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Residential Photovoltaic Systems:

The Solution to Peak Energy Demand

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A. Introduction

Traditional utilities have historically supplied electricity to the electric grid. However, as electricity demand continues to increase exponentially, traditional utilities' are having difficulties keeping up with supply. Base-level electricity demand is currently within utilities ability to supply; however, peak demand results in disproportionately large costs to utilities in supplying electricity.

These costs are shifted to consumers up to their statutory limits for retail rates. The remaining costs remain on utilities to bear. However, the Federal Energy Regulatory Commission (FERC) and subsequent case history approves incentives for utilities to assure wholesale rates remain "just and reasonable."

Increasing supply infrastructure is costly and too slow to respond to the threat of current peak demand. Therefore, rather than relying exclusively on supply-side improvements, utilities reduce demand through Demand Response. Utilities provide incentive payments or penalties to voluntary consumers to reduce electricity consumption during peak hours. FERC provides compensation to utilities to implement Demand Response for the purpose that Demand Response ensures just and reasonable rates.

However, as demand continues to increase, the limitations and negative externalities associated with Demand Response become more harmful to the economy. As a result, alternative means of electricity supply and demand reduction are required. This alternative is renewable energy—namely, residential solar panels.

Utilities are against the current support of solar panel use since solar users use more of the grid than they pay for, and cost of grid maintenance is disproportionately put on non-solar users. Utilities, therefore, lobby to institute surcharges on solar users for grid use.

However, utilities demand is shortsighted and will end in more costs to themselves and to the larger economy. Solar panel generators supply alternate sources of electricity, reduce grid demand most notably during costly peak hours, avoid economic opportunity costs associated with businesses shutting down from Demand Response, and promote environmental considerations of renewable and clean energy. For these reasons, incentives rather than restrictions should be applied to solar use and installation.

The way to incentivize solar use is to repurpose the FERC subsidy to utilities for implementing Demand Response to subsidizing utilities for sharing the grid with solar users. This subsidy would be repurposed gradually as solar panels become more prevalent and as Demand Response diminishes. Utilities benefit in the long-term from this plan since the need to share the grid will likely outlive the need for Demand Response; especially since renewable energy sources are growing to inevitably take over a large share of energy generation.

B. Electricity: Sources, Structure, and Generation

Most electricity is produced by traditional utilities in power stations by a multi-staged process of converting the energy extracted from resources into electrical energy, and has been produced by them for over 100 years.[1] Electricity flows from large central-station generating facilities through high-voltage transmission systems either for sale to

[1] Jon Wellinghoff and Steven Weissman, *The Right to Self-Generate as a Grid-Connected Customer*, Energy Bar Ass'n. Vol. 36:305, 305 (2015).

other utilities or for delivery through local distributing facilities to end-users.[2] This entire system from producing electricity to distributing it to the home or business is what comprises the power grid.

In the United States, about two-thirds of electric power is delivered through Regional Transmission Organizations (RTOs), which "operate the transmission grid within a defined region, provide transmissions services, and operate wholesale energy markets (and in some cases capacity markets) for their respective region." RTOs, their transmission services, and the consumers of their generated electricity are all subject to FERC's exclusive jurisdiction over transmission and wholesales.[3] FERC's jurisdiction is limited to interstate commerce, and since the electricity market in Texas does not cross state lines, FERC does not have jurisdiction over Texas's market.[4] (Since this paper focuses largely on a FERC subsidy, the Texas electricity market is left out of this more specific discussion. However, the general principles minus the federal subsidy would still apply).

Most of our electrical energy produced in large, centralized power plants comes from the burning of fossil fuels—i.e., coal (33%) and natural gas (33%).[5] Nuclear energy is also a large source of our electrical energy (20%).[6] These are the sources of electricity are produced by traditional utility companies for distribution through the grid and ultimately for sale to end-use customers by local retailers.[7]

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2 Robert R. Nordhaus, *The Hazy "Bright Line" / Defining Federal and State Regulations of Today's Electric Grid*, Energy Bar Ass'n. Vol. 36:203, 207 (2015).
3 *Id.* at 209
4 *Id.*
5 U.S. Energy Information Administration, WHAT IS U.S. ELECTRICITY GENERATION? https://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3
6 *Id.*
7 Jon Wellinghoff and Steven Weissman, *The Right to Self-Generate as a Grid-Connected Customer*, Energy Bar Ass'n. Vol. 36:305, 307 (2015).

