

ILLUMINATING INEQUALITY: GOING RESIDENTIAL SOLAR NEUTRAL TO NARROW THE ENERGY EQUITY GAP

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Synopsis: As the United States transitions to renewable energy, glaring inequalities in who benefits — and who bears the cost — have emerged. Millions of low-income families remain trapped in energy poverty, paying disproportionately for energy while receiving little of the economic or environmental subsidies. This is at least in part because the solar payment programs designed to reward early adopters are shifting costs onto those least able to pay. Residential solar can provide valuable resiliency and self-sufficiency benefits, but the way subsidies are currently structured, they will remain out of reach for poorer families who are more likely to be renters and less likely to be able to access tax credits.

Without intentional policy changes, these wealth transfers will exacerbate these divides even further. This article argues that utilities should adopt solar neutral policies, paying the true value of solar rather than predetermined higher rates, and that public investment should instead prioritize cost effective, system-wide solutions like utility scale solar and storage that benefit all customers, particularly those in energy poverty who need it the most.

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I. INTRODUCTION

The transition to renewable energy will be essential to address climate change, but without careful planning, it risks deepening existing social and economic inequalities. This article explains why utilities should adopt a solar neutral position to enable progress towards clean energy without burdening those least able to pay for it.

In Part II, it examines the scope and consequences of the millions of households in energy poverty. In Part III, it explains how these households are often left out in the shift to renewables, in part because taking part in it would be more expensive for them. In Part IV, it describes the problems integrating renewable energy into the grid due to the mismatch between supply and demand and the strain it places on existing infrastructure, as well as the necessity of widespread battery deployment to address these issues. In Part V, it explains why extra payments to solar homeowners are unacceptable and why utilities should only be paying the value of the solar power when it is received. It concludes by explaining what it means for utilities to be solar neutral and why that is necessary to reduce cost shifting and prioritize affordable, resilient, and equitable solutions for all.

II. AN INTRODUCTION TO ENERGY POVERTY IN THE UNITED STATES

Energy poverty affects millions of households, forcing them to spend a disproportionate share of their income on basic energy needs, often while living in inefficient housing with limited access to green energy solutions. This section defines and examines the scope of energy poverty before discussing in greater detail the harms it causes.

A. *The Meaning of Energy Poverty*

Energy poverty refers to the inability of the members of a family to obtain their necessary energy needs without it being an undue burden on the household.[1] In the United States, the focus of this article, it generally refers to economic burden on a family trying to meet its essential energy needs, including those for cooking, lighting, and heating and cooling.[2] Every household typically requires electricity,

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1. Emma Shumway et al., *Addressing Energy Insecurity Upstream: Electric Utility Ratemaking and Rate Design as Levers for Change*, 45 ENERGY L.J. 361, 362 (2024).

2. In other countries, it could refer to other methods of obtaining energy, like how much time is spent collecting wood for cooking. Mphemelang J. Ketlhoilwe & Kennedy M. Kanene, *Access to energy sources in the face of climate change: Challenges faced by women in rural communities*, JÀMBÁ: J. DISASTER RISK STUDS., Apr. 11, 2018, at 2 ("When a household is unable to afford purchasing firewood, the burden usually falls on women and/or children to collect firewood. In most villages they collect wood from distant areas without transportation. That means firewood collection has become labour intensive and time consuming with low results as women and children can only carry so much weight on the head or shoulders for a long distance.").

but electricity is not always the only requirement, particularly for parts of the country with cold winters.[3] In many areas, natural gas and oil furnaces supply a significant percentage of heat, and natural gas is often used for cooking.[4]

A common measurement to determine energy poverty is whether a family must spend more than 10% of its pretax income on energy.[5] No method is perfect, and there are complaints about this method as well, but it provides a reasonable starting point to the discussion.[6] Families forced to spend a disproportionate percentage of their income on energy have correspondingly fewer funds to pay for housing, food, and other necessities.[7]

An energy poverty analysis often looks simply at the high cost of electricity compared to household income, particularly in low-income households. Those are not the only factors at play, however. Families experiencing energy poverty are more likely to live in older homes, which are correspondingly less likely to have been built with energy efficiency in mind initially or to have been retrofitted to improve energy efficiency, resulting in higher energy demands than other similar

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3. Kaili Diamond & Matthew Sanders, *The majority of U.S. households used natural gas in 2020*, U.S. ENERGY INFO. ADMIN. [EIA]: TODAY IN ENERGY (Mar. 23, 2023), https://www.eia.gov/todayinenergy/detail.php?id=55940#:~:text=In%202020%2C%2061%25%20of%20U.S.%20households%20used%20natural,to%20our%202020%20Residential%20Energy%20Consumption%20Survey%20%28RECS%29.

4. *Id.* (showing that roughly half the country used gas for space heating and water heating while 38% used gas for cooking).

5. *See, e.g.*, Kayleigh Rubin et al., *1 in 7 Families Live in Energy Poverty. States Can Ease That Burden*, RMI (Dec. 18, 2023), https://rmi.org/1-in-7-families-live-in-energy-poverty-states-can-ease-that-burden/ (referring to this point as when a family is energy impoverished); *see also* ARIEL DREHOBL ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., HOW HIGH ARE HOUSEHOLD ENERGY BURDENS?: AN ASSESSMENT OF NATIONAL AND METROPOLITAN ENERGY BURDEN ACROSS THE UNITED STATES 4 (2020), https://www.aceee.org/sites/default/files/pdfs/u2006.pdf (identifying four primary drivers of high household energy burdens: physical (e.g., poor insulation, housing type, weather extremes), socioeconomic (e.g., sudden or chronic financial hardship), behavioral (e.g., lack of access to information or assistance programs), and policy-related (e.g., high fixed charges, inadequate bill-assistance programs), and classifying any utility burden above six percent of income as high); *see also* ROXANA AYALA & AMANDA DEWEY, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., DATA UPDATE: CITY ENERGY BURDENS 1–2 (2024), https://www.aceee.org/sites/default/files/pdfs/data_update_-_city_energy_burdens_0.pdf (finding that households with high energy burdens are more likely to experience poor health and poverty, and reporting that the median low-income household in the U.S. spends 8.3% of annual income on energy bills).

6. Qiang Wang et al., *Racial Disparities in Energy Poverty in the United States*, RENEWABLE & SUSTAINABLE ENERGY REVS., Dec. 6, 2020, at 1, 2 (discussing different ways of attempting to measure energy poverty).

7. *Id.* at 2; *see also* Shumway et al., *supra* note 1, at 362 (referring to the heat or eat dilemma). This type of calculation, however, assumes that sufficient energy would be available, even if it were cost prohibitive for the family. That is not always the case. There are places in the US that lack the type of stable and reliable grid that much of the rest of the country depends on. These families can be more closely compared to the families lacking sufficient wood, discussed initially, but the difference is that a family without access to sufficient electricity cannot send children out to the woods to attempt to collect it. It is instead a completely missed opportunity. *See* Abhiroop Chattopadhyay et al., *Can Renewable Energy Work for Rural Societies? Exploring Productive Use, Institutions, Support Systems, and Trust for Solar Electricity in the Navajo Nation*, ENERGY RSCH. & SOC. SCI., Nov. 23, 2023, at 1, 4 ("Due to the very high costs associated with last mile connectivity, most community members [of the Navajo Nation] who do not live close to major transport thoroughfares–where most of the utility electric and water infrastructure is concentrated–do not have access to running water and electricity from the utility networks.").

households experience.[8] In cities, lower-cost housing areas are also often the areas that experienced historic redlining[9] and that are often still likely to have predominantly minority populations.[10] This can result in energy poverty disproportionately affecting those already suffering from structural inequalities.[11]

The next section discusses in greater detail how the problem is measured and how many people are affected.

B. The Scope of Energy Poverty

Energy poverty is a way of describing and measuring the disproportionate energy burden faced by low-income families. More specifically, it is often measured by the percentage of families facing a certain energy burden. A family's energy burden is the percentage of the family's income spent on energy.[12] In the United States, 25% of all families face what is considered a moderate energy burden, spending at least 6% of their income on energy, while 13% face a severe energy burden, spending at least 10% of their income on energy.[13]

Energy poverty is more common in lower-income families. For families at twice the federal poverty line, 67% of families face a high energy burden (at least 6% of income), and of these, 60% face a very high energy burden (spending at least 10% of their income on energy).[14]

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8. Shelley Welton, *Grid Modernization and Energy Poverty*, 18 N.C. J.L. & TECH. 565, 590 (2017) ("[R]esearch suggests that the disparity in energy burdens results in large part from the fact that low-income homes are less efficient, such that the poor spend more not only as a percentage of income but also on a *per-square-foot* basis.") (emphasis in original).

9. *See, e.g.*, Noa T. Kraus et al., *Historic reclining and health outcomes: A systematic review*, 41 PUB. HEALTH NURSING 287, 287-88 (2024) ("Historic redlining refers to the system of discrimination against Black individuals that the federal government and banks used when providing housing loans in the 1930s and 1940s. In an effort to increase homeownership and support the economy after the great depression, the federal government created the Home Owners' Loan Corporation (HOLC) to determine levels of risk for housing loans, which was meant to encourage banks to give loans assisting middle-class families in homeownership. According to this system, neighborhoods were color coded into four categories: green, blue, yellow, and red. These four categories corresponded to a four-letter risk grading system ranging from A (best) to D (worst). HOLC appraisals explicitly cited the lack of Black individuals or immigrants as a reason for marking an area green (or with a lower risk grade letter, such as Grade A), and cited high Black populations, even middle class, when marking areas red (or with a higher risk grade letter, such as Grade D; Rothstein, 2017). This system led to decades of loan practices that explicitly benefited White individuals and discriminated against Black individuals, causing significant financial disadvantage, and separating Black individuals into urban ghettos with significantly worse conditions and lower housing prices (Perzynski et al., 2022)").

10. Melissa Powers, *An Inclusive Energy Transition: Expanding Low-Income* Access, 18 N.C. J.L. & TECH. 540, 556 (2017).

11. *See generally*, Wang et al., *supra* note 6.

12. DREHOBL ET AL., *supra* note 5, at iii.

13. *Id.* This data is from 2017 but appears to be the most recent. The percentage of income number is generally calculated pre-tax, and before other government benefits. However, those most likely to face significant energy burdens are also less likely to lose a large percentage of their income-to-income taxes due to the progressive nature of such taxes.

14. *Id.*

Not surprisingly, the energy burden increases as the family's income decreases. The average extremely low-income family[15] spends 14% of its income on energy, although that varies significantly by state, ranging from the single digits on the west coast to 20% or higher in Alabama, Mississippi, Tennessee, and Michigan.[16] In stark contrast, families with incomes above the poverty line typically spend closer to 3% of their income on energy.[17]

This high burden for low-income families exists despite the fact these families are already spending less than a typical family, both on a straight per capita basis and when compared on a per square foot basis.[18] When coupled with the fact that they are also generally living in less energy efficient housing, this means the high financial burden is often after the family is already making significant compromises.

Not only is this burden disproportionately borne by those with lower incomes, it also disproportionately borne by families of color.[19] For instance, while 9% of non-Hispanic White families face a severe energy burden (spending over 10% of their income on energy), the number jumps to 14% of Hispanic families[20] and 21% of Black families.[21] Energy poverty is widespread, but this does not reduce the issues it causes, issues the next section discusses.

C. The Consequences of Energy Poverty

Energy poverty has far-reaching consequences, affecting not only health and quality of life but economic stability and educational opportunities. At the same time, these families are often excluded from the transition to renewables. This section expands on these concerns.

1. Health and Quality of Life

Energy poverty can have both physical and mental effects on those experiencing it. "[E]nergy insecurity acts as a mediator in the poor housing to poor health continuum," contributing to a cycle of poor health outcomes that disproportionately impact low-income households.[22] This is due to a combination of effects that exacerbate existing health conditions, contribute to new conditions, and significantly diminish the overall quality of life of those exposed to them.

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15. One earning less than 30% of the state's median income.

16. *See, e.g.*, Rubin et al., *supra* note 5.

17. *Id.* This burden would likely feel higher to these families, however, since as the family's income increases, so does the percentage of it being taken in taxes. The after tax percentage spent on energy would therefore be higher than the pretax percentage.

18. Marilyn A Brown et al., *High energy burden and low-income energy affordability: conclusions from a literature review*, 2 PROGRESS ENERGY, Oct. 27, 2020, at 1, 5.

19. In part due to the history of redlining. *See infra* note 95.

20. DREHOBL ET AL., *supra* note 5, at 38.

21. *Id.* at 13.

22. Diana Hernández, *Understanding 'Energy Insecurity' and Why It Matters to Health*, 167 SOC. SCI. & MED. 1, 7 (2016).

Physical exposure to inadequate heating during the winter places physiological stress on the body.[23] This stress increases the damage from cardiovascular diseases, including hypertension, and raises the incidence of heart attacks and strokes.[24] In extreme cases, inadequate heating can lead to hypothermia, which can be deadly if not treated.[25]

Physical problems can also be exacerbated by efforts to cope with inadequate heating. For example, some houses will attempt to use a gas stove or even open flame to heat a house, exposing the occupants to harmful pollutants.[26] Poor temperature control within a house can also lead to high humidity and accompanying mold, which can cause or make worse already existing conditions like asthma and chronic obstructive pulmonary disease.[27]

An inability to properly control the indoor climate is not only a problem in winter. In the summer, inadequate cooling also puts stress on the cardiovascular system, and can lead to heat exhaustion and heat stroke if not addressed.[28] Extreme heat is responsible for more deaths than any other type of weather,[29] a situation that climate change is making even worse.[30] For those experiencing energy poverty, the inability to maintain a safe indoor temperature during summer heatwaves can be life threatening.

There are also significant mental issues caused by energy poverty. Poverty of all types is well known to put significant mental stress on those experiencing it.[31] Worrying about where the money will come from to pay bills, trying to decide which bills to prioritize, and how to handle other necessities like food, healthcare, and shelter, adds significantly to the mental load. Prolonged periods of worrying about whether the utilities will be disconnected or the electric bill can be paid also

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23. Fátima Lima et al., *A Review of the Relation between Household Indoor Temperature and Health Outcomes*, ENERGIES, June 4, 2020, at 1-2.

24. *Id.*

25. Mattheos Santamouris & Dionysia Kolokotsa, *On The Impact Of Urban Overheating and Extreme Climatic Conditions on Housing, Energy, Comfort and Environmental Quality of Vulnerable Population in Europe*, 98 ENERGY & BLDGS. 125, 130 (2015) (noting that older people have a diminished capacity to self-regulate temperature and are therefore at an increased risk for hypothermia).

26. Hernández, *supra* note 22, at 7 ("Further, the use of stoves for heat was a common strategy for seeking thermal comfort yet doing so induces harmful exposures shown to jeopardize health and safety. The lack of comfortable home temperatures also exacerbated asthma symptoms, particularly during winter months.") (citations omitted); *see also* Welton, *supra* note 8, at 568 ("Descriptions of Americans opening their ovens to stay warm in the winter appear a far cry from the cornucopia of technological wonders.").

27. *See generally* Hernández, *supra* note 26.

28. Ohashi, Yukitaka et al., *Machine Learning Analysis and Risk Prediction of Weather-Sensitive Mortality Related to Cardiovascular Disease During Summer in Tokyo, Japan*, SCI. REPS., Oct. 9, 2023, at 1.

29. MARK WOLFE, NAT'L ENERGY ASSISTANCE DIRS. ASS'N, SUMMER RESIDENTIAL COOLING OUTLOOK: RESIDENTIAL ELECTRIC UTILITY EXPENDITURES PROJECTED TO REACH RECORD LEVELS, HIGHEST IN 10 YEARS 7 (2024), https://neada.org/wp-content/uploads/2024/06/2024summeroutlook.pdf (noting that Maricopa County, Arizona, reported an increase of 469 heat-related deaths in 2023 from 372 in 2022).

30. There is also often more willingness to pay for heating for those unable to afford it than to pay for cooling, even though heat overall is a greater threat. *See* Robert Fleishman et al., *Energy Insecurity - What Is It, and Why Does It Matter?*, 45 ENERGY L.J. 67, 73-74 (discussing the disparity between heating and cooling assistance through LIHEAP).

