar. 11, 2021), https://www.bloomberg.com/news/articles/2021-03-11/california-s-solar-industry-is-getting-sunburned [https://perma.cc/YTH9-KLTA].

[57] *See id.*

By 2009, utilities in forty-three states and the District of Columbia had adopted some sort of net-metering policy.[58] However, in January of 2013, the Edison Electric Institute (EEI) called its members to arms against net metering, labelling rooftop solar energy generation from PV panels a "disruptive" technology that could be a "potential 'game changer[]' to the U.S. electric utility industry" and its investors.[59] The EEI report likened solar PV to cellphone technologies and the disruption those technologies brought to conventional landline phone companies.[60]

As a result, utilities and their lobbyists across the country began to attack net metering policies at state utility commissions arguing that net metering policies inappropriately subsidized solar deployment and unfairly placed additional burdens on other ratepayers who were not affluent enough to afford installation of solar panels.[61] By 2019, at least 48 states and the District of Columbia had reviewed their net-metering policies and modified them significantly.[62]

Although this net metering background is valuable, the topic has been extensively covered by other commentators.[63] This article, instead, focuses on other

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58 Sara Baldwin Auck, Justin Barnes, Thad Culley, Rusty Haynes, Lauren Passera, Joseph Wiedman, Rosalind Jackson & Rick Gilliam, *Best Practices in State Net Metering Policies and Interconnection Procedures*, FREEING THE GRID 101 (Nov. 2014), http://www.alta-energy.com/reports/FreeTheGrid2014finalreport.pdf [https://perma.cc/4GHF-JE7B].

59 PETER KIND, EDISON ELEC. INST., DISRUPTIVE CHALLENGES: FINANCIAL IMPLICATIONS AND STRATEGIC RESPONSE TO A CHANGING RETAIL ELECTRIC BUSINESS 1 (2013), https://www.ourenergypolicy.org/wp-content/uploads/2013/09/disruptivechallenges-1.pdf [https://perma.cc/H2KD-2DDG].

60 *Id*. at 14.

61 Gilbert Michaud, *Perspectives on Community Solar Policy Adoption Across the United States*, 33 RENEWABLE ENERGY FOCUS 1, 7 (2020).

62 TOM STANTON, NAT'L REGUL. RSCH. INST., REVIEW OF STATE NET ENERGY METERING & SUCCESSOR RATE DESIGNS 23–25 tbl.3 (2019); *see also State Net Metering Policies*, NAT'L CONF. OF STATE LEGISLATURES (Nov. 20, 2017), https://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx [https://perma.cc/NFG8-KDNS].

63 *See, e.g.*, Dani Brooks & Nick Gill, *Should Solar Advocates Reconsider Net Metering?*, GEO. ENV'TL L. REV. ONLINE (Oct. 21, 2019), https://www.law.georgetown.edu/environmental-law-review/blog/should-solar-advocates-reconsider-net-metering/ [https://perma.cc/9CTQ-Y4JG]; Aundene Szmolyan, *Disunity Among the United States: Navigating Net-Metering Without Getting Electrocuted*, 13 J. BUS. ENTREPRENEURSHIP & L. 129, 130–67 (2019); Adam Benshoff & Alison Williams, *Retail Net Metering: It's Time To Get It Right for All Customers*, 48 ENV'TL L. REP. NEWS & ANALYSIS 10729, 10729–32 (2018); Richard L. Revesz & Burcin Unel, *The Future of Distributed Generation: Moving Past Net Metering*, 48 ENV'TL L. REP. NEWS & ANALYSIS 10719, 10719–25 (2018); Conor T. Burns, *Sale or No Sale: Is It Time To Turn Back the Meter on State Net Metering Policies?*, 17 FLA. ST. U. BUS. REV. 149, 149–89 (2018); Jackson Salovaara, *Just and Reasonable Rooftop Solar: A Proposal for Net Metering Reform*, 7 ARIZ. J. ENV'TL L. & POL'Y 56, 57–116 (2017); Richard L. Revesz & Burcin Unel, *Managing the Future of the Electricity Grid: Distributed*

provisions in the 2005 EPAct that have received less attention, but have important implications as the penetration of solar PV has increased since that statute was enacted.

B. Time-of-Use Pricing

In October of 1973, the Organization of Arab Petroleum Exporting Countries (OPEC) imposed an embargo on the United States and other countries that supported Israel in the Yom Kippur War.[64] The oil production cuts instituted by OPEC caused the price of oil to nearly quadruple,[65] wreaking havoc on the U.S. economy.[66] Five years later, Congress passed the Public Utility Regulatory Policies Act of 1978 ("PURPA")[67] to "encourage energy conservation and greater use of domestic energy and renewable resources."[68] PURPA was one of the first

Generation and Net Metering, 41 HARV. ENV'TL L. REV. 43, 43–108 (2017); Mark James et al., *Planning for the Sun to Come Up: How Nevada and California Explain the Future of Net Metering*, 8 SAN DIEGO J. CLIMATE & ENERGY L. 1, 6–65 (2017); Megan McLean, *Throwing Shade: The Case Against Judicial Interference with Solar Net Metering Policies*, 46 ENV'TL L. REP. NEWS & ANALYSIS 10873, 10873–82 (2016); Erika Dopuch, *Judicial Review of Net-Metering Agreements: Seeking to Avoid Capture in the Western District*, 23 J. ENV'T & SUSTAINABILITY L. 217, 217–46 (2016); Harvey L. Reiter & William Greene, *The Case for Reforming Net Metering Compensation: Why Regulators and Courts Should Reject the Public Policy and Antitrust Arguments for Preserving the Status Quo*, 37 ENERGY L.J. 373, 373–74 (2016); Benjamin Hanna, *FERC Net Metering Decisions Keep States in the Dark*, 42 B.C. ENV'TL AFF. L. REV. 133, 133-161 (2015); Alexander D. White, *Compromise in Colorado: Solar Net Metering and the Case for "Renewable Avoided Cost"*, 86 U. COLO. L. REV. 1095, 1095–140 (2015); John V. Barraco, *Distributed Energy and Net Metering: Adopting Rules to Promote a Bright Future*, 29 J. LAND USE & ENV'TL L. 365, 365–400 (2014); Kevin Karges, *Net Metering: Do Non-Solar Homeowners and Utility Companies Have a Legitimate Gripe?*, 3 ARIZ. J. ENV'TL L. & POL'Y 1017, 1017–21 (2014); Valerie J. Faden, *Net Metering of Renewable Energy: How Traditional Electricity Suppliers Fight To Keep You in the Dark*, 10 WIDENER J. PUB. L. 109, 109–34 (2000).