Electricity generation and distribution must be highly responsive to electricity demand by the consumer. "Since there are currently very few buffers such as storage or price responsive demand in the electricity system, system operators have to ensure that the sum of all generation matches load [i.e., consumption] instantaneously. This requires balancing fluctuating renewable energy sources with other resources in real time."[8] Failure to balance electricity generation and consumption will result in brownouts, severe voltage fluctuations, or major grid failures.[9]

Traditional utilities supply most of our electricity in part because they are the historic suppliers of electricity but also because they are "relatively easily turned on and off…[and] are well-suited for backing up and smoothing out intermittent renewables and providing capacity."[10] That is, because traditional utilities have stores of resources (coal, gas, fuel, etc.) that they can convert into electrical energy as electricity demand increases, our electrical system relies on them to maintain the production-consumption balance.

However, traditional utilities do not provide all of the electricity in the grid. Renewable sources contribute a substantial, though still small (~13%), portion of electricity to the grid.[11] Renewable sources of energy include wind energy, solar energy, and hydroelectric power.[12]

Renewable sources are a useful source of electricity for their cost, abundance, and clean production. First, the process of converting resources into electrical energy is essentially free. The only costs associated with renewable sources are construction and

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[8] Jurgen Weiss et al., *The Brattle Group: Partnering Natural Gas and Renewables in ERCOT*, 7 (2013).
[9] *Id.*
[10] *Id.* at 3.
[11] U.S. Energy Information Administration, WHAT IS U.S. ELECTRICITY GENERATION? https://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3
[12] *Id.*

maintenance costs. Second, and by definition, renewable energy converts resources that virtually will not perish over time. This is an advantage over traditional utilities, which largely use finite carbon-based resources such as coal, gas, and fuel (nuclear energy uses uranium which, like carbon, is finite in quantity and will eventually perish; it is therefore non-renewable). Third, renewable energy generation is considered clean—that is, it does emit carbon or other waste (as in nuclear plants) that are harmful to the environment.

Though renewable sources have several benefits, they are not without problems. Most notably for electricity generation, renewable energy sources are non-variable in supply. That is, "unlike fossil-fired power generation, most renewable energy sources cannot be dispatched, i.e., they cannot increase or decrease production at will and in response to market prices."[13] So, renewable energy cannot be used in response to fluctuations in demand like traditional energy sources. Instead, "renewables are 'must-take generation' and feed electricity into the grid when the wind blows and the sun shines regardless of demand levels.… Since the wind doesn't blow and the sun doesn't shine all the time, the injections of power from renewable sources vary, sometimes a lot and sometimes over very short time frames."[14] Because renewable sources cannot respond to demand changes, they can at most contribute to the pool of electricity in the grid, but cannot displace it completely.

This could change with large-scale electricity storage such as batteries. These are becoming "increasingly available for balancing renewables, but still require substantial cost decreases to become competitive on a large scale."[15] Therefore, battery storage is a hopeful solution for a full conversion to renewable sources in the future, but it is

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[13] Jurgen Weiss et al., *The Brattle Group: Partnering Natural Gas and Renewables in ERCOT*, 7 (2013).
[14] *Id.*
[15] *Id.* at 8.

unrealistic right now.

Currently, renewable sources only contribute a small percentage in the overall electricity generation, with solar contributing an almost unnoticeable amount.[16] However, solar use is gaining speed and growing exponentially. "Globally, solar generating did grow at an average annual rate exceeding 50% from 2004 through the end of 2013. But that growth was from a tiny base, and solar energy accounted for only around 1% of global electricity generation in 2014.[17] Although renewable energy currently only contributes a small percentage of total electricity generation, it is growing at a fast enough rate to play a much larger role in the decades to come. "Renewable energy sources will contribute greatly to the power generation mix with an estimated growth for that period of 2.8% per annum, to achieve a weight of 24% of total power generation in the year 2040."[18]

C. Electricity Supply and Demand and Limitations

Day-to-day electricity supply usually follows a cost-conscious model, using the least expensive and most efficient source of generation first, followed by more expensive plants to meet increased demand.[19] Typically, utility operators will use renewable and nuclear power first since they cost the least, followed by coal and gas plants (though recently with the drop in gas prices, gas has taken a much higher priority for electricity

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[16] U.S. Energy Information Administration, WHAT IS U.S. ELECTRICITY GENERATION? https://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3

[17] Richard Schmalensee, *The future of solar energy: A personal assessment*, Energy Economics, Vol. 52, Supp. 1, S142 (2015).

[18] Antonio Colmenar-Santos et al., *Distributed generation: A review of factors that can contribute most to achieve a scenario of DG units embedded in the new distribution networks*, Renewable and Sustainable Energy Reviews, Vol. 59, 1131 (2016).