31. *See* Anandi Mani et al., *Poverty Impedes Cognitive Function*, 341 SCI. 976 (2013).

causes chronic stress, which can lead to mental health problems like depression and anxiety and back to physical problems like hypertension.[32] Energy poverty can also be socially isolating, as individuals may self-isolate to avoid inviting over friends or family due to embarrassment about their living conditions.[33] It can also harm other aspects of people's lives, as the next section explains.

2. Economic and Educational Harm

There are also problems when households that need to increase energy spending due to heating or cooling needs have less income to spend on other necessities like food.[34] This "heat or eat" dilemma[35] is well documented and particularly pronounced in the summer and winter.[36] Food insecurity increases seasonally in response to increased spending on heating and cooling, particularly in elderly households.[37] Inadequate access to nutritious food causes problems of its own, including weakening the immune system, which can increase susceptibility to infections and exacerbate chronic diseases.[38] The food available to low-income families experiencing financial strain is more likely to be calorie dense and nutrient poor.[39] This lower nutritional qualify food can lead to additional health problems, including obesity and related conditions.[40]

All of these effects are felt by everyone in the household, but they can be particularly problematic for children. Stress caused by inadequate housing conditions and concern over how utilities and housing will be maintained can also affect the child's ability to focus at school, leading to poor academic performance and

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32. Rebecca Bentley et al., *The Effect of Energy Poverty on Mental Health, Cardiovascular Disease and Respiratory Health: A Longitudinal Analysis*, LANCET, June 2023, at 1 ("When people can no longer afford to warm their homes, their mental health declines significantly . . . , their odds of reporting depression/anxiety or hypertension increases by 49% . . . and 71% . . . respectively.").

33. *See generally* Elena Druică et al., *Energy Poverty and Life Satisfaction: Structural Mechanisms and Their Implications*, ENERGIES, Oct. 20, 2019 (finding that the social impact of energy poverty can be even greater than the health impact).

34. Hernández, *supra* note 22, at 2 ("Cook et al. (2008) found that children in moderately and severely energy insecure homes are more prone to food insecurity, hospitalizations, poorer health ratings, and developmental concerns than children in 'energy secure' homes. The 'heat or eat' dilemma demonstrates the trade-offs that low-income householders make in order to meet the basic necessities of life whereby at-risk groups are forced to decide between food and energy, often sacrificing one for the other.").

35. Safiah Younis & Judith Eberhardt, *Heat or Eat: Exploring the Impact of the Cost-Of-Living Crisis on Single parents' Mental Wellbeing in the United Kingdom*, J. POVERTY, July 17, 2024, at 1.

36. Mark Nord & Linda S Kantor, *Seasonal Variation in Food Insecurity Is Associated With Heating and Cooling Costs Among Low-Income Elderly Americans*, 136 J. NUTRITION 2939 (2006). While the catchphrase does not work in the summer, both are a reflection of high energy bills. *Id.* at 2940.

37. *Id.*

38. Nicholas Freudenberg et al., *College Students and SNAP: The New Face of Food Insecurity in the United States*, 109 AM. J. PUB. HEALTH 1652, 1654 (2019) (making the individual more susceptible to infection and chronic diseases).

39. *Id.*

40. *Id.*

behavioral issues.[41] There is a correlation between poverty in general and increased absences from school.[42] Unsurprisingly, the environment in the home does not merely affect school performance. A house without electricity or one where an appropriate temperature cannot be maintained will affect the ability of a child to sleep, study at home, and develop properly — socially, emotionally, and physically. This can permanently affect a child's future health and education attainment, and correspondingly their future financial security.[43] Such families can also forego preventative healthcare, leading to more expensive problems later when preventable issues erupt.

The cost to heat and cool rental housing is often higher than the comparative costs for owner-occupied housing.[44] This is due to the split incentive problem, where landlords are less likely to financially benefit from improvements, as they are generally not paying the utility bills.[45] It therefore contributes to a rental housing stock that is older and less efficient than the housing stock overall.[46]

Financial problems can also compound. Households struggling to pay their bills can incur late fees, adding to the burden, as well as fees for disconnection and reconnection if power is turned off, aggravating the issue even more and drawing even more limited resources towards required utility payments.[47] These late payments can also damage the credit of the household, which in turn can affect their ability to obtain loans at favorable rates (including for a car to be able to go to work), pass background checks for desirable housing, or even obtain some jobs.[48] Families can instead be forced into higher interest loans or payday loans, which add even more to the costs they face.[49]

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41. Glen Bramley & Noah Kofi Karley, *Home-Ownership, Poverty and Educational Achievement: School Effects as Neighbourhood Effects*, 22 HOUS. STUD. 693, 696 (2007).

42. Markus Klein et al., *Mapping Inequalities in School Attendance: The Relationship Between Dimensions of Socioeconomic Status and Forms of School Absence*, CHILD. & YOUTH SERV. REV., Sept. 2, 2020, at 1.

43. Bramley & Karley, *supra* note 41, at 694-95. Internet access (generally running on an electrically powered modems) is also often required for schoolwork. This can impact work in grade school but will be particularly problematic for students taking online courses while struggling to balance work and family responsibilities. Anything hurting someone's academic achievement means they are more likely to drop out of school or struggle to obtain the credentials required for higher paying jobs, making it harder to break out of poverty.

44. Brown et al., *supra* note 18, at 5-6.

45. Teresa Parejo-Navajas, *The Energy Improvement of the Existing Urban Building Stock: A Proposal for Action Arising from Best Practice Examples*, 24 N.Y.U. ENV'T L.J. 353, 392 (2016).

46. JOINT CTR. FOR HOUS. STUD. OF HARV. UNIV., AMERICA'S RENTAL HOUSING 2017, at 15 (2017), https://www.jchs.harvard.edu/sites/default/files/media/imp/harvard_jchs_americas_rental_housing_2017_0.pdf.

47. Grace Adcox & Catherine Fraser, *Voters Strongly Support Banning Utility Junk Fees and Using Ratepayer Funds for Political Activities*, DATA FOR PROGRESS (Mar. 27, 2024), https://www.dataforprogress.org/blog/2024/3/27/voters-strongly-support-banning-utility-junk-fees-and-using-ratepayer-funds-for-political-activities.

48. Jim Akin, *Why Do Employers Check Credit?*, EXPERIAN (Aug. 19, 2024), https://www.experian.com/blogs/ask-experian/why-employers-check-your-credit-report-and-what-they-see (saying that employers may access a credit history to examine the overall reliability of a candidate).

49. Lois R. Lupica & Zach Neumann, *Thwarting the Inevitability of Over-Indebtedness*, 40 EMORY BANKR. DEVS. J. 155, 170 (2024).

The financial precarity of the situation, coupled with added stressors, like additional fees, can mean that families are more likely to also face housing instability, whether through eviction or foreclosure, which is both an added expense and an additional stressor for the family.[50] It will also be even more difficult to get into new housing if their credit has been damaged.[51] The challenges also extend beyond immediate concerns, preventing greater participation in renewables, as the following section explains.

3. Those in Energy Poverty Are Generally Left Behind in the Transition to Renewables

Households experiencing energy poverty are largely left behind in the transition to renewables due to financial and structural barriers. While community solar programs can help bridge the gap, their availability is limited, and many are not designed to prioritize participation by lower income families. This section explains why participation is often difficult for families, looking at both typical utility renewable energy programs and residential solar.

a. Barriers to Accessing Utility-Provided Renewable Energy

Many utilities offer customers the option to pay an additional charge on their monthly bill to support renewable sources like wind and solar.[52] These programs can be referred to as green power products.[53] Such an option, however, is generally not realistic for families already struggling to pay their regular bills.[54] For families experiencing energy poverty, even a modest additional increase in their utility bills can be cost-prohibitive.[55] These families are instead prioritizing meet-

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50. Kathryn Ramsey Mason, *Housing Injustice and the Summary Eviction Process: Beyond Lindsey v. Normet*, 74 OKLA. L. REV. 391, 421-22 (2022).

51. *Id.* at 422.

52. Greg Iacurci, *Here's How to Buy Renewable Energy from Your Electric Utility*, CNBC (May 21, 2024), https://www.cnbc.com/2024/05/21/heres-how-to-buy-renewable-energy-from-your-electric-utility.html.

53. *Utility Green Tariffs*, EPA, https://www.epa.gov/green-power-markets/utility-green-tariffs# (last updated Jan. 5, 2025). This is the term for use in residential settings, in more industrial settings where power is sourced directly from a single producer it is a green tariff. *Id.* The residential programs often work by purchasing renewable energy credits. *Id.*

54. This is true even if the cost is minor, and some programs are quite inexpensive. In Oklahoma, for instance, Public Service Company of Oklahoma allows customers to pay extra to source a percentage of their bill from renewables, up to 100% of the bill. See *Renewable Energy Choice*, PUB. SERV. CO. OF OKLA., https://www.psoklahoma.com/account/bills/programs/renewable-energy-choice. The cost for doing this is an additional .23 cents per kWh. *Id.* PSO estimates that a typical home would pay $2.50 per month to offset 100% of their electrical use. *Id.* (stating that a typical home could cover 50% of their use at $1.27 per month)

55. Madeleine Ngo & Ivan Penn, *As Utility Bills Rise, Low-Income Americans Struggle for Access to Clean Energy*, N.Y. TIMES (Jan. 11, 2024), https://www.nytimes.com/2024/01/11/us/politics/utility-bills-clean-energy.html (describing the life changes a customer has already gone through to try to save money for electric bills).

ing basic needs for food and shelter, leaving little additional room for environmental concerns.[56] As a result, they would have difficulty participating in such programs despite any potential interest. That means the only other option available is to directly capture green energy, most commonly with solar panels.

b. Barriers to Obtaining Residential Solar Panels.

There is a reason solar panels are often procured by the already well-off.[57] Families experiencing energy poverty are highly unlikely to be in a position to afford solar panels, particularly if they will need to buy them.[58]

In order to purchase solar panels an individual generally must own their own home, and the home must be in a location suitable for solar.[59] Families experiencing energy poverty are significantly more likely to be renters than homeowners.[60] Renters have little incentive to put major financial investments into a house that they do not own, and landlords have little incentive to invest in energy efficient upgrades on rental property.[61] A family in need of immediate relief from high energy costs is not going to be able to put in place systems to potentially lower the charges in five or more years.[62]

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56. Powers, *supra* note 10, at 544.

57. Naïm R. Darghouth et al., *Characterizing Local Rooftop Solar Adoption Inequity in the US*, ENV'T RES. LETTERS, Feb. 25, 2022, at 4 (stating that the median annual income was $64k, but the median annual income of solar adopters was 120k).

58. While the upfront costs are significantly higher to buy the panels, it is also generally going to be the most financially beneficial option long term, as the family can both capture the tax credit and gain home equity. Emily Glover, *Leasing Panels vs. Buying Solar Panels: Major Differences, Pros And Cons*, FORBES (May 2, 2024), https://www.forbes.com/home-improvement/solar/leasing-vs-buying-solar-panels/. Solar panels that are bought and installed on a house will generally raise the value of the house. Solar panels that are just leased, however, can hinder a home sale, as the new buyer must either take over the lease or the seller must break the lease contract, paying the penalties associated with it. Carlos Granda, *Exploring Hidden Costs of Solar Leases: How New Rules in California Can Add to the Price*, ABC7 (July 31, 2024), https://abc7.com/post/exploring-hidden-costs-solar-leases-how-new-rules-california-can-add-price/15129303/ (stating that a seller had to pay $75,000 to remove a leased system from a house to sell it).

59. Areas more likely to suffer from energy poverty are also less likely to include the upgraded grid enhancements required to enable residential solar panels to be connected. The house must also have sufficient sun exposure, and the roof should be relatively new, as it is costly to have to redo a roof with solar panels on it). In situations where this is not possible, community solar can be an option for some people, and can be structured specifically to enable use by lower income families. This, however, is not available everywhere, and generally offers, at most, modest benefits, rather than the more significant benefits enjoyed by homeowners taking advantage of net metering. *Community Solar*, NAT'L RENEWABLE ENERGY LAB'Y, https://www.nrel.gov/state-local-tribal/community-solar.html (last updated Apr. 7, 2025).

60. Maria Correa, *A Resource for Energy-Burdened Communities,* NAT'L RES. DEF. COUNCIL (Sept. 6, 2023), https://www.nrdc.org/bio/maria-correa/resource-energy-burdened-communities ("The median energy burden for renters is 13 percent higher than that of owners, making energy burden a primary contributor to displacement and high eviction rates.").

61. Abagael Giles, *The incentive problem keeping landlords from taking climate change action*, WBUR (Apr. 24, 2024), https://www.wbur.org/news/2024/04/24/landlord-climate-proofing-apartments-incentives.

62. *See generally* Megan E. Hatch & Michelle Graff, *Housing costs are not a monolith: The association between neighborhood energy burdens and eviction filing rates*, CITIES, Apr. 10, 2024 (explaining how energy poverty alone is a predictor of eviction).

If the family does own their home, financial barriers will often still be overwhelming. Not only will a family experiencing energy poverty not have the additional resources needed to purchase solar panels outright, the family will also face difficulty accessing credit due to generally lower credit scores and inconsistent financial stability.[63] Such families, if they do get solar panels, are more likely to be victims of predatory loans, thanks to sales methods that have been compared to the those used leading up to the subprime mortgage crisis.[64]

These loans can be problematic in part because have can have significant fees that are not disclosed.[65] There is also no guarantee that the family will save money with the system. Lower income families will generally not qualify for the full federal tax credit, since it is not refundable, and so a household paying little in income tax has little available to be refunded.[66] This means that poorer households will actually be paying more than a higher income household for the panels after the higher income household receives the tax credit. Not only does this affect the cost of the system, it can become an even greater problem for poorer families since solar loans can be structured to require a balloon payment with that refund.[67] An inability to make this payment not only fails to lower the principal, but could result in a significantly higher interest rate, raising the cost of the loan even more. Even in the best-case scenarios it takes years to recoup the cost of solar panels, and some panels will never break even.[68]

Leasing panels is sometimes marketed as a solution for families who cannot afford the upfront costs, but leasing has its own problems. Families that cannot purchase the equipment outright will also not benefit from the tax credits, as they are only to those who buy rather than lease solar equipment (if the equipment is

63. *See, e.g.*, Ngo & Penn, *supra* note 55 ("Ms. Camp would like to save money on energy bills by transitioning to more energy-efficient appliances like a heat pump and solar panels. But she simply cannot afford it. 'It's a struggle for me to even maintain food,' Ms. Camp said.").

64. ANNELIESE LEDERER & ANDREW KUSHNER, CTR. FOR RESPONSIBLE LENDING, THE SHADY SIDE OF SOLAR SYSTEM FINANCING 5 (2024), https://www.responsiblelending.org/sites/default/files/nodes/files/research-publication/crl-shady-side-solar-financing-jul2024.pdf ("The subprime crisis was marked by an absence of regulation, perverse incentives between lenders and brokers, lack of meaningful underwriting requirements, adjustable payments, and predatory targeting of elderly consumers and consumers of color. . . . Solar consumers are experiencing harms similar to the consumers in 2007 because elements of these products and process are identical.").

65. Walker Orenstein, *Minnesota Homeowners Say They Were Hit With Huge Hidden Fees When Going Solar*, MINN. STAR TRIB. (Nov. 8, 2024), https://www.startribune.com/minnesota-homeowners-say-they-were-hit-with-massive-hidden-fees-when-going-solar/601177876; *see also* LEDERER & KUSHNER, *supra* note 64, at 12-13 (describing hidden dealer fees on panels that required financing and illustrating these changes in a sample).

66. *Energy Efficient Home Improvement Credit*, INTERNAL REVENUE SERV., https://www.irs.gov/credits-deductions/energy-efficient-home-improvement-credit (last updated Jan. 28, 2025) ("The credit is nonrefundable, so you can't get back more on the credit than you owe in taxes.").

