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ON MATTERS THAT MATTER

Renewable Power Generation in a Larger Grid Context

November 2015

An Occasional Essay on Matters that Matter

Renewable Power Generation in a Larger Grid Context

As private equity investors in selected environmental markets in North America, NewWorld Capital Group publishes occasional essays on matters that matter in our investment strategy. We seek to present an analysis of the forces at work shaping investment opportunities and risks in our target markets and in the broader environmental opportunities sector.

Does generating more electric power from renewable sources mean more expensive electricity for consumers? Particularly as the industry has gathered more force in recent years, renewable power generation tends to capture much public attention—at times even claimed to cause a 'utility death spiral'.[1] Indeed, whether due to cost, technology, intermittency, or some other objection entirely,[2] renewable power has been cast as driving higher electricity prices for consumers.

Renewable power generation in the United States is frequently misperceived by the general public. Indeed, the story is complex—and is still being written. Yet the renewable energy industry merits an updated, fuller understanding. For despite rapid growth and development, renewables remain a relatively small piece of the electricity generation mix in the United States today, though renewables provide a significant share of electricity in some markets, varying tremendously across U.S. states and regions. Meanwhile, behind-the-meter renewable generation like residential solar (often called distributed generation) is frequently left out of tallies—though there is much commentary on the costs that distributed generation of renewables is thought to impose. And if the role played by renewables is misperceived, it follows that so too are its effects. Further, the potential benefits of renewables distributed generation are often left undiscussed in consideration of the costs.

This essay addresses both the role of renewable energy in the electricity generation mix and the idea that renewables are the cause of higher electricity prices. First, we explore the state of play with respect to renewable energy generation over the past decade in the United States, at both the national and state-level, by drawing on disparate datasets and information on the U.S. power industry. Importantly, we incorporate smaller-scale, distributed generation of renewables, down

[1] Christopher Helman, "Will Solar Cause A 'Death Spiral' For Utilities?," *Forbes*, January 30, 2015, http://www.forbes.com/sites/energysource/2015/01/30/will-solar-cause-a-death-spiral-for-utilities/.
[2] Rupert Darwall, "Obama's Renewable-Energy Fantasy," *Wall Street Journal*, July 5, 2015, http://www.wsj.com/articles/obamas-renewable-energy-fantasy-1436104555.

to the residential level, thereby providing a more comprehensive look at electricity generation in the United States, how it varies across the country, and the growing role of renewable power generation over time.

Second, we cast doubt on the contention that renewables actually result in higher electricity prices for consumers by looking at retail prices over time in the leading and lagging states by share of renewables. Considering this contention in the context of renewables' still-relatively limited share of power generation is a start. But we also observe that U.S. states with more electricity generated by renewables have seen electricity prices increase less rapidly (in real terms) over the past decade than states with small (or perhaps no) shares of renewable generation.[3] In addition, we see that states with higher shares of renewable power experienced lower electricity prices than the U.S. national average in 2014, across all end user segments.

It is important to note that a range of factors and dynamics are at play with respect to electricity prices. By observing price movements relative to trends in renewable power generation, we are not claiming to conclusively demonstrate cause and effect. While the data we have analyzed does not prove that more renewable power generation results in lower electricity prices, it does cast doubt on the opposite assertion—that renewables cause higher electricity prices for consumers.

Further, while electricity prices rightly merit serious attention and investigation, focusing only on any price effects from renewable power generation obscures an important discussion about broader benefits of renewable power generation, particularly at the smaller end of the electricity market. Just as renewable power generation can pose challenges to the grid, they offer important benefits as well, and we discuss some of the ways renewable distributed generation can contribute positively to the grid.

Indeed, due to certain features of the U.S. electricity market (such as inherent distribution subsidies or transmission constraints), distributed generation of renewables can play an important and constructive role by providing peak energy shaving benefits, co-locating supply and demand of power in some consumer segments (such as in the commercial and industrial markets), and allowing customers to navigate time-of-day pricing more efficiently.

Though renewables are poised to continue to gain ground in the United States, any potential effects must be considered and evaluated in the proper context: grid penetration of renewables is still relatively low. The opportunity of renewables is just beginning. Consumers, regulators, and policy leaders alike would do well to keep in mind the broader benefits, in addition to potential costs, when considering the role played by renewables in the U.S electricity grid.