[19] Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 711 (2015).

generation).[20]

Thus, during periods of high demand utility operators have no choice but to rely on more costly and less efficient factories. This results in disproportionately high costs to the utilities operators. "One recent estimate found that at least 10 percent of electricity supply costs are incurred in order to serve just 1 percent of hours of load, which are generally the hottest hours on the year's hottest day."[21] In other words, peak demand costs so much to utilities that 10 percent of their supply costs are incurred in just less than 100 hours of peak demand during the year. Moreover, "the ratio of peak load to average load is growing because peaks are growing taller."[22]

In addition to increased costs associated with peak demand, costs are also incurred as a result of grid outages and infrastructure damage resulting from peak demand. Utilities must run more of their factories to meet demand, which puts more electricity on the grid at once. Increased loads of electricity puts more strain on the grid. This leads to potentially more damage if any piece of the grid fails. "Like a circuit breaker, components of a power grid can 'trip' and shut off when a load is dangerously high. The result is that the load is passed on to other parts of the grid network, which may also shut down, creating a domino effect that leads to a blackout."[23]

As demand increases, utilities cannot just repair the grid when there are failures, but must upgrade the grid to be able to handle dangerously high loads to prevent future failure. Grid failure and outages hurt both electric companies and the consumers who

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[20] Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 712 (2015).
[21] *Id.* at 713.
[22] *Id.* at 725.
[23] Marshall Brain & Dave Roos, HOW POWER GRIDS WORK 1 April 2000. HowStuffWorks.com, http://science.howstuffworks.com/environmental/energy/power.htm

would have purchased and used the electricity. Electricity is so ubiquitously necessary for every business's means of production. As a result, economic losses are significant. To avoid these, there is an extra responsibility on utilities not only to implement responsive measures to outages but also to implement preventative measures too by predicting and upgrading grid weaknesses.

So increased demand results in increased costs to electricity producers. These increased cost are shifted to the consumer through increased electricity retail rates. However, utilities and local retailers are statutorily limited on how much they can increase rates—that is, they can only raise them so long as they remain just and reasonable.[24] Thus, at some point the increased cost to supply electricity during peak demand creates a major loss that utilities statutorily cannot put on the customers.

D. Utilities' Response to Increased Demand

Utilities have two ways to respond to increased demand. Increase supply or decrease grid demand.[25] They may increase supply by building more efficient, less costly factories. This would decrease costs associated with peak demand because they would rely less on the more costly factories. Additionally, utilities could upgrade their infrastructure to be able to handle dangerously high loads so that outages and other associated losses aren't suffered.

However, the same limitation exists that prevents utilities from just using more costly factories and just repairing the grid rather than upgrading it—it is very expensive

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24 Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 715 (2015).

25 Sezin Afsar et al., *Achieving an optimal trade-off between revenue and energy peak within a smart grid environment*, Renewable Energy, Vol. 91, 293 (2016).

and they can only impart so of this expense onto the customers while keeping rates "just and reasonable." And even if upgrading were within the utilities means (which it probably is given enough time to spread the costs over several years), it would take entirely too much time to respond appropriately to the immediate supply and demand needs. This may be an appropriate remedy, but it is a long-term remedy and not something that utilities can solely rely on.

The other alternative is to implement demand-side programs to reduce grid demand and make the best use of what utilities can currently supply.[26] One demand-side response is very straightforwardly called Demand Response.[27] Utilities implement Demand Response by using payments to incentivize voluntary residents and businesses to reduce their normal pattern of consumption during peak hours.[28] Demand response is used both when wholesale rates to utilities are unbearably high and when peak demand would cause power outages or equipment damage.

Demand Response programs can incentivize by monetary compensation or penalization.[29] Emergency Demand Response Program performs load shifting by allowing utilities to shed some of the loads in the peak hours by giving monetary compensation.[30] Another form is day Ahead Demand Response Program, where energy price is declared a day ahead.[31] If the user consumes more than the base line that day,

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[26] Sezin Afsar et al., *Achieving an optimal trade-off between revenue and energy peak within a smart grid environment*, Renewable Energy, Vol. 91, 293 (2016).
[27] *Id.*
[28] Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 701, 703 (2015).
[29] K.S. Reddy et al., *A review of Integration, Control, Communication and Metering (ICCM) of renewable energy based smart grid*, Renewable and Sustainable Energy Reviews, Vol. 38, 185 (2014).
[30] *Id.*
[31] *Id.*

excess tariff is implemented to curtail consumption.[32] Since demand response can be implemented through an agreement with consumers, it is a more immediate response to increased demand than upgrading supply-side infrastructure.