67. *See, e.g.*, LEDERER & KUSHNER, *supra* note 64, at 10 (showing payments of $146.45 rather than $103.85 per month for nearly twenty-three years if the balloon payment is not made).

68. Vikram Aggarwal, *Solar Payback Period: How Soon Will It Pay Off?*, ENERGYSAGE (June 20, 2024), https://www.energysage.com/solar/understanding-your-solar-panel-payback-period/ (listing the expected period of return for different states, ranging from a low of 3.68 years for Washington DC to a high of 19.39 for Utah).

leased the tax benefit is instead enjoyed by the entity that owns the panels).[69] Leased solar panels can also make it more difficult to sell the house.[70]

Given the documented predatory practices with lower income families, there is justifiable concern that the metrics showing that an increasing number of lower income families have solar would not necessarily correspond to a positive financial change for them.[71] Those who would be most in need of potential reductions in energy bills, therefore, are unlikely to get them through purchased or leased solar panels. Particularly since utility scale solar is so much cheaper, as discussed in Section IV.D.3, the focus does not necessarily need to be on ensuring that every household has solar. Of greater concern to many families is that they are more likely to be exposed to harmful pollutants, as the following section explains.

III. THE INTERSECTION OF ENERGY POVERTY AND REDUCED ENVIRONMENTAL QUALITY

The production of electricity has traditionally relied on large fossil fuel power plants that emit a great deal of pollution. This pollution has been concentrated in poor and minority communities. This section explains (very briefly) how electricity is produced, the health impact of the resulting pollution, and how to continue making progress to counter these harms in the current administration.

A. How Electricity Has Traditionally Been Produced

Traditional electrical production has depended on two types of power plants: baseload plants and ramping (or peaker) plants.[72] Understanding how these plants were designed to operate and how the grid (the entire production and transmission system for electricity) has traditionally worked is critical to understanding how the shift to renewables has upended it.

The demand for electricity is continually variable, although there are generally predictable patterns. Normally, demand is lowest in the early morning. As an example, in Texas in the spring around 5 a.m., demand on the grid is roughly 30 million kWh (kilowatt hours).[73] This rises to a high of around 40 million kWh

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69. Alana Semuels, *The Rooftop Solar Industry Could Be on the Verge of Collapse*, TIME (Jan. 25, 2024), https://time.com/6565415/rooftop-solar-industry-collapse/ (stating that by 2014 70% of the residential solar installations were leases rather than sales, meaning that the company not the homeowner got the tax credit). This credit could also be sold to companies with significant revenue to offset. *Id.*

70. *See, e.g.*, Granda, *supra* note 57 (stating that a seller had to pay $75,000 to remove a leased system from a house to sell it).

71. Sara DiNatale, *'Kneel for the deal': Inside the high-pressure sales culture that powered Texas' solar energy boom*, SAN ANTONIO EXPRESS-NEWS (Nov. 17, 2024), https://www.expressnews.com/news/article/solar-energy-scams-loans-texas-winter-storm-uri-19868556.php ("They might be on a fixed income where it's only Social Security or retirement,' [a solar salesman] can be heard saying, 'but they usually have passing credit.'").

72. Ramping plants are sometimes divided between intermediate plants and true peaking plants (those used less than 15% of the time), this article does not distinguish between the two because they are, for purposes of this article, variations of the same thing.

73. *Hourly Electricity Consumption Varies Throughout the Day and Across Seasons,* EIA: TODAY IN ENERGY (Feb. 21, 2020), https://www.eia.gov/todayinenergy/detail.php?id=42915.

around 6 p.m., before gradually falling back to the baseline in the early morning hours.[74]

Baseload power plants are used to meet the continual base demand, in this case the 30 million kWh.[75] That is the minimum constant amount required through the day. The baseload power plants are generally nuclear; coal (the most common in the past); hydropower, where there are big dams; and natural gas (the most common currently being built).[76] Baseload plants are most efficient when operating at a single high continuous output with little variation. When running like this, they can produce large amounts of comparatively cheap power.[77]

As demand goes above the baseline, utilities add output from ramping plants. Ramping plants can more easily vary their production output.[78] They are, however, less efficient than the baseload plants for each kWh of electricity produced.[79] In the Texas example, this would be the additional electricity needed to go from the 30 million kWh baseline to the 40 million kWh peak.

These ramping plants are most commonly natural gas. That is certainly the kind of ramping plant most commonly being built today, as it has been since the fracking revolution.[80] Historically there have also been other types of peaker plants, including oil[81] and diesel,[82] many of which are still in operation today.[83] Peaker plants are designed to more easily vary their output to ensure that production continually matches the demand. Insufficient production results in blackouts

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74. *Id.*

75. ALLAN MAZUR, ENERGY AND ELECTRICITY IN INDUSTRIAL NATIONS: THE SOCIOLOGY AND TECHNOLOGY OF ENERGY 117 (2013).

76. TOM STACY & GEORGE TAYLOR, INST. FOR ENERGY RSCH., THE LEVELIZED COST OF ELECTRICITY FROM EXISTING GENERATION RESOURCES 4 (2015), https://instituteforenergyresearch.org/wp-content/uploads/2015/06/ier_lcoe_2015.pdf.

77. U.S. GOV'T ACCOUNTABILITY OFF., GAO-24-106145, ELECTRICITY: INFORMATION ON PEAK DEMAND POWER PLANTS 1, 8 (2024), https://www.gao.gov/assets/gao-24-106145.pdf [hereinafter INFORMATION ON PEAK DEMAND POWER PLANTS].

78. *Id.* at 1.

79. *Id.*

80. *Use of Natural Gas-Fired Generation Differs in the United States by Technology and Region*, EIA: TODAY IN ENERGY (Feb. 22, 2024), https://www.eia.gov/todayinenergy/detail.php?id=61444.

81. The need for these peaker plants located close to cities can be seen in New York in particular. *See, e.g.*, PEAK COAL., ACCELERATE NOW!: THE FOSSIL FUEL END GAME 2.0 — TRACKING NEW YORK CITY'S PEAKER POWER PLANT CLOSURES AND THE CLEAN ENERGY TRANSITION 10 (2024), https://www.cleanegroup.org/wp-content/uploads/Accelerate-Now-Fossil-Fuel-End-Game.pdf ("In 2022, 7 percent of the electricity produced in upstate New York came from oil and fracked gas, whereas more than 95 percent of electricity produced in and around New York City came from oil and gas plants.").

82. Diesel plants can be useful in more remote areas where fuel transportation is itself an issue. Coal plants that are removed from baseload use are sometimes attempted to be converted to peaker plants, often with significant consequences as the nontraditional use adds additional stress to the plant and makes it work less efficiently.

83. While there have been efforts to move away from these plants it is not going as quickly as expected. *See* Robert Walton, *NYISO to Keep 4 NYC Peakers Running Past Planned 2025 Retirement to Maintain Reliability*, UTIL. DIVE (Nov. 21, 2023), https://www.utilitydive.com/news/nyc-peakers-planned-2025-retirement-remain-online-reliability-must-run-nyiso/700417/ (reporting that New York will need to keep the plants longer than expected to ensure there is still sufficient capacity).

and brownouts, while overproduction both wastes the fuel needed to create the electricity and can itself damage the grid.[84]

Demand does not just vary throughout the day; it also varies throughout the year. In Southern states like Texas, demand is highest in the summer. In summer, the average low demand on the system is about 40 million kWh, or close to the peak demand in the spring.[85] The average summer peak, in contrast, is well over 60 million kWh.[86] Utilities therefore need both more baseload power in summer (as much as the total demand in spring) and twice as much ramping capability for the 20 million kWh difference between the lowest and highest parts of the daily demand.

Many baseload plants can produce different levels of output, as long as it is a consistent amount (within limits), so a baseload plant might well produce more electricity consistently in the summer than in the spring.[87] The 40 million kWh baseload in the summer could therefore potentially still be met by baseload plants, but there will also be a significant need for additional peaker plant capacity. In the spring the utility needed to be able to vary the daily output by 10 million kWh, in the summer that doubled to 20 million kWh, most of which is produced by peakers. The utility therefore needs to nearly double the ramping capacity to handle these daily fluctuations. Given that the need for peakers varies from season to season, it is clear that some of these plants are used very infrequently. There are in fact peaker plants that run only on the very hottest days, when electrical demand hits its maximum. These are generally the least efficient plants available. In New York City, for example, there are oil fueled peaker plants that are potentially only needed a handful of times a year.[88]

These different types of plants do not just have different names and capacities, they are also typically located in different types of locations. This affects the health of neighboring residents, as the following section explains.

84. *See* Jarni Blakkarly, *Why "curtailment" is about to become a dirty word: rooftop solar's gone hard – now it's being told to go home*, COSMOS (Feb. 18, 2022), https://cosmosmagazine.com/technology/energy/rooftop-solar-curtailment/ (describing how the Australian government had been forced to mandate shutdown mechanisms on rooftop solar systems in an attempt to protect the integrity of the grid). The grid itself is also more vulnerable in poorer areas, as are the residents, exposing different communities to different risks from system failures. *See also* Benjamin K. Sovacool et al., *Energy justice beyond the wire: Exploring the multidimensional inequities of the electrical power grid in the United States*, ENERGY RSCH. & SOC. SCI., Mar. 6, 2024, at 3 ("Lower income households and neighborhoods are more vulnerable to blackouts, less likely to have backup power (e.g., battery storage), and are less able to recover quickly following blackouts").

85. *Hourly Electricity Consumption Varies Throughout the Day*, *supra* note 73.

86. *Id.*

87. *Electric generators' roles vary due to daily and seasonal variation in demand*, EIA: TODAY IN ENERGY (June 8, 2011), https://www.eia.gov/todayinenergy/detail.php?id=1710 (describing seasonal baseload plants).

88. PEAK COAL., DIRTY ENERGY, BIG MONEY 8 (2020), https://8f997cf9-39a0-4cd7-b8b8-65190bb2551b.filesusr.com/ugd/f10969_9fa51ccc611145bf88f95a92dba57ebd.pdf (describing a plant that was only used for thirty hours total in a year).

B. The Disproportionate Pollution Burden Placed on Poorer Communities

All communities rely on electricity, but they do not all equally experience the pollution this electricity generation has required. This section explains why power plants are placed near poor communities, the harms this causes, and how to attempt to redress the issue in the current political climate.

1. Why Power Plants are often Sited Near Poor Communities

The production of electricity has long had a disproportionately negative impact on poorer and minority communities.[89] While electricity generation using fossil fuels will inevitably create pollution, economic factors and a history of systemic discrimination have disproportionately directed that pollution towards marginalized groups.[90]

Large, utility-scale power plants require a significant amount of land.[91] Where that land must be located depends on the type of plant. Baseload plants, which operate continuously supplying constantly needed power, can be situated far out in the country where relatively few people will be affected by the pollution.[92] Peaker plants, however, are intentionally designed to run when the grid (the transmission wires, etc.) are likely to be most congested and it will not be possible to transmit the power longer distances. They must therefore be built close to the urban centers they will be serving.[93]

So peaker plants will necessarily be located closer to populated areas. To build in these areas the utility must both acquire land and not face zoning restrictions preventing the plants from being built. Lower income areas are likely to have lower land prices and also to lack the political capital to prevent the plant from being built.[94] Once an area begins to take on industrial development the industrial plants lower the value of the land, making it easier for new polluting

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89. *See* Priya Patel, *Energy Equity: A Framework for Evaluating Solar Programs Targeting Low-Income Communities*, 43 ENERGY L.J. 299, 301 (2022) (noting the additional burden placed on rural residents at every income level compared to their urban counterparts).

90. *See id.* at 332 (explaining why energy programs should look into whether the program fixes these historical injustices).

91. STRATA, THE FOOTPRINT OF ENERGY: LAND USE OF U.S. ELECTRICITY PRODUCTION 1 (2017), https://docs.wind-watch.org/US-footprints-Strata-2017.pdf (listing coal, natural gas, and nuclear power plants as requiring roughly twelve acres per MW, solar at just under forty-five, and wind at just over seventy).

92. Marilyn A. Brown & Valentina Sanmiguel Herrera, *Combined Heat and Power as a Platform for Clean Energy Systems*, APPLIED ENERGY, Dec. 15, 2021.

93. DIRTY ENERGY, BIG MONEY, *supra* note 88, at 6 ("In New York City, only a certain amount of base-load power can enter the city through transmission lines. So, when electricity demand rises above that amount — for example on hot days when residents turn up their air conditioners — highly polluting power plants known as 'peakers' fire up in the South Bronx, Sunset Park, and other communities of color, burning fossil fuels and spewing harmful emissions into neighborhoods already overburdened by pollution and exacerbating widespread health problems.").

94. R. Shea Diaz, *Getting to the Root of Environmental Injustice: Evaluating Claims, Causes, and Solutions,* 29 GEO. ENV'T L. REV. 767, 779-80 (2017).

sources to enter the area as well, further exacerbating the environmental burden borne by nearby communities.[95]

Systemic racism also helps explain why poorer, often predominantly minority communities are the most likely to face the pollution burden from these peaker plants.[96] This remains a vestige of historic redlining. A 2023 study in Nature showed that even just comparing redlined "D" districts to C districts, which were considered slightly more desirable, the D districts had a significantly higher risk of having a fossil fuel power plant built within 5 km of the district. This was most pronounced during the height of redlining — 1940-1969 (72% more likely) but still present between 1970 and 1999 (20%) and indeed even trended back up between 2000 and 2019, to 31%.[97] The correlation was even higher in the initial period for coal and oil plants (86%) and higher in all three periods examined for peaker plants, which are some of the least efficient (most polluting) methods of electricity generation, discussed further in Section III.A.

These location decisions will affect nearby neighborhoods for decades, as the average age of retirement for the power plants in the study was nearly fifty years. The same study showed that these formerly redlined neighborhoods still have higher pollution measures and continue to bear the environmental and health consequences of these decisions.[98]

2. The Health and Environmental Impact of These Power Plants

Fossil fuel power plants emit a number of pollutants with serious health consequences for those nearby, including nitrogen oxides, sulfur dioxide, and fine particulate matter. Nitrogen oxides, NO_x, cause airway inflammation and long-term lung damage, particularly in children.[99] Sulfur dioxide, SO_2, irritates the airways, increases the risks of respiratory infections, and can lead to severe asthma

95. *See* Vicki Been & Francis Gupta, *Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims*, 24 ECOLOGY L.Q. 1, 28 (1997) (describing how the siting of a plant appeared to negatively affect neighboring property values).

96. Lara J. Cushing et al., *Historical Red-Lining Is Associated With Fossil Fuel Power Plant Siting and Present-Day Inequalities in Air Pollutant Emissions*, 8 NATURE ENERGY 52, 53 (2023) ("In multivariable models comparing D-graded to C-graded areas and controlling for the presence of power plants before 1940 and US census region, red-lining was associated with a higher risk of having a fossil fuel power plant sited within 5 km during the 1940–1969 (72%), 1970–1999 (20%) and 2000–2019 (31%) periods. . . . The association was generally stronger when considering only coal or oil plants (86%, 22% and 3% higher risk over the three periods) or peaker plants (133%, 33% and 53% higher risk over the three periods)").

97. *Id.*

98. *Id.* at 55 ("[R]ed-lining was associated with an increase in average annual NOx (82%), SO2 (38%) and PM2.5 (63%) emissions when comparing D- versus C-graded neighborhoods").