64 Michael Corbett, *Oil Shock of 1973–74*, FED. RSRV. HIST. (Nov. 22, 2013), https://www.federalreservehistory.org/essays/oil-shock-of-1973-74 [https://perma.cc/X29B-3ZDF].

65 *Id.* (recording jump from "$2.90 a barrel before the embargo to $11.65 a barrel in January 1974.").

66 *See id.*

67 Pub. L. No. 95–617, 92 Stat. 3117 (1978).

68 JACK JACOBS & ANDREW HERNDON, RENEWABLE ENERGY LAW AND POLICY § 4.01(1)(a) (Matthew Bender ed., 2021) (restating self-proclaimed purpose of PURPA § 101: "[T]o encourage— (1) conservation of energy supplied by electric utilities; (2) the optimization of the efficiency of use of facilities and resources by electric utilities; and (3) equitable rates to electric consumers.").

federal statutes aimed at" [breaking] the stranglehold that utilities traditionally had on power generation."[69]

The previous sections addressed *supply-side management* or the incentive to build out different power generation facilities to have the capacity to meet maximum peak loads, even if those loads only occur a few hours a year. The flipside alternative is *demand-side management*. Demand-side management is traditionally the equivalent of electric power conservation from a customer perspective. It is not popular with utilities because they generally receive compensation for the number of electricity units in kilowatt hours that a customer consumes. Therefore, it is not generally in a utility's best financial interest to encourage customers to consume less.[70]

However, in terms of efficiency, it has always made some sense to encourage customers to consume less at times of the day when the utility might have trouble meeting peak load. Therefore, it is not too surprising that Samuel Insull introduced "demand-metered billing" in the early days of utilities as a way to reward consumers with discounted utility rates if they used electricity at non-peak times. While peak demand meters have existed for a long time, the problem was that, until recently, utilities had "dumb meters" that could only measure electricity units going one way, from the utility to the customer, and none showing real-time customer generation (*e.g.*, onsite solar PV) or demand response.

The OPEC energy crises created new urgency to control consumption and encourage the efficient use of electricity, so PURPA attempted to provide more transparency about rates to inform customers and allow them to play a role in modifying their behaviors to better conserve energy and avoid the building of unnecessary peak-power infrastructure. Time-of Day rates were the first step.

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[69] *Id.* (noting PURPA "is the only existing federal law that requires utilities to purchase electricity generated by non-utility companies, and the only law that grants special rate and regulatory treatment to encourage renewable energy production," but many states have renewable portfolio standards requiring utilities to purchase renewable energy); *see also* Andrew R. Wheeler & Nik Schoenherr, *PURPA Changes Could Shake Up Clean Energy Market*, LAW360 (Sept. 1, 2016), https://www.law360.com/articles/834505/purpa-changes-could-shake-up-clean-energy-market [https://perma.cc/EDS8-E3QC] (providing overview of PURPA and discussion of calls for reform, including from FERC); *Public Utility Regulatory Policy Act (PURPA)*, UNION OF CONCERNED SCIENTISTS (Oct. 26, 2002), https://www.ucsusa.org/resources/public-utility-regulatory-policy-act [https://perma.cc/QF3F-Q8YW].

[70] Some utility commissions created programs to encourage demand-side management—in Colorado, for example, Xcel Energy is compensated for every LED lightbulb installed. As the cost-of-service model guarantees expenses and a return on equity—irrespective of electric sales—utilities are nevertheless ill-advised to increase electric rates. Indeed, any price hike—regardless of source—is bad publicity, and lesser demand begets a reduction in infrastructure, which threatens the cost-of-service model upon which utility-investors tend to rely. *See* Michael Booth, *Governor Warns Colorado Utilities Again Over Storm-Surge Fees as Xcel Tallies Request at $264 per Customer*, COLO. SUN (Mar. 2, 2021) https://coloradosun.com/2021/03/02/polis-warns-xcel-on-264-storm-bills/ [https://perma.cc/JY7Q-WFK8].

Subsection 111(d)(3) of PURPA required state regulatory authorities to consider the use of "Time-of-Day Rates" as follows:

> (3) TIME-OF-DAY RATES—The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing electric service to such class of electric consumers at different times of the day.[71]

Despite the use of "shall" in the introduction to subsection 111,[72] the language immediately following undermines this mandate:

> (a) CONSIDERATION AND DETERMINATION.—Each State regulatory authority . . . *shall* consider each standard established by subsection (d) and make a determination concerning whether or not it is appropriate to implement such standard to carry out the purposes of this title. . . . *Nothing in this subsection prohibits* any State regulatory authority or nonregulated electric utility from *making any determination that it is not appropriate to implement any such standard*, pursuant to its authority under otherwise applicable State law.[73]

This qualification appears to recognize the traditional role of state utility commissions in setting electricity rates by allowing them to consider, but ultimately reject, the rate mechanism that Congress was attempting to promote.

The 2005 EPAct also addressed various ratemaking standards attempting to encourage customer behavior that might promote more efficiency and the use of solar PV through "smart metering." Subsection 1252 of the 2005 EPAct required utilities to provide their customers with "time-based rate schedules" so that customers could "manage [their] energy use and cost. . . .", as follows:

> (A) Not later than 18 months after August 8, 2005, each electric utility shall offer each of its customer classes, and provide individual customers upon customer request, a time-based rate schedule under which the rate charged by the electric utility varies during different time periods and reflects the variance, if any, in the utility's costs of generating and purchasing electricity at the wholesale level. The time-based rate schedule shall enable the electric consumer to manage energy use and cost through advanced metering and communications technology.[74]

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71 Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95–617, § 111(d)(3), 92 Stat. 3117 (1978) (emphasis supplied).