Although Demand Response is useful to curb some of the losses utilities suffer through improving or relying on more costly infrastructure and losses resulting from grid failure, utilities still must expend money to reduce demand—and to reduce it enough to have a comfortable buffer in case more electricity that expected is used. Essentially, utilities are paying consumers to not buy electricity from them. While this prevents many costs to utilities, it also prevents much revenue.

In response to this and since the overall economy benefits from the implementation of Demand Response to prevent increased rates and outages, in 2011, the Federal Energy Regulatory Commission (FERC) created a rule to uniformly compensate Utilities for using and implementing Demand Response to maintain "just and reasonable" utility rates.[33] This rule was promulgated in FERC Order No. 745.[34]

FERC found jurisdiction to create a rule to compensate utilities for Demand Response through sections 205 and 206 of the Federal Power Act of 1935 (FPA), which give FERC the authority to regulate the wholesale interstate transmission and sale of electric power.[35] The rule's stated purpose was to incentivize retail customers to reduce electricity consumption when it was economically efficient to do so.[36]

Additionally, FERC found justification for Order No. 745 through Congress.

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32 K.S. Reddy et al., *A review of Integration, Control, Communication and Metering (ICCM) of renewable energy based smart grid*, Renewable and Sustainable Energy Reviews, Vol. 38, 185 (2014).
33 *Federal Energy Regulatory Commission v. Electric Power Supply Association, et al*. (2016)
34 Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 701 (2015).
35 *Id.* at 713.
36 *Id.* at 703, 704.

Congress endorsed Demand Response—at least in vague terms—with the Energy Policy Act of 2005 (EPA).[37] With the EPA, Congress declared that it is the "policy of the United States that time-based pricing and other forms of Demand Response…shall be encouraged.[38]

Opponents to FERC Order No. 745 argued that it conflicted with FERC's efforts to promote a competitive market.[39] By providing this subsidy to utilities, FERC creates an advantage for them to continue operations while providing no similar advantage to any alternatives that might resolve the issue of increasing electricity demand.

Additionally, opponents argue that it over-compensates operators.[40] Since the order sets uniform rates for utilities that implement Demand Response, utilities can shop around and select the bidders that satisfies Demand Response quotas while leaving the utilities with extra compensation.

Opponents also argue that FERC just doesn't have the jurisdiction to regulate and employ Demand Response since it ends up regulating the retail market and not just the wholesale market.[41]

However, the opposition and arguments against FERC Order No. 745 did not win out. In Federal Energy Regulatory Commission v. Electric Power Supply Association, the Supreme Court of the United States held that the FPA grants FERC the authority to regulate the wholesale market operators' compensation for reduction in electricity

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[37] Justin M. Gundlach, *EPSA v. FERC—the End of Wholesale Demand Response?*, Ecology Law Quarterly, Vol. 42:699, 701 (2015).
[38] *Id*. at 731.
[39] *Federal Energy Regulatory Commission v. Electric Power Supply Association, et al*. (2016)
[40] *Id*.
[41] *Id*.

consumption, and FERC acted within its means to ensure "just and reasonable rates."[42]

So, it looks like Demand Response is sanctioned by the all branches of the Federal Government as a response to peak issues with peak demand and ensuring "just and reasonable" rates. However, there is only so much Demand Response utilities can use. Unless supply increases at least at the same rate as demand increases, more and more Demand Response will be implemented. As demand increases, either we will have to use more Demand Response or confront the needs of a better supply-side infrastructure. The former will lead to more economic loss resulting from temporarily non-operating businesses. The latter, as explained above, is costly and may result in "unjust and unreasonable rates" to consumers.

E. Solution — Residential Photovoltaic Systems

The problems above revolve around grid supply by utilities and demand by consumers. The existing power grid does not meet the needs of the twenty-first century because of increase in demand, complexity in managing the grid, generation and capacity limitations.[43] Utilities' stand to take on a lot of the costs if they decide to greatly increase electricity supply without raising rates above what is "just and reasonable." Alternatively, Demand Response will become increasingly prohibitive economic losses increase and as more and more payments will need to be made to incentivize users to temporarily abstain from using electricity.

Fortunately, traditional utilities do not provide all of the electricity in the grid. Though small, many renewable resources are privately owned and used to self-generate

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[42] *Federal Energy Regulatory Commission v. Electric Power Supply Association, et al.* (2016).