99. *Basic Information about NO2*, EPA, https://www.epa.gov/no2-pollution/basic-information-about-no2 (last updated July 16, 2024). Notably, this should be distinguished from laughing gas. *See, e.g.*, Alison Durkee, *Supreme Court Corrects EPA Opinion After Gorsuch Confuses Laughing Gas With Air Pollutant*, FORBES (June 28, 2024), https://www.forbes.com/sites/alisondurkee/2024/06/28/supreme-court-corrects-epa-opinion-after-gorsuch-confuses-laughing-gas-with-air-pollutant/.

attacks.[100] Fine particular matter, often called PM2.5, can settle deep in the lungs, causes a number of problems, including increasing the risks of heart attacks and strokes, and pregnancy complications like preeclampsia.[101]

Power plants also emit airborne carcinogens like benzene, formaldehyde, and polycyclic aromatic hydrocarbons, all of which are directly linked to increased cancer risks.[102] Water contamination is also a concern, as plants can discharge metal contaminants, including arsenic, lead, and mercury, into the nearby water, which can increase the risk of cancer as well as cause neurological disorders.[103] Lead exposure is particularly harmful to developing brains. As is mercury, which can cause learning disabilities and increased rates of ADHD and autism.[104]

All of the pollution being produced from the peaker plants, which must be sited near populated areas, are disproportionately harming those in poorer and minority communities. So not only are these families disproportionately burdened by the cost of electricity, they are also more likely to live where the electricity is produced, and thereby suffer the effects of the pollution created when fossil fuels are burned for energy production. Black families are exposed to 21% more pollution than the average, while Hispanic families are exposed to 12% more than the average pollution.[105] The difference is even more egregious when compared to the lower consumption of these families.[106] How to address these issues, however, is now less clear.

3. Advancing Energy Equity in a Shifting Political Landscape

The disproportionate burden faced by many lower income and minority communities is well documented, but efforts to explicitly address it as environmental justice remain politically volatile. Steps were taken in previous democratic administrations to address this energy burden through Executive Orders,[107] but those

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100. *Human Health & Environmental Impacts of the Electric Power Sector: Human Health Impacts*, EPA, https://www.epa.gov/power-sector/human-health-environmental-impacts-electric-power-sector (last updated Feb. 6, 2025).

101. *Air Pollution and Your Health*, NAT'L INST. OF ENV'T HEALTH SCIS., https://www.niehs.nih.gov/health/topics/agents/air-pollution (last updated Apr. 23, 2025) (reporting the results of a study that found exposure to PM2.5 from coal was twice as deadly as PM2.5 from other sources).

102. ENV'T HEALTH & ENG'G, EMISSIONS OF HAZARDOUS AIR POLLUTANTS FROM COAL-FIRED POWER PLANTS 10 (2011), https://www.lung.org/getmedia/25962184-d2fc-42f8-b5a3-8ece3257fbab/emissions-of-hazardous-air.pdf.

103. *Reducing Water Pollution from Power Plants*, EPA (Apr. 4, 2023), https://www.epa.gov/perspectives/reducing-water-pollution-power-plants.

104. *About Lead and Other Heavy Metals and Reproductive Health*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH (Feb. 14, 2024), https://www.cdc.gov/niosh/reproductive-health/prevention/lead-metals.html.

105. Christopher W. Tessum et al., *Inequity in Consumption of Goods and Services Adds to Racial–Ethnic Disparities in Air Pollution Exposure*, 116 PNAS 6001, 6002 (2019).

106. *See generally* Brown et al., *supra* note 18.

107. Of greatest importance were Exec. Order No. 12,898, 3 C.F.R. 859 (1995), which directed agencies to identify and address disproportionate impacts on low-income and minority communities, Exec. Order No. 13,990, 86 Fed. Reg. 7037 (Jan. 20, 2021), which sought to update policies relating to environmental justice,

have been rescinded under Trump.[108] There was also a section of the Environmental Protection Agency dedicated to addressing some of these issues, which was disbanded the same day.[109]

These steps show how vulnerable policies explicitly labeled as environmental justice can be to changing administrations. But the same ends can often be accomplished by reframing the issue. Focusing on economic efficiency, affordability, and reliability can accomplish some of the same goals but may be a more resilient approach with longer tern viability and better bipartisan support.

For instance, policies targeted at building up battery capacity to reduce reliance on peaker plants, as is already happening in some areas, can be justified based on their financial benefits to rate payers and role in stabilizing the grid, even though closing the peaker plants will also directly address the unfair environmental burden the nearby communities have borne.[110] This is already a pivot many renewable developers are making to try to appeal to the new presidential priorities under Trump and will likely be the most effective way forward.[111]

Some of the Biden era policies were intended to ensure that renewable energy directly benefitted these communities, in addition to removing harmful sources of pollution.[112] The extra incentives built into legislation to encourage building green energy sources in poorer communities may be difficult to replicate. Even without an explicit policy, however, the same factors that pushed the peaker plants to their original locations may similarly justify the battery replacements or other new initiatives in such areas.

IV. Issues Integrating Renewable Energy into the Grid

Solar and wind power will be critical components of a move to environmentally sustainable energy. This transition, however, faces a number of challenges as renewable production does not align with the typical demand curve. The section

including where power plants were located, and Exec. Order No. 14,008, 86 Fed. Reg. 7619 (Jan. 27, 2021), which attempted to target 40% of climate and clean energy investments to disadvantaged communities.

108. These revocations were done through Exec. Order No. 14,148, 90 Fed. Reg. 8237 (Jan. 20, 2025), which rescinded Exec. Order No. 13,990, 86 Fed. Reg. 7037 (Jan. 20, 2021) and Exec. Order No. 14,008, 86 Fed. Reg. 7619 (Jan. 27, 2021) (the Biden era orders) and was issued on Donald Trump's first day in office and Exec. Order No. 14,173, 90 Fed. Reg. 8633 (Jan. 21, 2025), which rescinded Exec. Order No. 12,898, 3 C.F.R. 859 (1995), (the Clinton era order) and was issued on Trump's second day in office.

109. Maxine Joselow & Amudalat Ajasa, *Trump moves to shutter environmental offices across the government*, WASH. POST (Feb. 6, 2025), https://www.washingtonpost.com/climate-environment/2025/02/06/environmental-justice-offices-trump-turmoil/ ("Trump appointees at the Environmental Protection Agency notified staff members that they plan to close the Office of Environmental Justice and External Civil Rights and place 168 of its employees on administrative leave.").

110. *See, e.g.*, *Justice40 Initiative*, WHITE HOUSE, https://bidenwhitehouse.archives.gov/environmentaljustice/justice40/ (last visited Apr. 28, 2025) ("[T]he Federal government has made it a goal that 40 percent of the overall benefits of certain Federal climate, clean energy, affordable and sustainable housing, and other investments flow to disadvantaged communities that are marginalized by underinvestment and overburdened by pollution.").

111. Brad Plumer, *Want Cheap Power, Fast? Solar and Wind Firms Have a Suggestion.*, N.Y. TIMES (Mar. 17, 2025), https://www.nytimes.com/2025/03/17/climate/renewable-energy-trump-electricity.html.

112. Inflation Reduction Act, Pub. L. No. 117-169, 136 Stat. 1818 (2022) (providing funding and tax incentives for clean energy projects located in or serving low-income and historically overburdened communities).

looks at the mismatch between supply and demand, the infrastructure and operational costs of integrating renewables, the added strain data centers have placed on all of this, and the essential role of batteries in enabling this transition.

A. Renewable Production Does Not Match Demand

One of the central challenges with integrating renewables into the grid is that production for both solar and wind depends on environmental conditions rather than the current electrical demand. This mismatch leads to times when renewable energy is overproduced and times when it is insufficient, both of which place strain on the grid. This section explains how these discrepancies occur for both solar and wind.

1. Solar Production Peaks Hours Before the Demand Peak

Solar power is most productive in the middle of the day, but this is not the point where the grid requires the most power. This section goes through the implications of the mismatch and how homeowners are compensated for excess solar energy generated. It then describes the problem this creates when homeowners are incentivized to treat the grid itself as a battery.

a. An Introduction to the Duck Curve

In areas where solar production forms a significant part of the electrical mix, the dramatic increase in solar power means other sources must be significantly reduced during the day, before being ramped up dramatically later in the afternoon as demand grows through the afternoon and solar production drops. If the utility controls the power plants, the utility will be directly making these ramping decisions.[113] In utilities that operate on the auction method, it is the market power that is creating the incentive for power producers to dramatically ramp up production (and, generally, price).[114]

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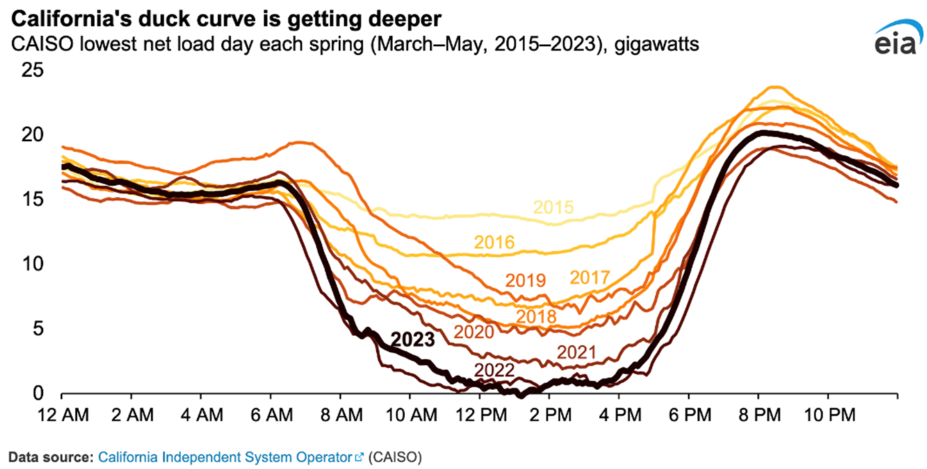
113. *Power Market Structure*, EPA, https://www.epa.gov/green-power-markets/power-market-structure (last updated Dec. 26, 2024) (stating that much of the South and West are covered by traditional wholesale electrical markets (vertically integrated utilities)).

114. Although this signal can lag, particularly given the discrepancy between the drive for electricity due to the fast growing data centers and the time needed to bring new production online, this disconnect appears to have resulted in a seven fold increase in the capacity cost in one year for the PJM Interconnection, which serves a number of mid-Atlantic states including Virginia with its rapidly developing data centers. *See* Molly Robertson, *Why Prices Soared in a Recent Auction Held by a Major Electric Grid Operator*, RES. (Oct. 4, 2024), https://www.resources.org/common-resources/why-prices-soared-in-a-recent-auction-held-by-a-major-electric-grid-operator/.

California, where solar power is pervasive and this has been a known issue for years, has been charting these events in what is referred to as the duck curve, after the shape formed by the initial demand rise in the morning, plummeting demand during the day, and steeper rise in the evening.[115] At times, particularly in the spring when overall electrical demand is lower than the summer, the solar panels alone can produce more electricity than needed for all customers. This dip, where production potentially outstrips the demand, grows increasingly deeper as more and more solar panels are added.[116]



Other areas of the country have their own version of the duck curve occurring. In New England, for instance, there are already days where the low point of overall demand on the grid is not the middle of the night, but the middle of the solar production peak, what ISO NE also refers to as duck curve days.[117] At a minimum, these days mean the baseload power plants cannot operate at their most efficient, since there is now a lower point at which constant production is required, without a corresponding reduction in the maximum demand later in the day. This is not merely a spring phenomenon either. These New England duck curve days have occurred from January to December, and in 2023, there were seventy-three such days, up from forty-five the previous year.[118]

115. Richard Bowers et al., *As Solar Capacity Grows, Duck Curves Are Getting Deeper in California*, EIA: TODAY IN ENERGY (June 21, 2023), https://www.eia.gov/todayinenergy/detail.php?id=56880. This is also the source of the image in the text.

116. Concern over this led California early on to attempt to rethink how to pay for power, as described *infra* Section V.A. *See, e.g.,* Meredith Fowlie, *California's Duck-Belly Blues*, ENERGY INST. AT HAAS (Mar. 13, 2023), https://energyathaas.wordpress.com/2023/03/13/californias-duck-belly-blues/.

117. *'Duck curve' days becoming more frequent as solar power spreads*, ISO NEWSWIRE (Feb. 28, 2024), https://isonewswire.com/2024/02/28/duck-curve-days-becoming-more-frequent-as-solar-power-spreads/ [hereinafter *'Duck curve' days*].

118. *Id.*

Considering this solar production a pure win for the environment dramatically oversimplifies what is going on. Section III.A discussed the different types of power plants that utilities rely on for general electrical production. Baseload plants provide the consistent base of power relied on throughout the day. These plants are designed to run and are most efficient when operating continuously at a consistent level. Situations where solar panels can potentially produce more than the total required grid consumption disrupt this optimal pattern. Forcing even the baseload plants to fluctuate wears out the equipment in them faster, increasing maintenance costs and potentially shortening the lifespan, as described in Section IV.B.2. It also reduces the efficacy of the plant itself (resulting in more fuel being required to produce the same amount of electricity).[119]

As described in Section III.A, utilities must ensure there is sufficient power for all demand, but the grid can also become unstable if there is too much electricity. If the utility is required to buy all solar power produced by customers, and the utility is responsible for maintaining the stability of the grid, it must ensure only enough additional electricity is produced to meet the demand.[120] When there is more electricity being produced by resources the utility is committed to than it can use, renewable sources that can be curtailed (functionally disconnected from the grid) must be, even if it would be producing cheaper power.[121]

This can mean that utility-owned solar farms must be curtailed, or that outside producers will be forced to curtail their production.[122] Curtailing utility scale farms means the electricity they would have produced cannot help humanity, will not be used to help meet renewable energy goals, and will result in no payment to the owner.

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119. *See* Jianglong Li & Mun Sing Ho, *Indirect cost of renewable energy: Insights from dispatching*, ENERGY ECON., Dec. 18, 2021, at 7 (finding that the inefficiencies caused by the use of renewables in China on the predominantly coal fired power plants cost the equivalent of $ 4.77 billion due to the reduced efficiency of the plants). The same thing is true in the U.S. *See, e.g.*, NAT'L ASS'N OF REGUL. UTIL. COMM'RS, RECENT CHANGES TO U.S. COAL PLANT OPERATIONS AND CURRENT COMPENSATION PRACTICES 21 (2020), https://www.osti.gov/servlets/purl/1869928 (For example, for one sample plant in Texas: "In December 2008, the [plant] operated at a capacity factor of 94.7%, had zero shutdowns over the course of the month, and its average hourly ramp rate was 1.1%. In December 2018, these numbers were drastically different. [The plant's] capacity factor dropped to 57.1%. It experienced five different startups (three hot starts and two warm starts), and its average hourly ramp rate increased to 4.9%. Additionally, on-peak and off-peak power prices for SPP-South, where [the plant] is located, dropped 38% and 23% between December 2008 and 2018, respectively."); *see also* STACY & TAYLOR, *supra* note 76, at 1 (demonstrating that intermittent power can increase the cost of gas fired resources).

120. *Power Market Structure*, *supra* note 113.

121. Shannon Osaka, *Rooftop solar panels are flooding California's grid. That's a problem*. WASH. POST (Apr. 22, 2024), https://www.washingtonpost.com/climate-environment/2024/04/22/california-solar-duck-curve-rooftop/.

122. *See Managing the Evolving Grid*, CAL. ISO, https://www.caiso.com/about/our-business/managing-the-evolving-grid (last updated Apr. 14, 2025); *see also* Kevin Novan & Yingzi Wang, *Estimates of the Marginal Curtailment Rates for Solar and Wind Generation*, J. ENV'T ECON. & MGMT., Mar. 1, 2024 (finding that 9% of the generation of new solar power in California would likely be curtailed).

This reduced return can disincentivize additional investment in the sector. Investors will be less likely to invest in projects with a substantial risk of curtailment and it becomes more difficult for a utility to add utility scale renewables (benefitting all users) if significant curtailment is necessary.[123]

At these high production times many non-solar sources will be turned off, and the inability to ramp can be a significant problem, as described in Section IV.B.2.b. Some plants, however, cannot ramp but still generate such cheap power that it is still economical to run the plants through these periods. Nuclear plants, for instance, nearly always require more than twelve hours to go to full power if turned off.[124] Nuclear in a system, therefore, generally cannot be turned off and on in response to the solar peak in the middle of the day. Instead, nuclear plants are generally operating at least at some capacity, even if not full capacity, the entire time.[125] So, the nuclear plant will also need to be paid during the solar peak, when potentially more power is being produced than can be used. This is not just a problem for nuclear power. Most power plants that rely on steam turbines for energy production take more than twelve hours to reach full operating load. This is nearly all nuclear plants, more than 80% of coal plants, and more than 60% of natural gas plants.[126] Many baseload plants, then, may maintain some production even when it may not be needed.[127]

In vertically integrated utilities a plant running unnecessarily in this manner will still be paid for this power, even if it is effectively curtailed. In a more open market, the producers may be paid nothing (making up the cost on the power that is sold later). Regardless, the residential solar households will still be paid the contracted amount, and often at an increased cost, as the following section explains.

b. Different Metering Methods for Residential Solar

One of the biggest fights over solar power is how homeowners who generate excess electricity should be compensated. This section explains the different methods currently being used: net metering, net billing, and gross metering.