Introduction

Renewable power generation has been growing in the United States in recent years, as consumers increasingly recognize the value of cleaner power generation in combination with other favorable trends. At the same time, electric utilities have come under pressure from increasing demand, aging infrastructure, and rising investment needs.[4]

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[3] We exclude Hawaii from our analysis largely because, unlike other U.S. states, a substantial portion of its electricity is generated from oil.

[4] See, for example, Ehren Goossens, Mark Chediak and Jim Polson, "TV, Web, Phone, Electricity? A New Threat to Utilities," BloombergBusiness, May 29, 2014, http://www.bloomberg.com/news/articles/2014-05-29/tv-web-phone-electricity-a-new-

Subsequently, the view that renewable power generation exerts additional costs on the grid—to the detriment of all customers—has gained traction, particularly in the policy realm, resulting in an active debate across many states. As deployment of renewable energy technologies continues to grow across the U.S., from residential rooftop solar to utility-scale wind farms, many voices still contend that more renewables mean higher electricity prices for customers.[5] One could interpret the drumbeat of dire warnings as a concerted effort to undermine renewables policy rather than as a conclusive analysis, given the absence of definitive data.

When the renewable power generation argument is scrutinized more closely, it becomes clear that the objection is not with all renewable generation.[6] Rather than centralized renewable power generation, such as utility-scale wind farms or solar projects, it is often the smaller-scale renewables—often called distributed generation—that tends to draw most of the ire, particularly in recent years.[7] Indeed, residential solar is often the main target.

However, these arguments tend to rest upon two main premises: first, that renewables play a substantial, even outsized, role in the U.S. electricity generation mix[8]; and second, that renewables are driving increasing electricity prices. In this essay, we explore both topics and present a fuller picture of renewable energy generation in the United States, using a comprehensive dataset of renewable energy at the state- and national-level over the past decade.

By doing so, we aim to present a thoughtful counterweight by providing an updated understanding of the role played by renewables in the U.S. electricity mix and considering the question of electricity prices and renewables, but we freely acknowledge the lack of conclusive proof in the datasets we analyze.

We created this dataset by compiling information on renewable energy generation over the past decade (2004-2014) from a variety of sources. Unlike studies that focus more narrowly on utility-scale renewable energy or residential solar[9], we incorporated information on electricity

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threat-to-utilities; Sara Murphy, "Utility stocks under big pressure," *USA Today*, February 2, 2014, http://www.usatoday.com/story/money/markets/2014/02/02/utility-stocks-under-pressure/5165127/.

[5] See for example, Kenneth P. Green, "Renewable Energy Sources Mean Higher Electricity Bills," *Huffington Post*, June 27, 2015, http://www.huffingtonpost.ca/kenneth-p-green/renewable-energy-higher-bills_b_7155666.html ("But if national and international experiences can teach us anything, it's that so far, more renewable generation leads to one thing -- higher prices."); Robert Bryce, "More Energy Mandates Mean Higher Prices," *Manhattan Institute for Policy Research*, March 9, 2012, http://www.manhattan-institute.org/html/miarticle.htm?id=7940#.VcS1jvlrnL8 ("There is growing evidence that the costs may be too high that the price tag for purchasing renewable energy, and for building new transmission lines to deliver it, may not only outweigh any environmental benefits but may also be detrimental to the economy, costing jobs rather than adding them."); Christine Harbin Hanson, "Bureaucrats Are Boosting Your Utility Bill," *Forbes*, April 7, 2014, http://www.forbes.com/sites/realspin/2014/04/07/bureaucrats-are-boosting-your-utility-bill/ ("However well-intentioned they are, states with RPS mandates have residential electricity prices nearly 30 percent higher than states without such mandates. This cannot be completely attributed to RPS laws, but it's undeniable that such mandates increase the cost of electricity.").

[6] Particularly as the prices to install both wind and solar continue to plummet. Since 2006, the cost to install solar has dropped by more than 73% (Solar Energy Industries Association, *Solar Industry Data: Q4 2014*, http://www.seia.org/research-resources/solar-industry-data), while in 2009 average levelized long-term price was $70/MWh in 2009, the average in 2013 fell to around $25/MWh (U.S. Department of Energy, *2013 Wind Technologies Market Report*, Energy Efficiency and Renewable Energy, August 2014, accessible at http://newscenter.lbl.gov/2014/08/18/new-study-finds-price-of-wind-energy-in-us-at-an-all-time-low-competitiveness-of-wind-has-improved/).