[43] K.S. Reddy et al., *A review of Integration, Control, Communication and Metering (ICCM) of renewable energy based smart grid*, Renewable and Sustainable Energy Reviews, Vol. 38, 181 (2014).

energy off the grid to meet individual demand. The residential solar panel, most notably, is becoming a common residential purchase and helps reduce demand of electricity through the grid.[44]

Residential solar panels provide a number of benefits to traditional utilities and to the grid itself. As an overview, "in the German system and other systems with substantial solar penetration and limited storage, the load that must be met by conventional generation, the net load, is both lower on average and more variable in percentage terms than the overall load."[45]

First, renewable resources serve as off-grid, alternative sources of electricity, and so reduce grid demand. The less electricity demanded from the grid, the lower peak demand is. And since peak demand caused most the problems that required implementation of Demand Response, renewable energy is an alternative to and will displace Demand Response.

Second, each unit of energy solar users self-generate displaces at least the same unit of electricity the utility would have supplied. As utilities need to supply less, costs associated with utilities' supplying electricity also drop. Since peak demand is lower, reliance on more costly, less efficient factories begins to disappear.

Additionally, grid infrastructure used to distribute electricity is more secure and less prone to failure since it is distributing less dangerously high amounts of electricity. Consequently, the weak spots in the grid infrastructure are not as vulnerable. Therefore,

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[44] Richard Schmalensee, *The future of solar energy: A personal assessment*, Energy Economics, Vol. 52, Supp. 1, S142 (2015).
[45] *Id*. at S144.

grid support can defer maintenance and upgrades in the power distribution system.[46]

Third, residential solar panels indirectly help strengthen the grid. A grid infrastructure itself is stronger when it does not constantly have to be repaired and upgraded. Since load is lower, the grid's voltage profile and energy efficiency is stronger as well because when grid load is high, "voltage tends to drop at the end of long distribution lines…and if it drops below a threshold level, the breakers will trip and a temporary blackout occurs."[47, 48]

In addition to benefitting traditional utilities and the grid, solar panels benefit the economy. By displacing Demand Response, economic loss associated with residences and businesses temporarily restricting their energy uses is no longer an issue. Indeed, if the residences and businesses generate some of their energy through renewable resources, they may be able to operate fully without even burdening the grid. Even the non-solar using residences and businesses benefit since there is just less need for Demand Response.

On an environmental level, solar use—as well as other renewable resources—is greener. As a society, we have a goal to utilize more and more clean energy sources over those that pollute our environment. Renewable sources further reduce the consumption of fossil fuels, the green house gas emissions, emissions or other gases, and will help reduce

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[46] Andreas Poullikkas, *A comparative assessment of net metering and feed in tariff schemes for residential PV systems*, Sustainable Energy Technologies and Assessments, Vol. 3, 2 (2013).

[47] Antonio Colmenar-Santos et al., *Distributed generation: A review of factors that can contribute most to achieve a scenario of DG units embedded in the new distribution networks*, Renewable and Sustainable Energy Reviews, Vol. 59, 1131 (2016).

[48] Andreas Poullikkas, *A comparative assessment of net metering and feed in tariff schemes for residential PV systems*, Sustainable Energy Technologies and Assessments, Vol. 3, 2 (2013).

noise pollution.[49]

Moreover, because renewable energy is by definition infinite, it leads to a more sustainable energy system. This especially contributes to more price stability, since we depend less on non-renewable resources that historically have been subject to price volatility.[50]

Even solar users who continue to buy part of their electricity consumption from traditional utilities (as most do) still contribute to all of the benefits stated above. In the past solar users had to remain disconnected from the grid; however, with technological advances and policy and regulation changes, individuals who generate their own electricity can remain connected to the grid.[51] Therefore, solar users still have access to the grid when their solar panels do not generate enough electricity to supply what they consume and during the times when solar panels are not generating any electricity.[52] These partial grid-users still contribute to lower grid demand simply by self-generating at least part of their electricity needs during peak hours.

Solar panel users also benefit from owning solar panels. Solar users much more self-sufficient by not having to rely solely on utilities to generate and distribute energy to them. Self-sufficiency not only leads to a feeling of independence but also allows these users more alternatives in case one system fails. For example, so long as the sun is at least partially shining, solar users are not stranded during minor or major outages.

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[49] Antonio Colmenar-Santos et al., *Distributed generation: A review of factors that can contribute most to achieve a scenario of DG units embedded in the new distribution networks*, Renewable and Sustainable Energy Reviews, Vol. 59, 1131 (2016).

[50] Shelly Hagerman, *Is rooftop solar PV at socket parity without subsidies?*, Energy Policy, Vol. 89, 93 (2016).