72 *Id*. ("Each State regulatory authority (with respect to each electric utility for which it has ratemaking authority) and each nonregulated electric utility *shall* consider each standard established by subsection (d).").

73 *Id*.

74 16 U.S.C § 2621(d)(14) (2011). Note that Congress mandated a similar rate in the 1978 Act:

> The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing

In comparison to net metering, some utilities have been slower to implement time-based rates. Traditionally, flat rates that involve a fixed charge per month or a uniform rate per kilowatt hour have been more popular.[75] These methodologies make billing easier for utilities and provide a more consistent income stream.[76] Yet, fixed monthly charges encourage more electricity consumption, and more related emissions to generate that electricity, as customers pay the same amount no matter how much or when they consume.[77] Uniform rates per kilowatt hour hide from customers the impacts of their behaviors and do not encourage decreased consumption during peak demand even though the utility must pay more for electricity at those times. The cost recovery systems for most regulated utilities encourage utilities to stick with such rates because utilities are allowed to overbuild for peak times and are rewarded with a guaranteed rate of return on those investments.[78]

> electric service to such class of electric consumers at different times of the day unless such rates are not cost–effective with respect to such class, as determined under section 115(b).

Pub. L. No. 95–617 (H.R. 4018), § 111, 92 Stat. 3117 (1978).

As with PURPA § 111(d)(3), the specific use of "shall" in §§ 1251(a)(11) and 1252(a) appears to require net metering and time-based rates: "Each electric utility *shall* make available . . . ." *See id.* (emphasis added); *see also* Publ. L. 109–58, § 1251(a)(11), 119 Stat. 963 (codified at 16. U.S.C. § 2621(d)(11)) ("[E]ach electric utility *shall* offer each of its customer classes, and provide individual customers upon customer request, a time-based rate . . . .") (emphasis added); Publ. L. 109–58, § 1252(a)(14), 119 Stat. 963 (codified at 16. U.S.C. § 2621(d)(14)(A)). However, the qualifying language in PURPA § 111(a) undercuts these mandates:

> Each State regulatory authority (with respect to each electric utility for which it has ratemaking authority) and each nonregulated electric utility shall consider each standard established by subsection (d) and make a *determination concerning whether or not it is appropriate to implement* such standard to carry out the purposes of this chapter. . . . *Nothing in this subsection prohibits any State regulatory authority or nonregulated electric utility from making any determination that it is not appropriate to implement any such standard, pursuant to its authority under otherwise applicable State law*.

Pub. L. 95–617 (H.R. 4018), 92 Stat. 3117 (1978) (codified at 16 U.S.C. § 2621(a)) (emphasis added).

[75] LORI BIRD, CAROLYN DAVIDSON, JOYCE MCLAREN & JOHN MILLER, NAT'L RENEWABLE ENERGY LAB'Y, IMPACT OF RATE DESIGN ALTERNATIVES ON RESIDENTIAL SOLAR CUSTOMER BILLS: INCREASED FIXED CHARGES, MINIMUM BILLS AND DEMAND-BASED RATES 44 (Sept. 2015), https://www.nrel.gov/docs/fy15osti/64850.pdf [https://perma.cc/MHX8-KCX7].

[76] Jeff Zethmayr & David Kolata, *The Costs and Benefits of Real-Time Pricing: An Empirical Investigation into Consumer Bills Using Hourly Energy Data and Prices*, 31 ELECTRICITY J. 50, 52 (2017).

[77] ENV'TL DEFENSE FUND, TIME-VARIANT ELECTRICITY PRICING CAN SAVE MONEY AND CUT POLLUTION FACT SHEET 1–2, https://www.edf.org/sites/default/files/time-variant_pricing_fact_sheet_-_april_2015.pdf [https://perma.cc/K646-2WDP].

[78] Booth, *supra* note 70 (noting that Xcel Energy in Colorado was paying premium price for electricity generation during 2021 storm in Texas, yet did not notify customers or

III. TIME-OF-RENEWABLES PRICING

The idea behind time-of-use or time-based rates was to educate consumers about the true cost and infrastructure impacts of their consumption. At the time of the 2005 EPAct and up to 2014, solar electricity generation provided premium power because the generation curve of solar electricity and the commercial peak demand were fairly well-aligned.[79]

Not surprisingly, the world has changed since 2005, especially with respect to technology. As the United States' energy profile has evolved, the amount of electricity generated midday can exceed demand in areas with high levels of solar power deployment, such as California. CAISO characterized this as the "belly of the duck" on its generation and demand charts.[80] To make matters worse, as the belly of the duck expands, new solar installments can "cannibalize" existing solar generation and convert solar power from a premium commodity to one that must be curtailed or consumed through negative pricing.[81]

Electricity is a commodity. When renewable generation peaks, surges of surplus energy can result in extremely low, and sometimes negative, energy prices in many wholesale electric markets.[82] Prices are considered negative when high levels of energy generation occur simultaneously with low energy demand. Instead of charging large electricity users, such as factories, for the electricity they consume, utility generators may encourage consumption at times of excess by instead paying these customers to consume more electricity.[83] Yet, this negative pricing strategy poses difficulties for some utilities, particularly with their wind and solar investments. Utilities see returns on investments in energy infrastructure as those sources generate electricity that is sold to their customers. Utilities use the electricity generated from a generation source to pay down the debt. If they are not getting paid for curtailed power or are paying someone else to take the power through negative pricing, then they will not be getting the revenue they need to pay off the investment in the time anticipated. Higher electricity

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encourage reduced consumption, as it expected to recoup those costs from ratepayers after the fact.).

[79] Bullard, *supra* note 56.

[80] CAL. INDEP. SYS. OPERATOR, FAST FACTS 1 (2016), https://www.caiso.com/documents/flexibleresourceshelprenewables_fastfacts.pdf [https://perma.cc/KG8H-QSLG].

[81] *See, e.g.*, Javier Lopez Prol, Karl W. Steininger & David Zilberman, *The Cannibalization Effect of Wind and Solar in the California Wholesale Electricity Market*, 85 ENERGY ECON. 104552, 104552–53 (2020).