[7] It's also worth noting that there's a significant proportion of non-renewable distributed generation, according to the U.S. Energy Information Administration (EIA).

[8] Even utilities themselves tend to over-emphasize the role played by renewables. See for example, David Roberts, "Solar panels could destroy U.S. utilities, according to U.S. utilities," Grist, April 10, 2013, http://grist.org/climate-energy/solar-panels-could-destroy-u-s-utilities-according-to-u-s-utilities/.

[9] See, for example, U.S. Department of Energy, *2013 Renewable Energy Databook*, Energy Efficiency and Renewable Energy, 2014, http://www.nrel.gov/docs/fy15osti/62580.pdf (utility scale only); U.S. Energy Information Administration, *Short-Term*

generation from utility-scale facilities in addition to distributed generation (1MW in capacity or smaller) of renewables and residential solar, using data on capacity submitted annually by utilities to the U.S. Energy Information Administration (EIA)[10] as well as information from the Interstate Renewable Energy Council (IREC).[11] By including smaller-scale renewable power data, we more fully account for the increasing role played by renewable power generation in states' electricity mixes. We also focused on the role played by wind and solar in states' electricity generation, excluding other renewable power sources such as biomass or hydroelectric power.[12]

Renewable Power Generation in the United States

Renewable power generation, such as wind and solar, has been grabbing headlines in the United States in recent years—even months—as consumer interest has risen, hydrocarbon prices have become more volatile, and investor appetite has grown. Renewables have become quite attractive thanks to falling costs and supportive government policies (both domestic and international) that have driven investment and, therefore, industry growth.

Looking only at solar and wind in the United States illustrates this strong growth. In 2014, the U.S. solar industry was a $13.4 billion market with over 640,000 systems in place.[13] Since 2008, solar capacity additions have seen a compound annual growth rate (CAGR) of over 50%, with similarly strong gains anticipated in the coming years.[14] In 2014, solar provided roughly one-third of all new electric generating capacity in the United States.[15] As of March 2015, cumulative operating PV solar capacity eclipsed the 18 Gigawatt (GW) mark.[16]

Likewise, the U.S. wind industry was a $10 billion industry in 2014, accounting for over 4% of total electricity generated in the United States, and the largest source of renewable power

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Energy and Winter Fuels Outlook (STEO), October 2015, http://www.eia.gov/forecasts/steo/report/renew_co2.cfm (utility scale only); Houlihan Lokey, *Residential Solar Market Growth*, June 2014, http://www.hl.com/uploadedFiles/11_Blogs/Strategic-Consulting/Residential-Solar-Market-Growth_WP.pdf (residential only).

10 U.S. Energy Information Administration, *Form EIA-860 detailed data*, 2001-2014, http://www.eia.gov/electricity/data/eia860/ (utility-scale); U.S. Energy Information Administration, *Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files*, 2001-2014, http://www.eia.gov/electricity/data/eia861/ (distributed generation); U.S. Energy Information Administration, "Net generation from electricity plants for all sectors," *EIA Electricity Data Browser*, http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2 (net generation of electricity by state); U.S. Energy Information Administration, "Average retail price of electricity," *EIA Electricity Data Browser*, http://www.eia.gov/electricity/databrowser/#/topic/7?agg=0,1&geo=vvvvvvvvvvvvo&endsec=vg&freq=M&start=200101&end=201402&ctype=linechart&ltype=pin&pin=&rse=0&maptype=0; prices by end user, http://www.eia.gov/electricity/data/eia826/xls/sales_revenue.xls, (electricity prices); U.S. Energy Information Administration, "Reference Case," *Annual Energy Outlook 2015*, April 2015 (capacity factors).

11 Interstate Renewable Energy Council, *Annual U.S. Solar Market Trends Report*, July 2014, http://www.irecusa.org/annual-u-s-solar-market-trends-report/. Additional data on residential solar capacity by state shared with NewWorld Capital by IREC staff via email for years prior to 2012.

12 Some states, such as Maine or Vermont, have a substantial portion of electricity generated from biomass facilities. Likewise, hydroelectric power is a large portion of renewable power in many places around the United States. However, these types of power generation facilities are typically baseloaded (that is, they run nearly all the time) and are not intermittent resources in the same manner that generates concern about other renewable resources such as wind or solar.