[51] Marshall Brain & Dave Roos, HOW POWER GRIDS WORK 1 April 2000. HowStuffWorks.com, http://science.howstuffworks.com/environmental/energy/power.htm

[52] *Id.*

Severe weather—such as high winds, lightning strikes, and heavy snowfall—is the number one cause of power outages in America.[53] Though solar panels have their limitations, they are surprisingly resistant to weather damage, and can remain undamaged even during most hailstorms.[54] Moreover, solar panels still remain somewhat efficient at generating electricity during less-than-ideal weather. One study has shown that in San Francisco, efficiency only drops at most 20% during heavy fog.[55]

Rain clouds reduce efficiency less, but do not appear to completely render the panels completely useless, dropping efficiency from 40% - 90% depending on how dark and heavy the rain and clouds are.[56] As a result, while severe storms may render solar panels almost useless, solar panels users still come out ahead. If the weather does not cause grid outages, the solar user can just resort to the grid to obtain their needed electricity. If the weather does cause a grid outage, usually the severe weather will pass before the outage is repaired—meaning the solar user will be at least partially back online before normal grid users are.

The truest limitation to solar panels is the nighttime. Solar panels generate energy from the sun, and generate virtually no electricity once the sun goes down. However, peak demand typically is over or is ending at nightfall. Thus, the need to curb peak demand with renewable energy is less.

In addition to self-sufficiency, solar panels also benefit individuals through net

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53 Marshall Brain & Dave Roos, HOW POWER GRIDS WORK 1 April 2000. HowStuffWorks.com, http://science.howstuffworks.com/environmental/energy/power.htm

54 1st Light Energy, THE DURABILITY OF A SOLAR PANEL: STRENGTHS, WEAKNESSES, AND TROUBLESHOOTING, http://1stlightenergy.com/the-durability-of-a-solar-panel-strengths-weaknesses-and-troubleshooting/

55 Residential Solar 101. DO SOLAR PANELS WORK IN THE RAIN?, http://www.residentialsolar101.org/do_solar_panels_work_in_the_rain/

56 *Id.*

metering, which many States adopt. An electric meter measures how much electricity the user uses and generates, and when a user generates more than he consumes, the meter runs backwards.[57] At the end of the billing cycle, if the user generates more electricity than he consumes, he is paid for the net amount of generated electricity at a set price (either at wholesale or retail rates, depending on the state).[58] If he consumes more than he generates, then he must pay the net amount of electricity consumed at retail electricity rates.[59] In many States, however, utilities aren't required to pay consumers for any surplus, but are only required to credit any surplus energy to reduce the user's next bill.[60]

This incentive is not absolute, as most States set a cap on how much electricity can be net-metered.[61] This limits self-generation to an incentive rather than a business, and also keeps utilities relevant for producing electricity from non-renewable sources.

F. Traditional Utilities' Opposition and Response

Traditional utilities have put on large, anti-solar campaigns, mainly with claims that solar users are getting "free rides" by not paying their fair share for the grid and thereby raising electricity prices for non-solar users.[62] Traditional utilities argue that solar users require utilities to supply energy when their solar panels are not working—during cloudy or foggy days and at night. As a result, these solar users rely on the grid to be

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[57] Yoshihiro Yamamoto, *Pricing electricity from residential photovoltaic systems: A comparison of feed-in tariffs, net metering, and net purchase and sale*, Solar Energy, Vol. 86, Iss. 9, 2678 (2012).
[58] *Id*. at 2678-2679
[59] *Id.* at 2679.
[60] Andreas Poullikkas, *A comparative assessment of net metering and feed in tariff schemes for residential PV systems*, Sustainable Energy Technologies and Assessments, Vol. 3, 1 (2013).
[61] Shelly Hagerman, *Is rooftop solar PV at socket parity without subsidies?*, Energy Policy, Vol. 89, 85 (2016).
[62] Edward Humes, *Throwing Shade*. Sierra, 47, 48 (2014).

there when they need it, but only pay a small portion of the costs to maintain the grid.[63] This disproportionately puts the cost on non-solar users to pay the bulk of the costs to maintain the grid.[64]

Furthermore, solar users use the grid to transfer surplus electricity back to the grid which utilities are required to buy or credit.[65] Solar users do not pay to use the grid to sell electricity. They are essentially getting a "free ride" on the grid as a means to further benefit. Non-solar users bear the cost of this use fully.