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123. Times when a resource must be curtailed are also likely to be the times when the resource is particularly abundant and would therefore be particularly cheap to purchase on an open market. It would be far below the retail price of electricity, particularly when prices go negative, as they can when there is strong wind production, as explained in discussion *infra* Section IV.A.2.

124. Owen Comstock, *About 25% of U.S. power plants can start up within an hour*, EIA: TODAY IN ENERGY (Nov. 19, 2020), https://www.eia.gov/todayinenergy/detail.php?id=45956 (noting that many current plants take more than 12 hours to reach operating temperature, but that only 4% of the recently built plants have the same requirement).

125. *Id.*

126. *Id.* Many of the remaining plants can achieve a full load within 1-12 hours. *Id.*

127. There are also instances where the legacy fuel operator will receive additional subsidies later because they bid less than the cost of the fuel on the spot market, in an attempt to ensure the plant will not need to shut down, given the long startup time already discussed. Thus the utility customers in some instances will be providing additional subsidies to the power plant for the extra unnecessary production, as well as the payments to the additional plants on standby if needed. How to handle these plants has been an issue for years. *See, e.g.*, N. KUMAR ET AL., NAT'L RENEWABLE ENERGY LAB'Y, POWER PLANT CYCLING COSTS, at vii (2012), https://www.nrel.gov/docs/fy12osti/55433.pdf ("Cycling costs can be avoided by the obvious method of not cycling a unit and that may include staying on line at a small market loss price.").

i. Net Metering

Conceptually net metering is easy to understand. The customer is credited one kWh for each kWh they export, that is, beyond their self-consumption, and they can then use that exported electricity to offset electricity drawn at a later time. For instance, a customer might export 4 kWh between 1pm and 3pm, and then draw 4 kWh between 7pm and 9pm. Such a setup could be monitored with a single meter that spins backwards when electricity is exported and forward when the house is consuming electricity.

Net metering is an artifact of the early push for solar adoption among the public.

> Initially, NEM [Net Energy Metering] was largely understood to be an administratively simple, rough-justice approach that was acceptable at a time when markets for solar . . . [were] uneconomic. In many of the initial decisions about NEM, policy makers assumed that the retail rate was a close-enough proxy for the value of solar . . . and the total numbers of participating customers and kilowatt hours being credited at the retail price were relatively small: The product of the close-proxy rate, representing a rough approximation of the avoided cost of utility generation or purchases that would otherwise be needed if NEM generators did not export some energy to the grid. When NEM was just getting started, the small number of participating customers multiplied by the small quantity of energy each would deliver to the grid, meant that any error associated with under- or over-estimating the true value would be small.[128]

This is no longer the case, although there are still net metering supporters.[129] Net metering is still common, including in solar-heavy states like Florida and New Mexico.[130]

Due to the problems with net metering discussed in Section V.B, many states have moved away from true net metering to various degrees. A number of states continue to use the term net metering for these variations,[131] although if the amount sent to the grid is not used to equally offset the amount drawn from the grid it is instead more accurately thought of as net billing, as described in the following section.

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128. *See* TOM STANTON, NAT'L REGUL. RSCH. INST., REVIEW OF STATE NET ENERGY METERING AND SUCCESSOR RATE DESIGNS 7 (2019), https://pubs.naruc.org/pub/A107102C-92E5-776D-4114-9148841DE66B/; *c.f.*, Todd Aagaard, *24/7 Clean Energy*, 94 U. COLO. L. REV. 571, 616 (2023) ("When renewable energy was in its early stages of development, these rough alignment efforts [regarding renewable energy certificates] may have been sufficient to leverage the impacts of renewable energy purchases. When there was almost no renewable energy on the grid, any renewable energy transaction was significant.").

129. Sanem Sergici & Long Lam, *Retail Pricing: A Low-Cost Enabler of the Clean Energy Transition*, 20 IEEE POWER & ENERGY MAG. 66 (2022). That said there have also long been detractors. *See generally* 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 (2016).

130. Sarah Drolet & Tyler Graham, *How Solar-Friendly Is Your State? We Scored Them All*, CNET (Aug. 12, 2024), https://www.cnet.com/home/energy-and-utilities/how-solar-friendly-is-your-state-we-scored-them-all/ (stating that seventeen states still use true net metering (including Florida and New Mexico), while referring to the reduced payout of another fourteen states as net metering despite explicitly describing the payment in those states as below retail rate).

131. *Id.*

ii. Net Billing

Net billing is similar to net metering in that the resident can self-consume all they want, and the utility only looks at what is sent to the grid and received from the grid, but the two are not compensated equally. Under net billing in some locations, the homeowner is compensated at a predetermined set amount,[132] in others the compensation is based on the true market rate at that moment.[133]

One feature that both net metering and net billing share is the ability of the consumer to self-consume any electricity generated. This self-consumption saves the consumer the retail price of that electricity, regardless of how excess electricity would be compensated. Concern over this self-consumption has led some to push for a further method, gross metering.

iii. Gross Metering — Buy All Sell All

Under gross metering the customer pays for every kWh used and is in turn compensated in some way for every kWh generated by the panels.[134] The customer is not allowed to self-consume, the billing is treated as though every kWh generated was sold to the utility and every kWh used was drawn from the utility.[135]

If this is mandated by a utility to try to force solar users to cover the full costs it could reduce the financial benefits of solar still further, because the customer is no longer saving the retail price for every kWh self-consumed.

This can have a particularly significant effect in locations where the electricity price rises as consumption rises based on a tiered progressive system.[136] Removing part of a household's electricity requirement under such a system reduces the usage the household would otherwise be paying for at the highest tier, the potion of the electricity that it would be most financially beneficial for the household to offset. Texas, with its highly deregulated energy market, can provide examples

132. Georgia uses a version of this net billing with a set rate that consists of an avoided cost component that changes annually and an extra addition of 4 cents per kWh to encourage renewable energy. GA. POWER CO., ELECTRIC SERVICE TARIFF: RENEWABLE AND NONRENEWABLE RESOURCES SCHEDULE: "RNR-11" (2023), https://www.georgiapower.com/content/dam/georgia-power/pdfs/residential-pdfs/residential-rate-plans/RNR-11.pdf. For 2024, the avoided cost rate was 4.184 cents per hour, and it was predicted to drop to 3.456 cents per hour in 2025. *See* Letter from Kelley Balkcom, Regul. Affs. Dir., Ga. Power Co., to Sallie Tanner, Exec. Sec'y, Ga. Pub. Serv. Comm'n (Oct. 13, 2023), https://www.nationalenergyscreeningproject.org/wp-content/uploads/2024/02/2023-GPC-Avoided-Cost-Projections-Errata.pdf.

133. Octopus Energy in Texas, for example, reimburses all exported solar at the wholesale rate, updated every fifteen minutes. *The Best Texas Solar Buyback Program*, OCTOPUS ENERGY, https://octopusenergy.com/solar (last visited Apr. 28, 2025). While unusual, even for Texas, Tesla only compensates at 90% of the wholesale rate for those who choose variable, or 5 cents per kWh for those who choose fixed). *See Buyback Plans for Texas Solar Owners*, TEX. POWER GUIDE, https://www.texaspowerguide.com/solar-buyback-plans-texas/ (last updated Apr. 28, 2025); *see also Tesla Electric*, TESLA, https://www.tesla.com/tesla-electric?utm_source=TPG&utm_medium=TX_SS (last visited Apr. 28, 2025).

134. Peter M. Schwarz et al., *Compensating Solar Prosumers Using Buy-All, Sell-All as an Alternative to Net Metering and Net Purchasing: Total Use, Rebound, and Cross Subsidization*, 44 ENERGY J. 143, 145 (2023).

135. *Id.* at 144.

136. As higher income households tend to use more electricity, this increasing block pricing is intended to place a higher share of costs on higher income households. Arik Levinson & Emilson Silva, *The Electric Gini: Income Redistribution through Energy Prices*, 14 AM. ECON. J.: ECON. POL'Y 341, 355 (2022).

here as well. Austin Energy compensates residential solar users using a buy all/sell all model.[137] While this has been argued by some as the most efficient method, it is less common than the others. How a household is compensated for solar impacts how they use not only the electricity they produce but the electricity required at other times as well, as the following section explains.

c. Many Households Improperly Treat the Grid Itself as a Battery

In states that require net metering, the customer is credited for all electricity produced above the amount the customer is personally using.[138] Those banked credits are then counted against the electricity used by the customer at other times.[139] As a simplistic example, a customer who produced 2 kWh more than needed between noon and 4 pm would then pay nothing for 2 kWh required between 6 pm and 8 pm that day.[140]

This system can intuitively seem fair — the customer provided the utility with electricity, the same thing being drawn from the grid later.[141] The financial benefits provided by net metering are also often important when determining whether adding solar panels makes financial sense.[142] This trade also makes the customer feel that the electricity they obtain from the grid later is just as environmentally friendly since it is merely compensating for electricity they have already produced with their solar panels.[143]

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137. The customer is credited for every kWh produced at 9.91 cents for residential customers, and billed at the standard residential rate for every kWh used, whether it was self-produced or obtained from the grid. *Commercial Rates — Value of Solar Rate*, AUSTIN ENERGY, https://austinenergy.com/rates/commercial-rates/value-of-solar-rate (last visited Apr. 28, 2025). Austin Energy also uses a tiered rate for residential solar costs, ranging from more than ten cents to 17.5 cents for high level residential users. *See, e.g.*, AUSTIN ENERGY, CITY OF AUSTIN UTILITY RATES AND FEES SCHEDULE (Jan. 1, 2025), https://austinenergy.com/-/media/project/websites/shared/pdfs/rates/coa-utilities-rates-and-fees.pdf.

138. Or that were using net metering when solar panels were installed for that customer.

139. As an example, in New Mexico, net metering clients pay the fixed portion of the electric bill but are credited one kWh for each excess kWh they send to the utility. Larry Blank & Doug Gegax, *Do Residential Net Metering Customers Pay Their Fair Share of Electricity Costs? Evidence from New Mexico Utilities*, UTILS. POL'Y, Dec. 2019, at 1.

140. *Id.* Utilities in New Mexico have an option to use the full retail rate for electricity or the set avoided-cost rate, which is closer to what midday electricity would normally cost the utility. *Id.* at 2. There are utilities using each option. *Id.* The example in the text would be based on the retail rate. *See Net metering: what you need to know*, SOLAR UNITED NEIGHBORS (Apr. 18, 2024), https://www.solarunitedneighbors.org/learn-the-issues/net-metering/ (stating that retail price compensation is most common).

141. *Net Metering*, SOLAR ENERGY INDUS. ASS'N, https://www.seia.org/initiatives/net-metering (last visited Apr. 28, 2025) [hereinafter SOLAR ENERGY INDUSTRIES] ("Net metering allows utility customers to generate their own electricity cleanly and efficiently. During the day, most solar customers produce more electricity than they consume; net metering allows them to export that power to the grid and reduce their future electric bills.").

142. *See* Amanda Lutz, *Understanding Net Metering: 2024 Guide*, ARCHITECTURAL DIGEST (Oct. 24, 2024), https://web.archive.org/web/20241121030259/https://www.architecturaldigest.com/reviews/solar/net-metering ("While solar panels can increase home value and reduce monthly energy bills, the ROI takes a long time to surface. With net metering, it's possible to see the benefits of this investment much faster. Property owners can notice significant energy savings in just a few months in states where net metering is currently in place.").

143. *See* Solar Energy Industries, *supra* note 141; *see also* Mary-Elisabeth Combs, *Does Your State Have Solar Net Metering?*, CNET, https://www.cnet.com/home/energy-and-utilities/new-to-solar-net-metering-heres-

However, this electricity is not equivalent.

What these households are effectively doing is treating the grid itself as a form of storage — a giant battery.[144] This is one of the explicit selling points to customers as well.[145] However, as described in Section IV.D, there have only been relatively small steps towards adding effective storage to the grid, so the modern grid is still almost entirely production exactly according to demand. This means that the demand later in the evening is served by supply obtained later in the evening, generally from more expensive peaker plants.[146] Net metering, therefore, as well as net billing if the billing is not structured properly, fail to provide the proper incentives for homeowners to structure their electrical usage in a more sustainable fashion.[147] Wind, the other major intermittent renewable, also does not reach peak supply when most needed by the grid, as the following section explains.

2. Wind Production Peaks in the Middle of the Night

As explained in Section IV.A, electrical demand in the United States generally peaks in the summer, particularly on hot sunny days when the demand for air conditioning is at its peak. While solar power does not fully match this profile, since significant power is needed into the evening, long past the solar peak, it is at least true that extremely hot days are likely to be days where a great deal of solar energy is produced.[148] The greatest problem with the duck curve, where more solar alone is being produced than the system can handle, is less dire during the summer, since the demand during the day is also generally steadily increasing,

what-you-need-to-know-for-your-state/ (last updated Feb. 5, 2024) ("'[D]uring the day, you're off at work and you don't have any lights on, nothing is running in your house. The sun is shining down [and] you're sending electrons back out through your electric meter.' In these situations, net metering is 'a fair crediting system that allows solar owners to earn credit for the electricity they generate but don't use themselves.'") (quoting Ben Delman, communications director of Solar United Neighbors).

144. For an early criticism of net metering, *see* Reiter & Greene, *supra* note 129.

145. *See* Tori Addison, *Solar Net Metering Explained*, MARKETWATCH, https://www.marketwatch.com/guides/solar/solar-net-metering/ (last updated Oct. 22, 2024) ("With net metering, the local electric grid acts as your 'solar battery' to absorb surplus production, and you can offset your nighttime grid consumption using net metering credits accumulated during the day.").

146. An overview of how the electrical demand is met is provided in discussion *supra* Section III.A.

147. K.K. DuVivier & Haley Balentine, *Time of Renewables*, 28 B.U. J. SCI. & TECH. L. 63, 71 (2022) ("Natural-gas peaker plants are an example of an especially expensive source of peak power."); *see* Aagaard, *supra* note 128, at 633 ("[Current policy] concentrates renewable energy development on times and places in which renewable energy is plentiful and cheap, leaving consumers otherwise dependent on traditional fossil fuel generation to meet their electricity needs.").

148. *See 'Duck curve' days*, *supra* note 117 (Although ISO-New England has noted that they see particularly strong solar production in the spring "when the sun's position in the sky is optimal and trees haven't yet sprouted leaves that will block some sunlight. Additionally, solar cells work best in cooler weather, losing efficiency in the heat and humidity of summer."). While overall solar production is highest in the US in the summer, when the sun is also at its maximum, this shows it is not true uniformly, and one more thing grid operators in different locations must take into account. EIA, ELECTRIC POWER MONTHLY: TABLE 6.07.B. CAPACITY FACTORS FOR UTILITY SCALE GENERATORS PRIMARILY USING NON-FOSSIL FUELS, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_b (last visited Apr. 28, 2025) [hereinafter TABLE 6.07.B] (showing that overall solar capacity peaked in 2022 in June in the US and in 2023 in July).

although the system does still need to ramp up considerably between the time of the solar peak and peak electrical demand.[149]

Wind power, however, is even more out of sync, as wind production generally peaks in the spring and fall.[150] Not only is wind out of sync with the seasonal summer electrical demand peak, it is also out of sync on a daily basis. Wind power is strongest at night.[151] This can help to balance solar, which is unusable at night if storage is unavailable, but it means that wind cannot be a significant contribution during peak demand on summer evenings (and the two together without storage cannot generate reliable electricity, since there is not a smooth transition from one to the other).[152] There are also other technological problems integrating wind and solar into the grid, as the following section explains.