[82] Specht, *supra* note 41.

[83] Soren Amelang & Kerstine Appunn, *The Causes and Effects of Negative Power Prices*, CLEAN ENERGY WIRE (Jan. 5, 2018), https://www.cleanenergywire.org/factsheets/why-power-prices-turn-negative [https://perma.cc/8GQU-Y7QE].

rates at other times during the day may be required to cover the investment costs.[84]

Traditional time-of-use rates can exacerbate the problem. Some localities in California are currently providing customers with time-of-use rate options, and by 2025 some 10 million Californians will have transitioned to opt-out-only time-of-use rates.[85] Time-of-use rates are praised for "promot[ing] economic efficiency in the allocation of scarce resources, lower[ing] overall costs of providing electricity to customers, and enhance[ing] equity between customers."[86] California's Clean Energy Director for the Environmental Defense Fund, Jayant Kairam, believes that time-of-use rates assist in the deployment of distributed energy resources, such as solar PV, citing work by state regulators describing time-of-use rates as "'a type of load modifying demand response' that could help save 'up to $700 billion annually by 2025' by optimizing now-curtailed renewables."[87]

But the 2005 EPAct's backward-focused nature of time-of-use rates has created a problem: the Act requires that these rates be "set for a specific time period on an *advance or forward basis*, typically *not changing more often than twice a year*. . . ."[88] This section furthermore states, "Prices paid for energy consumed during these periods shall be pre-established and known to consumers in advance of such consumption . . . ."[89]

Although it might be helpful for consumers to plan their actions in advance, allowing adjustments only twice a year or requiring pre-established peak-load reduction agreements means that adjustments cannot be made for real-time fluctuations in renewable electricity generation. For example, wind power generation might generally be more frequent at night. However, directing customers to charge their electric vehicles at night, regardless of whether the wind is generating electricity, encourages consumption of fossil-fuel generated electricity on windless nights, foregoing consumption of low-cost solar generation during the daytime.

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[84] Bethany Frew, Wesley Cole, Paul Denholm, A. Will Frazier, Nina Vincent & Robert Margolis, *Sunny with a Chance of Curtailment: Operating the U.S. Grid with Very High Levels of Solar Photovoltaics*, 21 iSCIENCE 436, 444 (2019).

[85] Ahmad Farugui, *6 Reasons Why California Needs To Deploy Dynamic Pricing by 2030*, UTILITY DIVE (May 19, 2020), https://www.utilitydive.com/news/6-reasons-why-california-needs-to-deploy-dynamic-pricing-by-2030/578156/ [https://perma.cc/YD86-K336].

[86] *Id.*

[87] Herman K. Trabish, *Beyond TOU: Is More Dynamic Pricing the Future of Rate Design?*, UTILITY DIVE (July 17, 2017), https://www.utilitydive.com/news/beyond-tou-is-more-dynamic-pricing-the-future-of-rate-design/447171/ [https://perma.cc/B5TA-URPQ].

[88] Energy Policy Act of 2005, Pub. L. No. 109–58, § 1252(a)(14)(B)(i), 119 Stat. 964 (codified at 16. U.S.C. § 2621(d)(14)(B)(iii)) (emphasis added).

[89] *Id.* § 1252(a)(14)(B)(iv) (providing optional "credits for consumers with large loads who enter into *pre-established* peak load reduction agreements that reduce a utility's planned capacity obligations") (emphasis added).

A time-of-use rate proposal by Xcel Energy in Colorado[90] illustrates the problems with similar time-of-use programs around the country and the advantages of switching to a time-of-renewables mechanism. The traditional rate models used by Xcel are a tiered model known as inverted block rates. These rate structures operate on a baseline, charging customers a fixed price if they stay at or below the designated baseline.[91] If customer usage goes above the set baseline, the rates go up.

Xcel proposed its version of a time-of-use rate structure to the Colorado PUC in 2019, and that proposal went through several periods of public comment and review by the agency before it was finalized.[92] Xcel's time-of-use proposal would charge customers the highest prices per kilowatt hour of electricity consumed during times of peak demand looking backward—i.e. from 2:00 to 6:00 p.m. on weekdays.[93] Xcel will be charging customers almost half the peak rate overnight from 9:00 p.m. to 9:00 a.m.,[94] thus using price signals to encourage customers to charge their electric vehicles during these overnight time periods.

This backward-looking time-of-use rate is based on traditional consumption and generation patterns that are quickly changing with new technologies.[95] Electric vehicles represent a significant new consumption load and charging them on nights when the wind is not blowing simply encourages them to be charged with back-up baseload fossil-fuel generation instead of taking advantage of otherwise curtailed renewable solar PV generation if they were charged during a sunny day.[96]

A solar PV project built in Haiti by an organization called Earth Spark International elegantly illustrates the possible simplicity of how customer demand can be coordinated with the time that solar power is generating electricity. The Earth Spark International project in Haiti has neither a large backup fossil-fuel

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[90] *See, e.g.*, Application of Pub. Serv. Co., Dec. No. R18–0153, Colo. Pub. Utils. Comm'n Proc. No. 17A–0146E (Jan. 22, 2021) (Farley, A.L.J.) (recommended dec. granting certificate for N. Greeley Area Transmission Plan Project).

[91] ENERGY LAW, *supra* note 11, at 106.

[92] TOU rates are typically designed as either an opt-out or opt-in program. With an opt-in strategy, utilities offer the TOU rate structure to customers who may either choose to participate, or stick with the utility's traditional rate structure. The program proposed by Xcel Energy is an opt-out program, whereby all customers are initially registered, and may choose to unenroll thereafter. *See* Application of Pub. Serv. Co., *supra* note 90, at 18.

[93] *Time of Use Pricing FAQs*, XCEL ENERGY, https://www.xcelenergy.com/staticfiles/xe-responsive/Programs%20and%20Rebates/Residential/Solar-Res-Plans-TOU-FAQ.pdf [https://perma.cc/D8MA-8AA9].