13 Daniel Cusick and ClimateWire, "Solar Power Sees Unprecedented Boom in U.S.," *Scientific American*, March 10, 2015, http://www.scientificamerican.com/article/solar-power-sees-unprecedented-boom-in-u-s/; Travis Lowder, "New NREL Report Explores Solar Securitization," National Renewable Energy Laboratory, June 6, 2014 https://financere.nrel.gov/finance/content/new-nrel-report-explores-solar-securitization.

14 Travis Lowder, "New NREL Report Explores Solar Securitization," National Renewable Energy Laboratory, June 6, 2014.

15 Solar Energy Industries Association and GTM Research, *U.S. Solar Market Insight 2014 Year in Review*, March 2015.

16 Solar Energy Industries Association and GTM Research, *U.S. Solar Market Insight 2014 Year in Review* March 2015, http://www.seia.org/research-resources/solar-industry-data*r*.

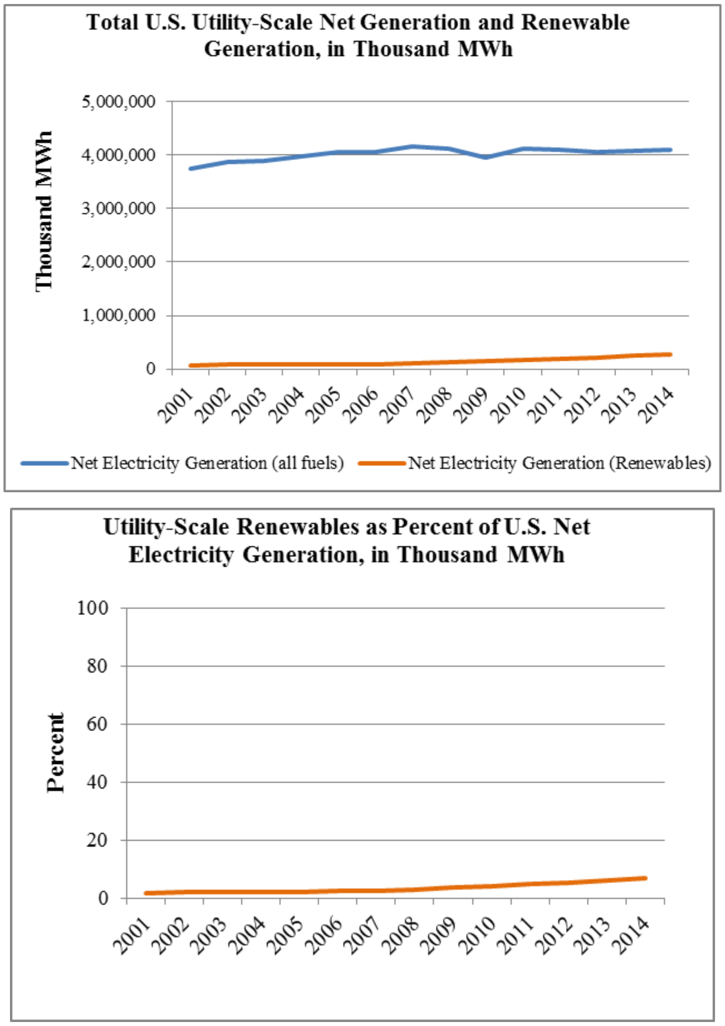
generation (after hydroelectric).[17] As of 2015, the wind industry had grown 30% annually on average for the past five years.[18] From 2010 to 2015, wind accounted for over 30% of new electricity generating capacity installed in the U.S., totaling over 66GW of utility-scale wind power capacity alone.[19]

Putting Renewables in Context

Despite such rapid growth, renewable energy continues to play a relatively modest role in the U.S. energy mix, led by utility-scale renewable generation. Although states like Iowa, Kansas, and South Dakota supply around a quarter of their in-state electricity from wind power[20] and Texas has achieved double-digit grid-system penetration of renewables[21], they tend to be the exception. Additionally, on a global scale, renewable energy generation remains only a small part of global electricity—estimated at 3.3 percent as of 2013.[22]