B. Costs and Complexities of Grid Integration

As an increasing number of renewables are added to the grid, significant infrastructure costs will be required to enable them to be fully integrated. The intermittent and variable nature of renewables also requires more flexibility than traditional baseload power plants were designed for, adding additional costs.

1. Infrastructure Costs to Add New Sources

The traditional electrical grid was designed to send power from central power plants out, in only one direction, to the end user. Adding variable and widely distributed renewables, like residential solar panels, means the grid must now be upgraded to handle two-way electrical flow. This requires infrastructure upgrades to enable electricity to enter and exit the grid at different points.[153]

At an individual consumer level, the meters on houses must be updated to include advanced systems capable of monitoring and managing two-way electrical flow.[154] But the issues go beyond electrical upgrades for the individual house,

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149. The comparative contribution of solar can be seen in the monthly capacity factors - the percentage of total potential generation that was actually generated by a given source. In June 2022, the solar capacity factor peaked at 33.2%, compared to a December 2022 low of 12.5%. TABLE 6.07.B, *supra* note 148. In July and August, it was still 31.2% and 28.4%, relatively high. *Id.* Similarly, in 2023, in July, the peak was 31.1%, and 29% in August, compared to 13.7% in December. *Id.*

150. *Id.* In 2023, the wind capacity was above 40% in February through May, and November. *Id.* In 2023 it was above 40% in February through April. *Id.* In 2022, July and August, two of the hottest months, had wind capacity factors of 28.6% and 24%. *Id.* In 2023, July and August were 25.9% and 26.4%. *Id.*

151. *Top 10 Things You Didn't Know About Offshore Wind Energy*, U.S. DEP'T OF ENERGY (Aug. 21, 2024), https://www.energy.gov/eere/wind/articles/top-10-things-you-didnt-know-about-offshore-wind-energy.

152. While solar and wind complement each other in a broad scale, they cannot form the basis of a stable system without storage since there are gaps between when each is active. This mismatch between generation and demand has led to calls for stronger regulation in renewable credits. *See* Aagaard, *supra* note 128, at 573 ("Existing renewable energy policies and markets thus treat renewable energy as largely fungible, allowing consumers to 'use' renewable energy even if the renewable energy they purchase was generated months earlier or later and therefore could not have been the electricity the consumer actually used.").

153. This is also true for smaller scale community renewable projects that are located in the middle of the established grid, as opposed to the more removed utility scale farms.

154. *Grid-Connected Renewable Energy Systems*, U.S. DEP'T OF ENERGY, https://www.energy.gov/energysaver/grid-connected-renewable-energy-systems (last visited Apr. 28, 2025).

which can be the responsibility of the homeowner as part of the solar panel installation.[155]

The physical grid itself, including substations and other equipment components, also need to be upgraded to handle a bidirectional load that can fluctuate significantly from moment to moment.[156] The electrical supply is maintained as a specific frequency and voltage, deviations from which can destabilize the grid unless properly managed.[157]

Finally, both large solar and wind farms are often located far from major population areas, necessitating that very long, expensive, transmission lines be built.[158] These lines are particularly expensive because they must be built for a significantly higher capacity than will generally be sent over them, since renewables operate at a much lower capacity level than traditional base plants (produce electricity only a fraction of the time, and only for a portion of their maximum rating when production is occurring). Recently installed wind farms have an average capacity factor of 40%, meaning if the farm is a 100MW farm it would, on average, produce 40,000 kWh each hour.[159] The problem, is that it does not consistently produce the same amount each hour, the amount being produced is constantly changing, up to a maximum of 100,000 kWh each hour. A transmission line built to capture the maximum load would therefore rarely be operating at full capacity. Conversely, a line built to transmit no more than 80 MW would have a greater portion of the capacity used when the wind farm was producing up to 80

155. *Id.*

156. PRITHPAL KHAJURIA & DEAN SAMARA-RUBIO, THE POWER OF INFRASTRUCTURE MODERNIZATION: ENVISIONING AN "INTELLIGENT EDGE" FOR POWER SECTOR DIGITALIZATION 3-4 (2021), https://gridwise.org/wp-content/uploads/2021/09/Power-of-Infrastructure-Modernization-Ebook.pdf (noting that substations have become bottlenecks, in part because many of them were built using outdated proprietary hardware); *see also* Chris de Morsella, *Renewable Energy Has a Variability Problem*, GREEN ECON. POST, https://web.archive.org/web/20230203003341/http://greeneconomypost.com/renewable-energy-variability-problem-12006.htm (last visited Apr. 29, 2025); Amy L. Stein, *Reconsidering Regulatory Uncertainty: Making A Case for Energy Storage*, 41 FLA. ST. U.L. REV. 697, 711 (2014) (discussing the benefits of batteries to assist with "voltage spikes, sags, momentary outages, and harmonics").

157. Flywheels and supercapacitors can be used to help maintain the frequency, as they can hold sufficient power in reserve that can be immediately available. *See generally* Weiming Ji et al., *Applications of Flywheel Energy Storage System on Load Frequency Regulation Combined with Various Power Generations: A Review*, RENEWABLE ENERGY, Jan. 10, 2024 (discussing the use of flywheels to meet the new frequency control demands). Voltage regulators and capacitors can also be required to maintain the voltage. *See generally* Kamel Alboaouh & Salman Mohagheghi, *Voltage, Var and Watt Optimization for a Distribution System with High PV Penetration: A Probabilistic Study*, ELEC. POWER SYS. RSCH., Dec. 18, 2019 (discussing the additional challenge of voltage regulation with rooftop solar panels and methods to address it).

158. David Gelles, *It's All About the Grid: Billions of Dollars in New U.S. Funding Won't be Enough*, N.Y. TIMES: CLIMATE FORWARD (Oct. 31, 2023), https://www.nytimes.com/2023/10/31/climate/its-all-about-the-grid.html (noting that the Department of Energy says high voltage transmission lines may need to expand by up to two thirds to bring in power from distant sites of production to population centers). The time needed to build the line is also a problem. Elizabeth Burleson, *Wind Power, National Security, and Sound Energy Policy*, 17 PENN ST. ENV'T L. REV. 137, 148 (2009) ("While wind farms can be built in a year and a half, transmission line expansion can require a decade.").

159. U.S. DEP'T OF ENERGY, LAND-BASED WIND MARKET REPORT: 2021 EDITION 31 (2021), https://www.energy.gov/sites/default/files/2021-08/Land-Based%20Wind%20Market%20Report%202021%20Edition_Full%20Report_FINAL.pdf [hereinafter LAND-BASED WIND MARKET REPORT].

MW, but would be unable to take full advantage when the wind farm was producing at the full 100 MW. In a situation where the line was built at 80 MW, if the farm produced more than that, the excess would have to be curtailed (not transmitted or used) unless storage were somehow available.[160]

The capacity factor for recent wind projects higher than the overall wind capacity, which is around 35%.[161] This is still better than that of solar, which is closer to 25% (solar cannot produce anything at night and produces most efficiently only in the middle of the day).[162]

These broader grid updates are paid for by the customers of the utility, through charges that generally depend on the amount of electricity used.[163] A customer with net metering, and consequently little billed electrical use, is also paying a much smaller portion of this increased charge.[164] Nor will they fully pay for the costs due to the ramping the solar power necessitates, as the following section explains.

2. Additional Costs Placed on Existing Power Plants

Adding renewables to the system requires more than simply upgraded infrastructure, it also changing the demands on the existing power plants, as they are now required to be able to react in real time to the varying intermittent power from renewables. This increases the costs for the plants that are able to make this transition and increases costs for utility customers for plants that cannot make the required changes, as this section discusses.

a. Increased Wear and Costs from Ramping

The ability to quickly ramp production up and down is increasingly critical for the longevity of fossil fuel power plants in a system with a significant amount of variable renewable energy. This makes traditional ramping power plants a critical component of the grid. It also means that in some cases what were previously baseload plants have been repurposed to makeshift ramping plants.[165] Power

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160. The obvious solution to this is to build storage as part of the renewable plant itself to enable a consistent power output. This increases the utility of the plant but also adds to the cost, in part because the cheapest form of stored energy, pumped hydro, is only possible in locations where two massive reservoirs can be built at different heights. Batteries, while growing cost competitive for peaking plants, are still significantly more expensive than pumped hydro.

161. *Compare* LAND-BASED WIND MARKET REPORT, *supra* note 159, at 31 (showing the overall wind capacity factor at 36%), *with What is Generation Capacity?*, U.S. DEP'T OF ENERGY (Mar. 30, 2025), https://www.energy.gov/ne/articles/what-generation-capacity (showing a wind capacity factor of 34.3%).

162. *See What is Generation Capacity?*, *supra* note 161 (providing a capacity factor of 23.4% for solar projects).

163. Alexandra B. Klass, *Regulating the Energy* "*Free Riders*", 100 B.U. L. REV. 581, 607 (2020) ("Costs associated with maintaining the electric grid are primarily recovered from customers through volumetric rates, if solar owners are now purchasing 50-80% less electricity each year but the utility still needs to maintain the same level of grid service for when the sun is not shining, the utility will need to raise rates since they are selling less power overall. When those rates go up, the increase will be disproportionately borne by non-solar owners.").

164. *Id.*

165. JAQUELIN COCHRAN ET AL., FLEXIBLE COAL EVOLUTION FROM BASELOAD TO PEAKING PLANT 3 (2013), https://www.nrel.gov/docs/fy14osti/60575.pdf.

plants not originally designed for ramping experience significantly mechanical stress when forced to ramp frequently.[166] This leads to accelerated wear and tear on critical components, necessitates increased inspections, and can shorten the life of the plant (or end it prematurely, if ramping is not possible).[167]

Even plants that are designed to ramp are not necessarily designed to do so as quickly as demanded under a grid with heavy renewable penetration.[168] This, too, can lead to increased wear as well as reduced efficiency and higher fuel usage.[169] In no case is a ramping plant more efficient than a similar fueled plant built and running as a baseload plant. Requiring more fuel both increases the cost of the electricity produced and the pollution produced by the plant. As the traditional ramping plants are the ones most likely to be located near highly populated areas, increasing the use of these means this additional pollution is going to cause the most comparative harm to human health.[170]

Solar homeowners can feel that the power they are receiving from the utility at times their system is not producing electricity is clean, to the extent it balances out the extra they put into the grid earlier. Without storage, however, they are instead getting particularly polluting power in return. While in many cases the overall climate effect will still be lessened by running a ramping plant less than the baseload would have been before the addition of the renewables, that is not true in every case.[171] It is also likely going to be more expensive, as the following section explains.

b. Premature Retirement if Plants Cannot Ramp

Many of the current power plants in operation were built long before renewables became a significant part of the energy market and were designed for the electrical grid described in Section III.A, where baseload plants work continuously to produce large quantities of power.[172] However, the transition to renewables has meant that plants that cannot adapt to flexibly meet the varying demand are no longer economically feasible.

If the plant was owned by the utility, as is the case in a vertically integrated utility, the cost of this early closure will need to be borne by the utility.[173] In

166. *Id.*

167. *Id.*

168. Nathaniel Pearre & Lukas Swan, *Reimagining Renewable Electricity Grid Management with Dispatchable Generation to Stabilize Energy Storage*, ENERGY, July 15, 2020, at 1 ("[C]onsiderations of controlling thermal stress and operating conditions in combustion even limit small recuperating gas turbines, traditionally thought of as being the fastest responding conventional generation.")

169. *Id.*

170. INFORMATION ON PEAK DEMAND POWER PLANTS, *supra* note 77, at 1 (noting that peakers generally are not only less efficient, but they are also less likely to have pollution controls).

171. *Id.* at 5 (Comparing the emissions of sulfur dioxide and nitrogen dioxide from peaker and non-peaker plants and showing how much higher peaker emissions are).

172. The average coal plant was 47.2 years old in 2023. *See* Metin Celebi et al., *A Review of Coal-Fired Electricity Generation in the U.S.*, BRATTLE 18 (Apr. 27, 2023), https://www.brattle.com/wp-content/uploads/2023/04/A-Review-of-Coal-Fired-Electricity-Generation-in-the-U.S..pdf.

173. This is a particular problem with old coal plants and has led to some interesting accounting actions.

situations where the plant was still making loan payments for the construction cost, that schedule is often sped up significantly, and this cost will need to be paid by the utility, without the financial benefit power produced by that plant would have brought in.[174] This is most common with coal, although not exclusively. The forced early retirement of coal plants can seem like an environmental win, but it is a win with a significant financial cost attached.[175] There are also planned closures that have had to be postponed or cancelled altogether, as the following section explains.

C. The Added Pressure from Data Centers

Data centers are putting an unprecedented strain on the power system. This section explains why this has been such an unexpected surprise and how most companies cannot simply buy their way to entirely green power.

1. Artificial Intelligence has Far Outpaced Previous Energy Predictions

Power demands were fairly predictable for decades.[176] This made it easy for utilities to do their required predictions years if not decades into the future.[177] In 2021, utilities remained confident that they could reliably forecast demand, even with the push to move households to heat pumps and electric cars, both of which would add to electrical demands.[178] Since 2022, however, when artificial intelligence (AI) models burst onto the scene, electrical demands have increased far faster than expected.[179]

Ron Lehr, *How arcane accounting rules could help save coal-heavy utilities*, UTIL. DIVE (May 15, 2019), https://www.utilitydive.com/news/how-arcane-accounting-rules-could-help-save-coal-heavy-utilities/554773/ (cross to revivals of plants due to increased demand).

174. *Id.* Those in favor of the move to clean energy argue that the increased costs this imposes have slowed down the move to renewables. *Id.*

175. Coal is more polluting than natural gas when being burned to produce electricity. However, if these old plants are replaced not with storage but instead with new gas plants that will be expected to run for decades, we are not necessarily closer to a zero emissions grid, and at a significant financial cost. This choice has not been lost on regulators, who have in some instances refused to allow the replacement of a coal plant with a natural gas plant to avoid the locked in cost of the new gas plant. *See* Devashree Saha, *Natural Gas Beat Coal in the US. Will Renewables and Storage Soon Beat Natural Gas?*, WORLD RES. INST. (July 8, 2019), https://www.wri.org/technical-perspectives/natural-gas-beat-coal-us-will-renewables-and-storage-soon-beat-natural-gas.

176. Cy McGeady, *Strategic Perspectives on U.S. Electric Demand Growth*, CSIS (May 20, 2024), https://www.csis.org/analysis/strategic-perspectives-us-electric-demand-growth (describing the different phases of electrical demand growth in the US, including a period of little growth for the fifteen years before the rise of AI).

177. *Id.*

178. *See, e.g.*, ELLA ZHOU & TRIEU MAI, NAT'L RENEWABLE ENERGY LAB'Y, ELECTRIFICATION FUTURES STUDY: OPERATIONAL ANALYSIS OF U.S. POWER SYSTEMS WITH INCREASED ELECTRIFICATION AND DEMAND-SIDE FLEXIBILITY, at ix (2021), https://www.nrel.gov/docs/fy21osti/79094.pdf (confidently predicting power demands until 2050).

179. Delger Erdenesanaa, *A.I. Could Soon Need as Much Electricity as an Entire Country*, N.Y. TIMES (Aug. 23, 2024), https://www.nytimes.com/2023/10/10/climate/ai-could-soon-need-as-much-electricity-as-an-entire-country.html (looking at the difference in expected energy demand less than a year after chat gpt was released).

The data centers that power AI are enormous power drains. Data centers operate twenty-four hours a day and require large amounts of constant power.[180] The power requirement goes up further if the machines must be cooled with electricity rather than water.[181]

A single data center can require as much power as a city but be up and running in less than two years, making planning hard in the traditionally slow moving utility sector.[182] In states that are heavily recruiting data centers, power demands are escalating rapidly. Virginia, the top data center state, will need to add as much power as all of New Jersey uses by 2040.[183] There are already repercussions to the need to add power this quickly. A recent power auction in the mid-Atlantic will result in double-digit price increases for consumers this year, and potentially an additional $40-50 per month after the next auction if it goes as expected.[184]

This surge in power demand has led to a rollback in planned plant closures, including some of the most polluting,[185] as no alternatives exist to meet the electricity demand. Almost one third of the expected coal plant retirements are being pushed back, in some cases indefinitely so.[186] This is true even if there might be sufficient production elsewhere, as the electricity not only needs to be produced,

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180. Brad Plumer & Nadja Popovich, *A New Surge in Power Use Is Threatening U.S. Climate Goals*, N.Y. TIMES (Mar. 14, 2024), https://www.nytimes.com/interactive/2024/03/13/climate/electric-power-climate-change.html.