[94] *Id.*

[95] Rocco Canonica & Kassia Micek, *Rapid Renewables Growth Brings Challenges for U.S. States: Part I —California*, S&P GLOBAL PLATTS: INSIGHT BLOG (Apr. 8, 2020), https://www.spglobal.com/platts/en/market-insights/blogs/electric-power/040820-rapid-renewables-growth-brings-challenges-for-us-states-part-i-california [https://perma.cc/LRS7-6Q2L].

[96] *See* Testimony of Dan Regelson & Ken Regelson, *supra* note 46.

generator[97] nor extensive batteries, so it is critical to match demand to generation to avoid outages and damage to the system.[98] On that scale, the method used by customers to respond to expected generation is simple: they look outside to see if the sun is shining. If it is shining, then they use electricity because they know the PV panels will be generating electricity at that time. If they look outside and see clouds or the darkness of night, these same customers know that the PV panels will not be generating, and they avoid unnecessary consumption accordingly.

Life is a bit more complex with grid-connected renewables that may be generating in the distance. These customers cannot simply look at the sky to see if the sun is shining or wet their fingers to feel the wind if the generation sources are not in the immediate neighborhood. However, modern technology can provide the necessary signals.

A time-of-renewables rate would be more effective than time-of-use to align electricity rates and energy demand with renewable energy production. Solar production is predictable; it peaks in the middle of the day. Wind is less predictable. Wind often peaks at night, but not always.[99] The issue is that these peak production times do not always align with peak electricity demand.[100] The historic solution to this disjunction of demand and generation was for the utility to ramp up generation through fossil fuel-based sources during peak demand.[101]

Alternatively, load shifting through demand response is an important tool to resolve the issue of oversupply, and studies by a working group for the California Public Utilities Commission showed that load shifting is effective at reducing the amount of curtailed renewable energy.[102]

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[97] The project has only a small diesel generator for back-up. *No Shortage of Opportunities—How a Solar Microgrid is Providing Resiliency in Uncertainty*, EARTHSPARK INT'L BLOG (Sept. 16, 2019), http://www.earthsparkinternational.org/blog [https://perma.cc/M5Q5-MH6W].

[98] Adam Eberwein, Tech. Lead, EarthSpark Int'l, Presentation at ASES Solar 2021 Conference, Community Solar via Micro/Mini/Macrogrids Session: Reaching 100% Solar with DSM (Aug. 4, 2021), (available at https://drive.google.com/file/d/1SgHOjMJJU3iDCZLFxNzNImKVm2N-diMe/preview [https://perma.cc/6VVQ-PYYQ]); *see also* EARTHSPARK INT'L, http://www.earthsparkinternational.org/ [https://perma.cc/V5DN-E6GY].

[99] Jonathan Suuser, *Why Is Peak Demand a Concern for Utilities?*, ADVANCED ENERGY (Mar. 13, 2018), https://www.advancedenergy.org/2018/03/13/why-is-peak-demand-a-concern-for-utilities/ [https://perma.cc/AD6Y-FWQK].

[100] CAL. PUB. UTILS. COMM'N, FINAL REPORT OF THE CALIFORNIA PUBLIC UTILITIES COMMISSION'S WORKING GROUP ON LOAD SHIFT 2–3 (2019), https://gridworks.org/wp-content/uploads/2019/02/LoadShiftWorkingGroup_report.pdf [https://perma.cc/EUS8-QPNU] (noting residential customer peak is now generally early evening, while commercial peak is closer to midday, coincident with solar electricity production).

[101] Whitlock, *supra* note 9.

[102] CAL. PUB. UTIL. COMM'N, *supra* note 100, at 1–3, 8, 13.

Load refers to the amount of electricity that must be generated to meet consumer demand. Load shifting, also referred to as demand shifting, occurs when a utility or grid operator can incentivize customers to alter their energy consumption to shift their load to different lower-demand times of the day.[103] Load shifting has been used as a tactic to prevent blackouts on the grid by requesting that a certain number of customers stop or reduce their use of electricity for a period of time.[104] Sometimes, a utility will even cut off energy supply to certain areas, so they can re-route that energy to somewhere that needs it. This is a load shifting tactic commonly referred to as a "rolling blackout."[105]

Time-of-renewables rates are a method of load shifting. If certain utility customers were encouraged to shift their energy use to times of peak wind and solar production, the demand for surplus renewable energy would increase, and in turn reduce the utilities' need to curtail renewable energy production.[106] Time-of-renewables rates also would incentivize a demand response by rewarding customers when they use power during these peak production times, and the resulting load shift would allow utilities to avoid curtailing renewable energy resources.

Unlike time-of-use rates that look back at historical usage, time-of-renewables rates utilize real-time price signals to incentivize energy use when there is a surplus of renewable generation.[107] Another way to characterize this type of pricing is to call it "dynamic." As Dr. Ahmed Faruqui, a principal and energy economist with Brattle Group, points out, dynamic pricing is nothing new to the average American. We realize that prices for a commodity—whether it is watching a movie, buying an airline ticket, engaging an Uber ride, or paying for tolls

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[103] *See* RYAN HLEDIK, AHMAD FARUQUI, TONY LEE, & JOHN HIGHAM, BRATTLE GRP., THE NATIONAL POTENTIAL FOR LOAD FLEXIBILITY: VALUE AND MARKET POTENTIAL THROUGH 2030, at 1–2, 7, 24 (2019), https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf [https://perma.cc/6QKN-6HUU].

[104] BRIAN F. GERKE, GIULIA GALLO, SARAH J. SMITH, JINGJING LIU, PETER ALSTONE, SHUBA RAGHAVAN, PETER SCHWARTZ, MARY ANN PIETTE, RONGXIN YIN, & SOFIA STENSSON, LAWRENCE BERKELEY NAT'L LAB'Y, THE CALIFORNIA DEMAND RESPONSE POTENTIAL STUDY, PHASE 3: FINAL REPORT ON THE SHIFT RESOURCE THROUGH 2030, at 8–9 (2020).

[105] *Id.* at 40.

[106] *See* Herman K. Trabish, *Two Barriers to Utility and Customer Savings with Flexible Loads and How Regulators Can Help*, UTILITY DIVE (Jan. 6, 2021), https://www.utilitydive.com/news/two-barriers-to-utility-and-customer-savings-with-flexible-loads-and-how-re/592084/?:%202021-01-06%20Utility%20Dive%20Newsletter%20%5Bissue:31725%5D [https://perma.cc/U2S2-TZ4B].