To fix this, traditional utilities lobby many states to impose monthly surcharges on solar users for use of the grid.[66] In Arizona, utilities propose that solar users should pay $8 a month for every kilowatt of generating capacity the solar panel has.[67] Since these solar panels' capacity is just under 7 kilowatts, each customer ends up paying $50 to $100 per month, depending on system size.[68] Utilities argue that this surcharge would effectively shift the cost of maintaining the grid back from overburdening non-solar users something more fair for all grid users.[69]

Traditional utilities' position is problematic because it focuses too narrowly on direct monetary compensation in exchange for grid use. It is true that solar users are not paying as much for grid use. However, this point overlooks the cost-saving benefits solar-users provide to traditional utilities and to non-solar consumers.[70] "For every dollar of solar cost to the utility (primarily from net metering), the state's solar homeowners pro-

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[63] Edward Humes, *Throwing Shade*. Sierra, 47, 48 (2014).
[64] *Id.*
[65] Robert R. Nordhaus, *The Hazy "Bright Line" / Defining Federal and State Regulations of Today's Electric Grid*, Energy Bar Ass'n. Vol. 36:203, 207-208 (2015).
[66] Edward Humes, *Throwing Shade*. Sierra, 48 (2014).
[67] *Id.*
[68] *Id.*
[69] Jon Wellinghoff and Steven Weissman, *The Right to Self-Generate as a Grid-Connected Customer*, Energy Bar Ass'n. Vol. 36:305, 305 (2015).
[70] Edward Humes, *Throwing Shade*. Sierra, 47, 48 (2014).

vided $1.54 in long-term benefits."[71]

As stated above, electricity generation from solar panels increases grid supply and reduces grid demand.[72] This causes utilities to avoid costs associated with increasingly costly production, damage response from grid failures, and upgrading infrastructure. One step further, these cost savings are not shifted to non-solar users. While non-solar users may bear a larger *share* of the cost to maintain the grid, they are overall paying less since peak demand pricing does not cause cost of production to surge. Moreover, as peak grid demand decreases, utilities will have to implement less Demand Response, thus will receive business from residents and businesses that utilities would otherwise pay to not use electricity during peak hours.

Even if the cost to non-solar users increased as a result of solar users not paying their fair share to grid use, solar generation still just constitutes a small fraction of total U.S. electricity generation.[73] Indeed it only constitutes just 0.2% of total U.S. electricity consumption.[74] It therefore cannot have more than a proportionately small effect on overall electricity generation that it is unrealistic that any significant change in pricing has occurred as a result of solar use.

It is true that solar use is increasing at an impressive rate: "Globally, solar generating capacity did grow at an average annual rate exceeding 50% from 2004 through the end of 2013."[75] However, this growth is from such a tiny base that solar

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[71] Edward Humes, *Throwing Shade*. Sierra, 48 (2014).
[72] *Id.* at 49
[73] Shelly Hagerman, *Is rooftop solar PV at socket parity without subsidies?*, Energy Policy, Vol. 89, 85 (2016).
[74] Andrew Satchwell et al., *Quantifying the financial impacts of net-metered PV on utilities and ratepayers*, Energy Policy, Vol. 80, 133 (2015).
[75] Richard Schmalensee, *The future of solar energy: A personal assessment*, Energy Economics, Vol. 52, Supp. 1, S142 (2015).

energy still only accounts for 1% of global electricity generation in 2014.[76]

G. Balancing the Interests and Finding a Solution

The divergent set of interests makes coming up with a compromise difficult. FERC aims at ensuring "just and reasonable" wholesale rates. Utilities want compensation for solar users' excessive use of the grid and for grid maintenance. Solar users want greater availability of solar panels and fewer restrictions limiting purchase and use. Economically, we want to maximize production and not have periods where production is halted as a response to factors such as decreasing peak demand. Environmentally, we want to transition into a greener electricity generation system.

The way to satisfy all of these interests is to further incentivize residential solar panel use rather than regulate them. The incentive proposed here is to repurpose FERC Order No. 745. Rather than providing utilities with uniform compensation for implementing Demand Response—which while ensuring "just and reasonable rates," seems to have problems with market competition and abuse—provide the same compensation in exchange for solar users to use the grid as they currently do. This will cover utilities concerns that solar users aren't paying their fair share for grid use and maintenance.

Utilities would respond that this isn't a benefit to them since now they aren't being compensated for Demand Response. This is an appropriate concern, which requires more than just automatically repurposing FERC Order No. 745. Instead, the subsidy should be repurposed gradually and in proportion to the rate solar panels are used to

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[76] Richard Schmalensee, *The future of solar energy: A personal assessment*, Energy Economics, Vol. 52, Supp. 1, S142 (2015).

generate electricity. In this way, traditional utilities are still compensated for implementing Demand Response while peak demand is still a prevalent problem. Moreover, since solar panels are only such a very small portion of electricity generation currently, providing a large subsidy to cover grid maintenance immediately would amount to overcompensating utilities in this area. Therefore, as peak demand is reduced by increased residential solar panel use, the subsidy should be repurposed in proportion.