181. Sean Patrick Cooper, *Noisy, Hungry Data Centers Are Catching Communities by Surprise*, N.Y. TIMES (Sept. 15, 2024), https://www.nytimes.com/2024/09/15/opinion/data-centers-ai-amazon-google-microsoft.html ("People who live near one Northern Virginia center have complained that the mechanical whir of the fleet of industrial fans needed to cool the sensitive computer equipment inside can sound like a leaf blower that never turns off.") The choice on how to cool the center could be due to heat pollution in the water, a financial decision, or it could be simply a total lack of water, like the data centers proliferating in Arizona.

182. This slow movement is one reason why a plant may be kept open even if it is not yet needed. *See* Evan Halper & Caroline O'Donovan, *As Data Centers For AI Strain The Power Grid, Bills Rise For Everyday Customers*, WASH. POST (Nov. 1, 2024), https://www.washingtonpost.com/business/2024/11/01/ai-data-centers-electricity-bills-google-amazon/ ("The Sierra Club, an environmental organization, warns that utility Georgia Power's plans to extend the life of fossil fuel plants to serve data centers is leaving other customers burdened with a bill of potentially tens of millions of dollars. It points in a regulatory filing to substantial payments required to keep a Mississippi coal plant from shutting down before unfinished data centers start using the power.").

183. *Id.* The newly recruited data "centers alone are projected to increase demand for power up to 50 percent by 2030." *Id.*

184. In the PJM Interconnection, which serves thirteen states and DC, the most recent power auction resulted in an 800 percent increase in the price for power during extreme weather and demand, which will translate to bill increases of ten to nearly 20 percent this year, as no additional supply was available. *Id.*; *see also* discussion about the PJM interconnection *supra* note 114.

185. N.Y. ISO, 2024 RELIABILITY NEEDS ASSESSMENT (RNA) 25 (2024), https://www.nyiso.com/documents/20142/2248793/2024-RNA-Report.pdf/0fe6fd1e-0f28-0332-3e80-28bea71a2344 (stating that peaker plants serving New York City will continue in use past their intended retirement to ensure sufficient capacity in the network).

186. Austyn Gaffney & Mira Rojanasakul. *Which Coal Is Retiring, and Hanging On, in the U.S.*, N.Y. TIMES (Feb. 6, 2025), https://www.nytimes.com/interactive/2025/02/06/climate/coal-plants-retirement.html.
This is also likely due, in part, to the expected rollback of environmental regulations that encouraged coal plant retirement before 2032. *See* Dan Gearino, *Has Trump Changed the Retirement Plans for the Country's Largest Coal Plants?*, INSIDE CLIMATE NEWS (Jan. 16, 2025), https://insideclimatenews.org/news/16012025/inside-clean-energy-trump-coal-plant-retirement-plans/.

it must be transmitted to where needed, and transmission is a major bottleneck.[187] This is also not a problem that a company can unilaterally solve through contract, as the following section explains.

2. Limits to Green Power Purchasing

Energy hungry businesses, including data centers, sometimes say they run entirely on green energy.[188] A business can make this claim by buying renewable energy credits or pay a provider extra to ensure that an equivalent amount of their electricity use is from renewables,[189] similar to how individuals can participate in green power programs, described in Section II.C.3.a. However, these purchases do nothing to ensure that fossil fuels are not required to supply the business. As discussed in Section IV.A, renewables do not run continuously. Data centers, however, do.[190] A data center could buy renewable energy credits for enough solar power to meet all of the demand for the entire data center.[191] However, that solar power will be produced based on the strength and angle of the sun when the sun is out or when the wind is blowing.[192] A business in New York City may buy enough credits to offset all of its electrical use, but if it is running during the evening peak, the energy running it will include the highly polluting peaker plants needed to meet the peak demand.[193]

This is particularly true if the renewable credit is paid to a faraway power source, such as that New York City business purchasing credit from a physically separate grid in the Midwest. The power purchased cannot actually help ease the local load the business is relying on. In fact, a lack of sufficient transmission capacity also caps the ability to fully integrate renewables in the Midwest into the grid on the energy-hungry East Coast.[194]

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187. Kevin Clark, *Delaware's last coal plant to close ahead of schedule*, FACTOR THIS POWER ENG'G (Dec. 30, 2024), https://www.power-eng.com/coal/delawares-last-coal-plant-to-close-ahead-of-schedule.

188. An early example was Google. *See, e.g.*, Urs Hölzle, *We're set to reach 100% renewable energy — and it's just the beginning*, GOOGLE: THE KEYWORD (Dec. 6, 2016), https://blog.google/outreach-initiatives/environment/100-percent-renewable-energy/ ("[W]e'll be directly buying enough wind and solar electricity annually to account for every unit of electricity our operations consume, globally.").

189. *Id.* Google is still in the process of moving away from this model. *See, e.g.*, Urs Hölzle, *Four consecutive years of 100% renewable energy — and what's next*, GOOGLE CLOUD: BLOG (Apr. 20, 2021), https://cloud.google.com/blog/topics/sustainability/google-achieves-four-consecutive-years-of-100-percent-renewable-energy ("Though we're thrilled to have matched Google's annual electricity consumption with renewable energy for four years running, we're now building on our progress to target an even larger ambition: by 2030, Google aims to run on entirely 24/7 carbon-free energy, everywhere we operate. As we discuss in a new explainer, achieving this goal means shifting away from a net-zero model of "emit and compensate" and instead targeting "absolute zero," where we simply never emit carbon from our operations in the first place.").

190. *See, e.g.*, Plumer & Popovich, *supra* note 180.

191. This is what Google was describing in *supra* note 188.

192. The intermittent nature of renewables is discussed in *supra* Section IV.A.

193. Isabel O'Brien, *Data center emissions probably 662% higher than big tech claims. Can it keep up the ruse?*, GUARDIAN (Sept. 15, 2024), https://www.theguardian.com/technology/2024/sep/15/data-center-gas-emissions-tech ("[T]he renewable energy in question doesn't need to be consumed by a company's facilities. Rather, the site of production can be anywhere from one town over to an ocean away.").

194. *See* Will Englund, *Plug-in cars are the future. The grid isn't ready*, WASH. POST (Oct. 16, 2021), https://www.washingtonpost.com/business/2021/10/13/electric-vehicles-grid-upgrade/ (describing how the

This is similar to the fallacy described in Section IV.A.1.c that leads solar homeowners to believe that the electricity they use at night is as environmentally friendly as the electricity they produced but did not use during the day.

A business paying to offset twenty-four hour use with power produced during the solar power peak helps provide a subsidy to renewables, but does not solve their integration into the grid, and can even add to the problem if storage is not available. Unless a company has a direct link to the renewable power source, and that source has sufficient storage capacity to actually supply the data center, it cannot actually be running entirely on green energy. This is because the only way to address the mismatch between supply and demand timing is through batteries, as the next section explains.

D. Batteries Are Necessary to Fully Transition to Renewables

Addressing climate change will require widespread replacement of fossil fuel-based appliances and transport with fully electrical equivalents.[195] While electric cars now are already more fuel efficient than internal combustion cars, even if the electricity comes from fossil fuels itself, the ultimate goal is electrical supply fed by renewables.[196]

This is impossible without batteries. This section explains why they will be so crucial to help smooth out the issues with renewables as well as the benefits individual homeowners can get from installing batteries and the significant cost difference between residential and utility scale batteries.

1. The Crucial Role of Batteries

This section explains how batteries reduce the amount of electricity that must be generated at the peak time thereby reducing reliance on peaker plants.

a. Peak Shaving and Load Shifting

In areas where air condition is essential, the peak electrical demand is generally late afternoon in the summer, hours after the solar production peak, as explained in Section IV.A.1. This creates a mismatch between when solar energy is being generated and when it is most needed. Batteries play a crucial role in addressing this gap by allowing the excess midday energy to be stored for later use

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transmission lines in New York State are already congested half the time); *see also* Plumer & Popovich, *supra* note 180 ("Nationwide, just 251 miles of high-voltage transmission lines were completed last year, a number that has been declining for a decade.").

195. Nadja Popovich & Brad Plumer, *How Electrifying Everything Became a Key Climate Solution*, N.Y. TIMES: CLIMATE (Apr. 14, 2023), https://www.nytimes.com/interactive/2023/04/14/climate/electric-car-heater-everything.html.

196. DAVID REICHMUTH ET AL., UNION OF CONCERNED SCIENTISTS, DRIVING CLEANER: ELECTRIC CARS AND PICKUPS BEAT GASOLINE ON LIFETIME GLOBAL WARMING EMISSIONS 8 (2022), https://www.ucs.org/sites/default/files/2022-07/driving-cleaner-report_0.pdf ("Everywhere in the country, driving the average EV results in lower emissions than the average new gasoline vehicle. Over 90 percent of the people in the country live in places where driving the average EV has a higher MPGghg, and thus produces lower emissions, than the most efficient gasoline vehicle (59 mpg).").

during the peak, thereby reducing strain on the grid.[197] Given the intermittent nature of renewables, a transition to entirely green energy is impossible without sufficient battery storage capacity to bridge the difference between the supply and demand peaks.

Even without solar panels, batteries can be used on their own to perform the same function, charging during off peak times when the electrical rate is low and discharging when the rate is higher.[198] This practice, called load shifting, can enable utilities to meet the later afternoon demand with reduced reliance on expensive peaker plants, as the following section expands on.[199]

b. Grid Stability and Reduced Reliance on Peaker Plants

Batteries help manage the transition period between the solar peak and the demand peak, the point of steepest ramping for peaker plants, as well as the differential between the peak of wind production in the night and the increased demand during the day. Peaker plants have traditionally been required to run during periods of high demand, but if this demand can instead be met with previously produced and stored energy, the demand on the peakers (often the most expensive electricity the utility will obtain) will be reduced, both saving money and reducing pollution.

Recognizing this potential, some utilities have already begun planning to replace peaker plants with large-scale battery systems.[200] While these retirements are not always possible due to the increase in demand from artificial intelligence, as described in Section IV.C, batteries are still a critical component of the energy supply.

2. Residential Battery Installation Benefits to Homeowners

Batteries can significantly add to the cost of a solar panel installation, but they provide two potential benefits. The following sections explain how batteries can enable a house to function independently of the grid during a power outage and how they can also enable the homeowner to get a higher payment for electricity exported to the grid.

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197. Amandeep Kaur, *Batteries + Storage: The Implications of Integrating A Battery Energy Storage System into Renewable Energy Power Purchase Agreements*, 7 OIL & GAS, NAT. RES. & ENERGY J. 911, 920 (2022) (explaining the benefits of a battery energy storage system).

198. *Id.*

199. The fire in January 2025 at a massive battery storage facility may have repercussions for the move towards the required battery storage. *See* Dan Gearino, *Making Sense of the Giant Fire that Could Set Back Energy Storage*, INSIDE CLIMATE NEWS (Jan. 23, 2025), https://insideclimatenews.org/news/23012025/inside-clean-energy-moss-landing-battery-storage-fire/.

200. Nicolás Rivero & Emily Wright, *These batteries could harness the wind and sun to replace coal and gas*, WASH. POST (Nov. 26, 2024), https://www.washingtonpost.com/climate-solutions/interactive/2024/flow-batteries-renewable-energy-storage/ (describing not only the deployment of lithium ion batteries but also the potential for flow batteries to also help the transition).

a. Self-Sufficiency and Resilience

One surprise to many people looking to add solar panels to their house is that solar panels alone will not be able to supply the house with electricity if the power is otherwise out.[201] In some locations, however, that is not true if the house has batteries.[202]

These batteries will therefore have a double benefit. Not only can a house run on solar power during the day when the power is otherwise out, but the extra power stored in the battery can enable the house to continue running after the sun goes down as well.

Concern over self-sufficiency seems to have particularly driven a boom in solar in Texas after a winter storm in 2021 with extremely low temperatures froze gas wellheads and windmills.[203] This cut off power to some houses for days and resulting in hundreds of deaths.[204] In some states, therefore, this feature alone will likely be enough to encourage homeowners to get batteries. However, payment by the utility for extra power generated can also be structured in such a way that the payoff for a system with batteries is faster than the payoff for a system without batteries, as the following section explains.

b. Improved Payback Time Under Some Metering Methods

Utilities structure payment to solar homeowners in different ways, as described in Section IV.A.1.b. As described in Section IV.A.1, demand for electricity peaks hours after the solar production peak. If a homeowner sends power to a utility during the demand peak rather than forcing the utility to take it during the production peak, the power is far more beneficial to the utility.

Enabling the utility to value (and pay for) received solar at the true value to the utility at that point in time means that homes with batteries can send power to the grid during the true peak, when it is most needed and the utility is willing to pay more for the power, rather than during the production peak when supply is so great some utilities will not connect additional customers.[205] The cost differential can be great enough that a system with batteries will be paid off faster than one without, despite the significant additional cost of the batteries.[206]

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201. Hannah Glenn, *Can I Use Solar Panels Without Battery Storage?*, SOLAR (Mar. 21, 2025), https://www.solar.com/learn/can-i-use-solar-panels-without-a-battery ("[S]olar owners without battery storage draw power from the grid, which acts as a giant energy backup system.").

202. *Id.* (describing "a growing number of scenarios where having a solar battery bank is beneficial, if not completely necessary.").

203. Sara DiNatale, *'Rinse, wash, repeat': How Texas' solar energy boom victimized thousands of homeowners*, SAN ANTONIO EXPRESS-NEWS (Nov. 10, 2024), https://www.expressnews.com/news/article/solar-energy-scams-loans-texas-winter-storm-uri-19868542.php (describing how Winter Storm Uri led many homeowners to look more seriously at solar).

204. *Id.*

205. LEDERER & KUSHNER, *supra* note 64, at 14 ("These are zones where new solar systems are not allowed to connect to the grid or there are rules that limit the amount of energy the grid will accept.").

206. *California's NEM 2.0 vs NEM 3.0: A Comprehensive Comparison*, EXRO, https://www.exro.com/industry-insights/california-net-energy-metering-policies (last visited Apr. 28, 2025) ("The transition from NEM

The same incentive structure will work if the cost for electricity the homeowner must pay is high enough that it is worth it for the homeowner to save electricity to be able to self-consume during the demand peak rather than draw from the utility at that point in time.

Utilities will also discuss the idea of virtual power plants, or groups of batteries situated in different houses that the utility controls and can tap when needed during peak demand periods.[207] Given the cost differential between residential and utility scale installations, this is likely not the most financially effective method to obtain this backup power. While it does provide security benefits for the individual homeowner, the cost difference is significant, as the following section explains.

3. Utility Scale Batteries are Significantly Cheaper

Energy storage will be critical to truly transition the grid to renewables to fix both the mismatch between peak production and demand and the fluctuating production that are inherent in solar and wind. Residential batteries can add resilience to the grid, particularly when the utility also has control over the battery; residential batteries are often of particular value to the homeowner for self-sufficiency. However, residential batteries are also significantly more expensive than utility scale batteries. Utility scale batteries are now closer to 1/6 to 1/10 the cost of residential batteries.[208] This is due to the tremendous difference in scale. Not only can the utility buy in bulk, it can also install and service the unit in bulk. The extra time needed to select, install, and certify each residential unit means residential will always be significantly more expensive. As an example, in 2024, the estimated cost for residential batteries was roughly $1000 per kWh.[209] This is compared to a utility scale cost of $148 per kWh.[210] The current tax credit intended to encourage individuals to invest in renewables is 30% of the cost — 30% of $1000 is $300.[211] This means that for the cost of a tax subsidy to a homeowner an integrated utility could instead have full control and benefit from more than twice the battery capacity.