[107] Energy Policy Act of 2005, Pub. L. No. 109–58, § 1252(a)(14)(B)(iii), 119 Stat. 594, 963–64 (codified at 16 U.S.C. § 2621(d)(14)(B)(iii)) (defining "real-time pricing" as where "electricity prices are set for a specific time period on an advanced or forward basis, reflecting the utility's cost of generating and/or purchasing electricity at the wholesale level, and may change as often as hourly"). Although this definition involved advanced setting of prices, it does allow changes hourly.

or parking—can increase or decrease depending upon demand.[108] Faruqui goes on to note, "'[backward-looking time-of-use] rates solve yesterday's problem.' California's move to [backward-looking time-of-use] rates 'will not be a failure but will produce peak demand changes that will be too little, too late.'"[109]

In contrast to time-of-use rates, which generally have too low of a price differential between on-peak and off-peak rates, dynamic pricing would alert customers to steeper increases in kilowatt hour differentials. This larger gap between prices will "drive more significant reductions during the highest demand days."[110]

In 2005, the technology to fully implement dynamic pricing that can give customers true price signals for the value of the electricity they are consuming did not exist. Some of the original "smart meters" in the 1990s only allowed monitoring within a building, with monthly reports sent retroactively to a utility. Now with fiber optic connections, utilities have the ability for two-way communication with customers and should use that capability to maximize the efficiency of the grid by matching customer demand with the renewable energy being generated.[111]

IV. Examples of Time-of-Use and Time-of-Renewables Pricing

The technology of 2005 is not the technology of 2021. It is obvious that the grid is shifting away from traditional, inflexible fossil-fuel *generation* sources, such as coal and natural gas, to renewables. What might be less obvious is that the *consumption* or demand-side of the equation is also rapidly changing. We now have low-cost ways to shift demand to better correlate with generation load.[112]

Currently, some utilities employ demand response technologies, such as direct load control, which allows utilities to cycle appliances such air conditioners and water heaters to turn off during peak periods.[113] Furthermore, new

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[108] *See* Ahmad Faruqui, *6 Reasons Why California Needs To Deploy Dynamic Pricing by 2030*, Utility Dive (May 19, 2020), https://www.utilitydive.com/news/6-reasons-why-california-needs-to-deploy-dynamic-pricing-by-2030/578156/ [https://perma.cc/CLK7-SKUS].

[109] Trabish, *supra* note 106.

[110] *Id.*

[111] Technology now allows "transactive energy" pricing, so consumers can purchase electricity at the actual price the utility is paying for it, thereby taking advantage of lower pricing when renewable generation is more abundant. Timothy Schoechle, *Intelligent Energy: Operating System for the Solar Homes and Microgrids of the Future*, Solar Today, Fall 2020, at 18, 21–22.

[112] *See, e.g.*, Camus Energy, https://www.camus.energy/ [https://perma.cc/3KGL-F44S]; Utilidata, https://utilidata.com/ [https://perma.cc/R6DF-2U83], and associated company offerings.

[113] For example, the Xcel/CO Smart Wi-Fi Thermostat Program. Justin Brant, Sw. Energy Efficiency Project, Grid-Interactive Efficient Buildings: Providing Energy Demand Flexibility for Utilities in the Southwest 6 (2019), http://swenergy.org/pubs/grid-interactive-efficient-buildings-report [https://perma.cc/V6KE-6W28].

technologies are changing electricity load requirements. Some of the biggest players will be electric vehicles and building electrification to address water heating and space conditioning for heating and cooling.[114] While these sources were not a significant factor in past utility load equations, they can increasingly play a critical role in shifting demand and allowing a smarter use of electricity during time-of-renewable generation.

Unlike time-of-use, time-of-renewables rates utilize real-time price signals to incentivize energy use when there is a surplus of renewable generation. Some utilities, such as Xcel Energy in Colorado, are rolling out their "new" backward-looking time-of-use rates along with installation of smart meters in their customers' homes. While this smart-meter technology can facilitate future interaction between the utility and its customers, it will take years and requires a huge investment of customers' money. The traditional rate structure may also be an incentive for the utility to favor the investment in smart meters. Recall that the higher the utility's investment in this type of infrastructure, the larger its rate base upon which it earns a guaranteed rate of return.

Fortunately, there is a simpler, less-costly solution. Many appliances are already "smart" and do not need to wait until smart meters are installed before taking advantage of a time-of-renewables rate structure. Jigar Shah, Director of the U.S. Department of Energy's Loan Programs Office,[115] recently noted that much of the hardship during the blackouts in the 2021 Texas freeze could have been avoided, especially for disadvantaged communities, if utilities had been mandated to enable and interact with "saver" mode software currently available in many devices.[116]

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[114] Testimony of Dan Regelson & Ken Regelson, *supra* note 46, at 4 ("[T]he following uses that are large enough to be worth investing in: 1. Electric car charging, 2. Electric hot water heating, 3. Air conditioning and electrified residential heating, 4. For the few that have them, saunas, pools, spas, and hot tubs.").

[115] *Jigar Shah, Director, Loan Programs Office,* U.S. DEP'T OF ENERGY, LOAN PROGRAMS OFF., https://www.energy.gov/lpo/person/jigar-shah [https://perma.cc/5QDX-4F63].

[116] *See* Jigar Shah, Exec. Director, U.S. Dep't of Energy, Loan Programs Off., Remarks at the Getches-Wilkinson Center for Natural Resources, Energy, and the Environment Webinar Series, The Climate Justice Lens Is Here To Stay—Farther & Faster: The Integral Role of Technology in an Equitable Clean-Energy Economy (Apr. 30, 2021) (recording available at https://www.youtube.com/watch?v=rUbf_ZZPI2A [https://perma.cc/XK37-3524]); *see also* E-mail from Ron Sinton to K.K. DuVivier, *supra* note 50 ("There is a 21st-century improvement to the concept (and reality) of 'rolling blackouts.' One (of many) problems that they had in Texas is that many circuits had essential facilities and could not be turned off. Therefore the 'rolling blackouts' turned into days-long blackouts for everyone that was not near a hospital or other critical infrastructure facility. The modern equivalent would be for every large power user, and perhaps residences as well, to have an 'eco mode' or low-power mode for their building and operations. That way, instead of a rolling blackout, you could have entire regions toggle into low-power mode. This could include buildings directly adjacent to hospitals. This would address inequities in blackouts by spreading the load shedding more widely

This section will address two categories of energy consumers that could take particular advantage of time-of-renewables rates: (A) residential EV users and (B) commercial and industrial customers.