Utilities will still argue that they this is not a benefit to them since they are receiving the same compensation either way. Again utilities are correct, at least in the short term—their compensation is essentially the same, just repurposed for a projected shift to renewable energy.

However, the long-term benefits to utilities are more convincing. Inevitably our country and many other countries are transitioning to cleaner and more renewable sources of electricity generation. Individuals see residential solar panels as a smart long-term purchase both financially and environmentally. Even absent further governmental incentives to purchase solar panels, these global and individual concerns and the increasing technological advances that make solar panels more affordable are going to continue to increase the portion of solar panels that generate electricity. Peak demand will eventually be adequately buffered as a result of increased generation from solar panels and other renewable energy sources. Without peak demand causing rates to surge, rates will stabilize and not be "unjust or unreasonable." Consequently, the need for Demand Response will diminish and eventually disappear. FERC will respond accordingly by diminishing its subsidy for Demand Response and ultimately withdrawing it when it is no longer needed.

Therefore, traditional utilities will benefit from agreeing to repurpose the subsidy to ensure that they do not lose the current compensation they are receiving through FERC. Moreover, they will benefit from agreeing to repurpose the subsidy sooner when the compensation is currently high rather than later when the amount of compensation by FERC is unknown and potentially diminished as a result of less need for Demand Response.

Setting the interests of traditional utilities aside, the other interests are more apparent and straightforward. FERC's interest of ensuring "just and reasonable" wholesale rates would be satisfied as more electricity generated by solar panels increases supply, reduces peak grid demand, and consequently reduces surging costs associated with peak demand. Solar users would clearly be satisfied since the incentives would benefit them directly. The economy would benefit since lower peak demand means less Demand Response and thus less electricity restrictions on residents and businesses. And the environment would benefit from more clean and renewable sources of generation rather than non-renewable sources that release carbon and other chemicals as byproducts of electricity generation.

Incentivizing residential solar purchases avoids the inefficiencies that traditional utilities would suffer in responding to increases in marginal demand by building new factories. Electricity demand grows fluidly. On the other hand, utilities' increase in supply occurs in large increments. In other words, when demand increases to a certain point utilities must make large responses to small changes in demand. Even with smart planning, new factories will often either be built too early, causing it or older factories to sit idly until average demand catches up, or be built too late resulting in costs associated with peak demand that utilities cannot yet offset. Contrarily, solar panels are implemented easily and quickly and contribute to supply in intervals similar to the rate that demand increase. The inefficiencies suffered by building the additional factory to increases in marginal demand are avoided by installing new solar panels.

H. Conclusion

The constantly increasing demand for electricity and the costly and slow expansion of the grid causes problems that traditional utilities cannot solve without many other negative externalities. However, by encouraging residential electricity generation via solar panels and other renewable resources, utilities are not solely relied on to accommodate for electricity demand that is beyond their capacity. Moreover, by encouraging residential electricity generation, users consume electricity they generate themselves and so are off the grid more often, thus relieving the grid of demand especially during peak hours.

Currently, utilities rely on Demand Response to reduce peak demand by providing incentive payments or penalties to voluntary consumers to temporarily reduce electricity consumption. The Federal Energy Regulatory Commission promulgated a rule in FERC Order No. 745 that provides uniform compensation to utilities that implement Demand Response for the purpose of ensuring “just and reasonable rates.” However, Demand Response is unsustainable as demand continues to increase faster than traditional utilities can expand its infrastructure.

The proposed solution of this paper is to repurpose FERC Order No. 745 from compensating utilities for implementing Demand Response to compensating utilities to continuing to share the grid with solar users. This will allow solar users to use the grid without worry that the State will regulate solar users and require them to pay utilities a monthly surcharge for using the grid. Repurposing Order No. 745 will be gradual and increase as solar panels take a larger share of the electricity market and as Demand Response diminishes as peak demand no longer becomes an issue.

The repurposed FERC Order No. 745 provides benefits to everyone involved. Utilities will have a long-term subsidy from FERC that will likely outlive the utility of Demand Response. Solar users benefit by keeping solar panels affordable. FERC benefits because they still ensure “just and reasonable rates.” The economy benefits by not losing business due to Demand Response to peak demand. Finally, the environment benefits by moving towards a renewable and cleaner system.