Those most concerned about a transition away from fossil fuels towards a sustainable future should therefore be pushing to pour all possible resources into

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2.0 to NEM 3.0 in California marks a significant shift in solar energy policy, primarily by . . . significantly increase[ing] the value of battery energy storage systems . . . as it incentivizes solar system owners to store excess energy for later use rather than exporting it at lower rates.”).

207. This is what Tesla Electric is trying to do in Texas. *See, e.g.*, *Tesla Electric Virtual Power Plant Pilot with ERCOT*, TESLA, https://www.tesla.com/support/energy/virtual-power-plant/tesla-electric (last visited Apr. 28, 2025).

208. *Comparing* the per kWh cost of home batteries in *infra* note 209, *with* the cost of utility scale batteries in *infra* note 210.

209. Mike De Socio, *How Much Does a Home Battery Cost?*, CNET (Aug. 16, 2024), https://www.cnet.com/home/energy-and-utilities/how-much-does-a-home-battery-cost/ (providing a range of $1,000-1,500 but also providing examples where the cost would go under $1000 in some instances).

210. Cameron Murray, *BESS prices in US market to fall a further 18% in 2024, says CEA*, ENERGY STORAGE NEWS (Feb. 7, 2024), https://www.energy-storage.news/bess-prices-in-us-market-to-fall-a-further-18-in-2024-says-cea/.

211. *Energy Efficient Home Improvement Credit*, *supra* note 66.

utility scale renewables and storage, enabling the cost savings to benefit all customers rather than providing a partial offset for those earning enough to take advantage of the tax credits (which, as discussed in Section II.C.3, will generally not be families experiencing energy poverty).

While this makes it appear that the tax credit is therefore not being used in the most efficient manner, this does not automatically harm families in energy poverty, as they are not being forced to directly subsidize those purchases. However, payments coming from the utility rather than the federal government do directly impact everyone, as the following section explains.

V. Utility Solar Costs and Payment Policies Impact All Utility Customers

A. Overpayments for Solar Increase Costs for All Other Customers

Utilities are entirely funded by the fees paid by customers.[212] Any extra money the utility pays out to some customers — such as those with solar panels — will therefore be coming directly from the other customers of the utility. Families in energy poverty are highly likely to be in the group that does not have solar, since, as discussed in Section II.C.3, it is likely to not only be expensive in general terms, but more expensive for a poor family than a rich family that can fully take advantage of the tax credit and obtain better financing terms if needed. When utilities are required to purchase solar at rates that do not reflect its true value to the system, costs for everyone else rise, including those who can least afford to pay. It is for this reason that states should adopt variable rate net billing, as described in the following section.

B. States Should Use Variable Net Billing

Overpayments to families with solar, who are already likely better off, take money away from other customers of the utility. To ensure this does not happen, homeowners should be compensated based on the value of their power at the time it is fed to the grid, using variable rate net billing as discussed in Section IV.A.1.b.ii.

Allowing utilities to pay for the real time value of solar helps ensure that extra money is not going to families with solar. It also allows solar families to better understand the true value of the electricity. While the electrons are identical at any time of day, their value to the grid is not. This can both enable families to shift usage to help reduce the peak as well as consider investing in energy storage, so that they can either self-consume a greater amount of the self-generated power or feed it to the grid when it is actually useful to the grid. These incentives make

212. *See generally* ELIZA MARTIN & ARI PESKOE, HARV. L. SCH., EXTRACTING PROFITS FROM THE PUBLIC: HOW UTILITY RATEPAYERS ARE PAYING FOR BIG TECH'S POWER (2025), https://eelp.law.harvard.edu/wp-content/uploads/2025/03/Harvard-ELI-Extracting-Profits-from-the-Public.pdf (arguing how the traditional funding structure of utilities forces regular ratepayers to subsidize the increased costs of providing the ever growing power demand to data centers). This is true whether it is a nonprofit aiming to cover operational costs or an investor-owned utility seeking a reasonable rate of return in the most common utility model.

a difference. A national labs report found that when California shifted from net metering to metering that better reflected the value of the electricity, the number of systems being installed with batteries went from around 10% to close to 60%.[213]

As states continue to move away from net metering over the concerns about cost shifting discussed in this section and the prior section, the industry continues to push back. However, much of the industry literature relies on studies from the 2010s, when solar was a small enough percentage of the market that any difference would be negligible, and the projections assumed relatively low growth.

For instance, on April 18, 2024, a pro solar group correctly stated that a "report from the Lawrence Berkeley National Laboratory finds that even a dramatic increase in rooftop solar adoption would have minimal impact on utility rates."[214] However, that report is from 2014, and was looking at increases from the then current overall U.S. penetration rate of .2%.[215] Another National Labs report from 2017 still estimated the impact of distributed solar on far lower solar penetration rates than have been observed.[216] For instance, by 2030, it expected only that "three states within the contiguous U.S. [would] surpass 10% penetration by 2030"[217] As of 2025, however, six states had already surpassed it, with at least three more about to. This includes not merely very sunny states, like California and Nevada but also less expected states like Massachusetts and Maine.[218]

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213. GALEN BARBOSE, LAWRENCE BERKELEY NAT'L LAB'Y, ONE YEAR IN: TRACKING THE IMPACTS OF NEM 3.0 ON CALIFORNIA'S RESIDENTIAL SOLAR MARKET 9 (2024), https://eta-publications.lbl.gov/sites/default/files/ca_nem_3.0_technical_brief.pdf. While some have questioned whether residential batteries do much to ease the load on the grid and found that it would be better for the utility to control the batteries as a virtual power plant than for the homeowner to rely solely on excess solar, there is little dispute that if there is going to be widespread solar, batteries are better than no batteries. *New Berkeley Lab research explores implications of residential storage for net metering reforms*, ENERGY MKTS. & POL'Y: BERKELEY LAB (July 27, 2022), https://emp.lbl.gov/news/new-berkeley-lab-research-explores (finding that allowing discharge to the grid during high value times would provide greater value for the grid). There is an experiment in Texas with Tesla's energy company that draws from customers batteries based on the price of electricity and pays proportionately. *Tesla Electric Virtual Power Plant Pilot with ERCOT*, *supra* note 207.

214. *Net Metering: What You Need To Know*, *supra* note 140.

215. ANDREW SATCHWELL ET AL., LAWRENCE BERKELEY NAT'L LAB'Y, FINANCIAL IMPACTS OF NET-METERED PV ON UTILITIES AND RATEPAYERS: A SCOPING STUDY OF TWO PROTOTYPICAL U.S. UTILITIES 18-19 (2014), https://eta-publications.lbl.gov/sites/default/files/lbnl-6913e.pdf.

216. *See generally* GALEN BARBROSE, LAWRENCE BERKELEY NAT'L LAB'Y, PUTTING THE POTENTIAL RATE IMPACTS OF DISTRIBUTED SOLAR INTO CONTEXT (2017), https://eta-publications.lbl.gov/sites/default/files/lbnl-1007060.pdf.

217. *See, e.g.*, *id.* at 11.

218. CHOOSE ENERGY, SOLAR ENERGY GENERATION BY STATE REPORT MAY 2025 (May 1, 2025), https://www.chooseenergy.com/solar-energy/solar-energy-production-by-state/. California and Nevada were at 28.6% and 24.8% respectively, while Massachusetts and Maine were at 18.9 and 12.5%, respectively. *Id.*

Similarly, another page from May 3, 2024, referenced a Brookings report from 2016 that is said found "that net metered rooftop solar is a net benefit to all ratepayers." *The value of solar for everyone*, SOLAR UNITED NEIGHBORS (May 3, 2024), https://solarunitedneighbors.org/resources/the-value-of-solar-for-everyone/ (citing Mark Muro & Devashree Saha, *Rooftop solar: Net metering is a net benefit*, BROOKINGS (May 23, 2016), https://www.brookings.edu/articles/rooftop-solar-net-metering-is-a-net-benefit/).

They will also dramatically simplify the issue, setting up straw man arguments such as "Rooftop solar users generate their own electricity. Therefore, they buy less electricity from utilities. Solar owners still rely on the grid infrastructure the utility maintains. As a result, utilities claim, solar cuts into their revenue and forces

This widespread adoption means it is time to not only rethink the compensation system but also evaluate the degree to which existing customers should be grandfathered into the old rate.

C. Customers Currently Under Net Billing Should be Moved Off

Since utility rates are generally controlled by state utility boards, it is possible to change the rates received by solar homeowners.[219] States that switch will often grandfather in current beneficiaries to net metering, potentially for decades into the future, with major consequences.[220] In California, for instance, net metered homes were projected to cost other ratepayers $8.5 billion in 2024, more than double the $ 3.4 billion in 2021, despite California explicitly moving away from net metering for new homes.[221]

The first step is ensuring that if a house with net metering is sold that the new owners will benefit under the currently applicable rates, not the prior grandfathered rate.[222] The transition for currently grandfathered homeowners could also

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them to raise rates on their other customers to maintain the grid." SOLAR UNITED NEIGHBORS, THE MYTH OF THE SOLAR "COST SHIFT" AND THE TRUE VALUE OF SOLAR 1 (2021), https://solarunitedneighbors.org/wp-content/uploads/2021/01/Myth-of-the-Solar-Cost-Shift-FINAL.pdf.

The primary problem with rooftop solar is not that the utilities cannot sell customers the electricity, or the electricity the customers generate and use on site, it is customers exporting electricity at a low value time and taking electricity at a high value time without paying the difference in cost. Rooftop solar with batteries can undoubtedly be a benefit to the grid, as discussed further in *supra* Section IV.D. It would therefore be far more beneficial for the companies to "prepar[e] for the worst; expand[] into storage" Matt Powers, *Net-metering changes are sweeping the country. Here's how solar companies can prepare*, SOLAR POWER WIND (Feb. 10, 2025), https://www.solarpowerworldonline.com/2025/02/net-metering-changes-are-sweeping-the-country-heres-how-solar-companies-can-prepare.

219. Explicit permission to do this was granted by the Nevada legislature, although it was later repealed due to the outcry. *See, e.g.*, NEV. REV. STAT. ANN. § 704.7735 (Supp. 2017) (repealed 2017); *see also* No Solar Tax Pac v. Citizens for Solar & Energy Fairness, No. 70146, 2016 WL 4182739, at *1 n.1 (Nev. Aug. 4, 2016) ("[T]he new law gives discretion to the [Public Utilities Commission of Nevada] to act in the public interest, authorizing it to establish different rate classes for net metering customers . . . and to determine whether the tariff should be applied to existing net metering customers.").

220. Courtney Moran & Casey Ball, *Structuring Better Caps for Sustainability Incentive Programs*, 54 IDAHO L. REV. 177, 198 (2018) (arguing in favor of grandfathered periods for the amortization life of the panels to protect investor backed expectations and saying that the Nevada law failed because it did not have sufficient notice, respect investor backed expectations, or implement sufficiently gradual change).

221. *California rooftop solar subsidy to cost $8.5 billion a year, says ratepayer advocate*, REUTERS (Aug. 23, 2024), https://www.reuters.com/sustainability/climate-energy/california-rooftop-solar-subsidy-cost-85-billion-year-says-ratepayer-advocate-2024-08-22. These numbers have been disputed. *See, e.g.*, *How California's Rooftop Solar Customers Benefit Other Ratepayers Financially to the Tune of $1.5 Billion*, M.CUBED: ECON. OUTSIDE THE CUBE (Nov. 14, 2025), https://mcubedecon.com/2024/11/14/how-californias-rooftop-solar-customers-benefit-other-ratepayers-financially-to-the-tune-of-1-5-billion/, which the commission responded to, *see* Shelly Lyser, *Response to Claims that Rooftop Solar Creates Net Benefits for Non-Solar Customers*, PUB. ADVOCS. OFF. (Nov. 25, 2024), https://www.publicadvocates.cpuc.ca.gov/press-room/commentary/241125-nem-cost-shift-rebuttal, and was responded to in turn, *see Replying to PAO's response on its rooftop solar "cost shift" analysis*, M.CUBED: ECON. OUTSIDE THE CUBE (Jan. 31, 2025), https://mcubedecon.com/2025/01/31/replying-to-paos-response-on-its-rooftop-solar-cost-shift-analysis/.

222. This is not currently true in every state. *Compare* ARK. PUB. SERV. COMM'N, NET-METERING RULES § 2.06(E)-(F) (2023), https://arkleg.state.ar.us/Home/FTPDocument?path=%2FAssembly%2FMeeting+Attach-

be sped up.[223] Planning for a change a few years out still provides a great deal of notice.

VI. Conclusion — Utilities Should be Solar Neutral

Utilities should be solar neutral, that is, there should not be policies or practices of the utility that channel additional funds to homes with solar panels. A solar neutral approach allows utilities to support clean energy without imposing unfair costs on those who can least afford them. A key principle of solar neutrality is that utilities should not pay solar homeowners more than the true, real-time value of the electricity they contribute to the grid. Paying above market rates creates a subsidy, shifting costs onto non-solar customers, many of whom are low-income or already struggling with high energy bills.

Payments that more closely resemble the actual value of the electricity to the grid will help encourage solar households to self-consume — using storage to offset peak electrical use. This will let them provide an actual benefit to the grid rather than simply adding extra costs, as they can potentially reduce the peak demand on the system. The fact that this requires an extra cost — a battery — is more in line with the costs to the grid of providing electricity back to the house during peak demand times. There is one person who can actually save the retail cost of electricity through self-production, and that is the homeowner. It makes sense then, that the homeowner only enjoys this benefit when that electricity is used where it is produced.[224]

Losing net metering would mean that solar would likely be less financially favorable in certain locations, potentially even where it would not be expected to break even for decades if ever. That's OK. Solar should grow where it makes economic sense. States with high electricity prices and abundant sunshine, like California, will see more cost-effective installations than places like Oregon, where power is cheaper and the cloudy weather much of the year is less favorable for solar generation. Individuals in less than ideal locations can still choose to install solar panels for environmental reasons, or for the extra protection against outages. But it should not be the responsibility of other ratepayers to subsidize this. Utility funds should prioritize system-wide improvements that benefit all

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ments%2F040%2F26244%2FF.2.a+PSC+Net-Metering+Rules+and+Act+278+of+2023.pdf& ("The legacy status period shall attach to the Net-Metering Facility on the premises rather than the Net-Metering Customer. . . . If the Net-Metering Customer sells a premises with a Net-Metering Facility, the Standard Interconnection Agreement and Facilities Agreement may be transferred to the new Net-Metering Customer and the legacy status period shall continue until June 1, 2040."), *with Frequently asked questions about changes to California's rooftop solar rules (aka "NEM3")*, SOLAR RIGHTS ALL. (Oct. 1, 2024), https://solarrights.org/blog/2024/10/01/faqnem3/ (Customers on the first two net metering plans can transfer the plan with the system when they sell the house but that is no longer the case in the third version).

223. It does not need to be the entire estimated life of the panels. For instance, North Carolina is currently in a transition where current net metered customers will keep the same rate until 2027, four years after the switch. *See* MaryElizabeth Mooney, *North Carolina's new net metering policy*, ENERGYSAGE (May 24, 2023), https://www.energysage.com/blog/north-carolina-new-net-metering-policy/.

224. Gross metering does not provide the same incentives, since the homeowner cannot come out ahead financially by adding battery storage or engaging in other forms of self-consumption, that do provide a broader benefit to the grid.

customers, such as utility scale solar and storage, rather than systems that primarily benefit an individual household.

Public dollars can still promote solar adoption, such as tax credits, since the tax burden is not shared in the same way that utility rates are. Locations that want to encourage solar could therefore enact additional tax benefits on a state-by-state basis in addition to the federal tax credit if it remains. While there are arguably problems with the federal tax, particularly given how that money could otherwise be spent buying the same product at a cheaper price directly for the utility, it is a political issue rather than an issue of straight economic fairness.

Economic fairness also means utilities should be more aggressive about how to handle customers that adopted solar under grandfathered rate systems. In many instances, the rates can legally be changed at any time, and they should be. At a minimum, upon the sale of a home with net metering the benefit should end, and it should also end after a period of time for all homes, a much shorter period of time than the decades that are often grandfathered into plans.