A. Targeting EV Owners and Incentivizing EV Charging to Utilize Surplus.[117]

EVs represent a fast-growing new load for U.S. utilities with predictions they will account for over 11% of total U.S. electricity demand by 2040.[118] Perhaps the best example of time-of-renewables pricing for EVs comes from an energy company in the United Kingdom. Good Energy has implemented a version of time-of-renewables for residential electric vehicle (EV) users. The program is offered through an EV charging company called ZapMap and alerts customers who are enrolled in the program when the charging events will occur.[119] Customers are given 24-hours' notice of a four-hour window the following day. Due to surplus production of renewable energy, charging for EVs during this window will be free.

The ZapMap requires customers to be alerted and to react. Most EVs have software already installed that is not being utilized to make charging decisions without monitoring by the customer.[120] Data from ZapMap's success is not yet available, however as more utilities and energy companies develop projects such as this, this added information will help maximize use of surplus renewable energy generation.

Xcel Energy in Colorado has a project with a similar objective in its Demand Side Management plan.[121] The initiative is called Electric Vehicle Optimization,

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but with less damaging results. It is also exactly the same hardware and software that could be used to implement a flexible grid to integrate the maximum renewables into the grid at the lowest possible cost—essentially supplementing batteries. When the power grid looks at alternatives for dealing with the once-per-ten-year reliability events, it is likely preferable to use something like this instead of (or in addition to) the expense of building extra power plants that are rarely used.").

[117] This Article does not go into the more challenging, and not as quickly deployable, use of EVs as batteries for the grid. Instead it focuses only on battery charging, which is a demand application that can be deployed immediately.

[118] COLIN MCKERRACHER, ALEKSANDRA O'DONOVAN, NICK ALBANESE, NIKOLAS SOULOPOULOS, DAVID DOHERTY, MILO BOERS, RYAN FISHER, COREY CANTOR, JAMES FRITH, SIYI MI, ANDREW GRANT, JINGHONG LYU, KWASI AMPOFO & ALLEN TOM ABRAHAM, BLOOMBERGNEF, ELECTRIC VEHICLE OUTLOOK 2021, at 4 & 1 fig.4 (2021) (available at https://about.bnef.com/electric-vehicle-outlook/ [https://perma.cc/83WH-KT28]).

[119] ZAPMAP, https://www.zap-map.com/ [https://perma.cc/4WMC-C73U].

[120] *See, e.g.*, EV.ENERGY, https://ev.energy/ [https://perma.cc/DNW6-H2HH] (offering services used in pilot projects with Texas ERCOT and Madison Gas & Electric in Wisconsin); ENERGYHUB, https://www.energyhub.com/ [https://perma.cc/2ACB-JM4W].

[121] *See generally* PUB. SERV. CO. OF COLO., 2021/2022 DEMAND-SIDE MANAGEMENT PLAN: ELECTRIC AND NATURAL GAS (2021), https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/CO-DSM/CO_2021-22_DSM_Plan_Final.pdf [https://perma.cc/7R2J-ZU6E].

and the purpose is to observe the impacts of EV charging on the grid within Xcel's service area. One part of the EV optimization initiative is a pilot project that Xcel refers to as Dynamic Optimization or "Charging Perks."

The goal of this project is to take advantage of electric vehicles as a flexible load to improve grid-integration of renewable electricity. The utility has involved several EV manufacturers to serve as the liaison between the utility and any participating residential EV charging stations. Xcel works with manufacturers to develop the customers' charging schedule based on day-ahead forecasts of power production costs, the vehicles' state of charge, and the customers' driving requirements. One of the benefits of working directly with the EV manufacturers is that they have access to the vehicles' states of charge through smart chargers, which is valuable for understanding the impacts that shifting the energy load from EVs can have on the grid.[122]

While the dynamic optimization pilot from Xcel Energy in Colorado is not the same as time-of-renewables, there are aspects of the program that may be useful for a time-of-renewables pilot project. The dynamic optimization pilot demonstrates that utilities have the ability to make day-ahead predictions about energy use and electricity generation which allows them to make load shifting decisions. Renewable electricity generation peaks are essential to time-of-renewables rates so that customers can be alerted when a charging event is going to occur.

B. Targeting Commercial and Industrial Consumers

As noted above, renewable electricity production is most in line with the energy load required by commercial and industrial entities, accounting for nearly 34 percent of total U.S. energy consumption.[123] The commercial and industrial end-use sector includes warehouses and large public office buildings, as well as federal, state, and local government infrastructure.[124] In many states, the commercial sector accounted for approximately 19 percent of those states' total energy consumption.[125]

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[122] *See generally id.*

[123] *U.S. Energy Facts Explained—Consumption and Production*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/us-energy-facts/ [https://perma.cc/LD7K-RXFU].

[124] *Commercial Entry*, *GLOSSARY*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/tools/glossary/index.php?id=Commercial%20sector [https://perma.cc/RTC7-WVCA] ("Commercial Sector—An energy-consuming sector that consists of service-providing facilities and equipment of businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities.").

[125] *Colorado —State Energy Profile Overview*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/state/?sid=CO#tabs-2 [https://perma.cc/2AGP-E2JW] (showing commercial consumption accounted for 19.1% of Colorado's total energy consumption in 2019); *see* U.S. ENERGY INFO. ADMIN., *supra* note 123.

The City and County of Denver, Colorado is an example of a commercial customer that could take advantage of time-of-renewables rates. The City and County of Denver has around 100 electric vehicles as a part of its fleet.[126] These vehicles charge on ChargePoint chargers. Utilities could alert ChargePoint of an upcoming charging event, so that the company could then notify its customers. Denver could then adjust its vehicle charging schedules to take advantage of the free or low-cost electricity to charge the fleet. Note that this solution ultimately takes out the human component and allows the vehicle applications to automatically adjust charging times.

Google is another entity that could benefit from time-of-renewables rates at a commercial scale. Google has initiated a "24-7 clean energy" objective, the goal of which is to match its energy use to the hours when renewables are actually being produced.[127] While the initiative is not to take advantage of surplus, Google is focused on the important fact that renewables do not produce electricity 24/7. Traditionally, when an entity—such as a government building, company, or state—claims to be powered by 100% renewable energy, it means that that entity has purchased renewable energy credits to cover whatever its energy demand is for a full year even though the entity may be using electricity generated from fossil fuels at times renewables are not generating.[128] With a 24/7 clean power goal, those same entities would need to purchase enough true renewable electricity generation to cover their energy demands for every hour of every day.[129]

While the 24/7 goal presents a variety of challenges, time-of-renewables rates can play a critical role in achieving the goal. Because time-of-renewable rates consider the fact that renewable sources, such as wind and solar, do not produce electricity 24 hours a day, the load shifting that time-of-renewables suggests contributes to making 24/7 renewable energy a reality by matching demand to generation. Time-of-renewables rates are based on the predictable measure of curtailed renewable electricity, so they enable companies and other commercial

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[126] SW. ENERGY EFFICIENCY PROJECT, THE BENEFITS OF ELECTRIC VEHICLES FOR LOCAL GOVERNMENTS 2 (2021), https://swenergy.org/pubs/local-government-electric-vehicle-fact-sheet [https://perma.cc/T7T3-ZWAL].

[127] *Operating on 24/7 Carbon-Free Energy by 2030*, GOOGLE SUSTAINABILITY, https://sustainability.google/progress/energy/ [https://perma.cc/NC87-P2D8]. Tim Schoechle likens Renewable Energy Credits or RECs to indulgences that the Catholic church allowed the faithful to purchase to improve their chances of entering Heaven. Timothy Schoechle, *Green Electricity or Green Money? Why Some Environmental Groups Hamper Clean Energy*, https://gettingsmarteraboutthesmartgrid.org/green_electricity_or_green_money.html [https://perma.cc/SP4C-ABZP].

[128] Uma Outka, *"100 Percent Renewable": Company Pledges and State Energy Law*, 3 UTAH L. REV. 660, 692 (2019).

[129] Shannon Osaka, *Why the Federal Government is Buying Into the Promise of 24/7 Clean Power*, GRIST (Apr. 21, 2021), https://grist.org/energy/can-the-federal-government-run-on-24-7-clean-energy-biden-wants-to-try/ [https://perma.cc/7A5K-6NUE].

entities to use electricity based on real-time generation, which ensures that the electricity they are using is from a renewable generating source.

CONCLUSION

The effort to tackle emissions reduction in the electricity sector requires energy policies that drive the consumption of renewable sources of electricity generation instead of fossil fuels. Congress' 2005 effort to encourage the wise use of electricity through time-of-use rates is not only outdated but now contradicts the stated-goals of governments and utilities to reduce their carbon emissions.[130] Time-of-use regimes look backward at historic electricity consumption patterns, ignoring the emerging technologies that can significantly match electricity consumption to the actual time when renewable resources are feeding electricity into the grid. By encouraging electricity consumption in the night, regardless of whether the wind is blowing, utilities are perpetuating the use of fossil-fuel baseload generation and consumption, at the expense of solar electricity that is being generated and thrown away in the daytime. A time-of-renewables regime would match energy consumption to actual renewable energy generation and avoid the waste of curtailing this otherwise available electricity.

There are several additional benefits to a progressive time-of-renewables system. Time-of-use relies on changes in customer behavior: the utility advises customers about the hours when energy prices are higher and then it is up to the customers to remember this and to make decisions about their electricity use during those times. The ZapMap EV charging program described above also requires customer monitoring and participation. A similar system in the United States in which utilities share their day-ahead wind and solar forecasts[131] could be the first step in shifting demand through a customer driven time-of-renewables system.

However, a simpler and more elegant solution is currently available. Most EVs and key home appliances,[132] as well as large commercial and industrial devices that use significant amounts of electricity, either already have, or could inexpensively be equipped with, software to manage their time of electricity consumption. These existing software programs can be fully automated with the option of customer override if desired. Simplifying the process will not only

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[130] Jeff St. John, *How 4 Top U.S. Utilities Are Grappling With Climate Change and the Energy Transition (or Not)*, GREENTECH MEDIA (Jan. 22, 2020), https://www.greentechmedia.com/articles/read/how-4-top-u-s-utilities-are-grappling-with-the-energy-transition [https://perma.cc/R9EP-KFRC].

[131] The accuracy of these types of predictions has improved dramatically in recent years. Allen Best, *Xcel Energy Has an Aggressive Clean Energy Goal. How Will it Get There?*, ENERGY NEWS NETWORK (Mar. 6, 2019), https://energynews.us/2019/03/06/with-100-clean-energy-goal-xcel-bets-on-advancements-in-solar-and-storage/ [https://perma.cc/PF2E-XU3Q].

[132] Through a program like NEST or software within the appliances themselves. NEST, https://nest.com [https://perma.cc/5YC4-UNGN].

maximize the use of renewable electricity so that it not curtailed, but also will provide incentives to accelerate customer adoption.

Finally, this low-cost solution to converting to time-of-renewables has the maximum impact with minimal investment. By most efficiently using the generation sources already constructed, instead of curtailing them, the utility can build less infrastructure. While this may decrease the rate base, and consequently reduce the guaranteed rate-of-return that utility investors seek, it should also avoid rate increases that disproportionally impact those who have less ability to pay for electricity.[133] Finally, requiring utilities to use existing software to convert demand into an eco-mode can spare the pain of blackouts for those who are least able to ride through times of crisis.

[133] Testimony of Dan Regelson & Ken Regelson, *supra* note 46, at 4.