[17] Wind Energy Foundation, "Interesting Wind Energy Facts," http://www.windenergyfoundation.org/interesting-wind-energy-facts. Accessed December 2014; U.S. Energy Information Administration, "What is U.S. electricity generation by energy source?" *Frequently Asked Questions*, June 13, 2014, http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3.
[18] U.S. Department of Energy, "The Production Tax Credit is Key to a Strong U.S. Wind Industry," April 10, 2014, http://energy.gov/articles/production-tax-credit-key-strong-us-wind-industry.
[19] American Wind Energy Association, "Wind Energy Facts at a Glance," www.awea.org/Resources/Content.aspx?ItemNumber=5059&navItemNumber=742. Accessed July 2015,
[20] U.S. Department of Energy, "EERE 2014 Wind Technologies Market Report Finds Wind Power at Record Low Prices," Energy.gov, August 10, 2015, http://www.energy.gov/eere/articles/eere-2014-wind-technologies-market-report-finds-wind-power-record-low-prices.
[21] David Roberts, "The economic limitations of wind and solar power," *Vox*, June 24, 2015, http://www.vox.com/2015/6/24/8837293/economic-limitations-wind-solar.
[22] David Roberts, "The economic limitations of wind and solar power," *Vox*, June 24, 2015, http://www.vox.com/2015/6/24/8837293/economic-limitations-wind-solar.

Figure 2. Renewables in the U.S. Power Generation Context



Source: NewWorld calculations, based on data from the U.S. Energy Information Administration (EIA) and Interstate Renewable Energy Council (IREC).

In 2014, renewables made up roughly 7% of net electricity generation, according to EIA data.[23] But this figure only includes the larger-scale, centralized renewable energy across the United States, and therefore does not provide a sense of how renewables vary across states and the role played by distributed generation at the smaller-scale end of the market.

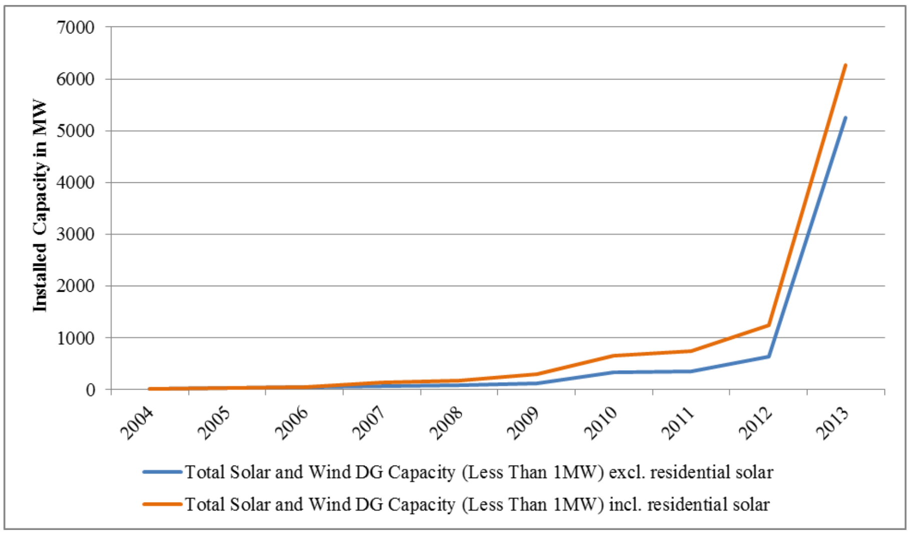
Stepping Back: Distributed Generation of Renewables

Smaller-scale, distributed generation of renewables is an even more modest piece of an already small slice of U.S. energy production. Apart from Arizona, California and a few others, most states do not have large amounts of solar penetration, let alone distributed generation or residential solar, which is a type of smaller scale distributed generation often installed on rooftops of houses.

[23] U.S. Energy Information Administration, "Net generation from electricity plants for all sectors annual," Electricity Data Browser, http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2. Accessed September 2015.

But despite the small baseline, recent growth in non-utility-scale renewables has been strong. According to EIA and IREC data, distributed generation of renewables across the entire United States has increased over 300x from 2004 to 2013.[24] But it was only in recent years that distributed generation of renewables began to significantly ramp up every year, led by residential solar. Revolutionized by financing products like the solar lease, the residential solar PV market is very active and increasingly broadly served. In 2014, the residential solar segment reached 1.2GW.[25] In 2014, residential solar marked three consecutive years of greater than 50% annual growth.[26] The commercial and industrial solar space has followed suit: in 2014 alone, over 1GW of commercial solar was installed.[27]

Figure 3. U.S. Distributed Generation Capacity, Solar and Wind



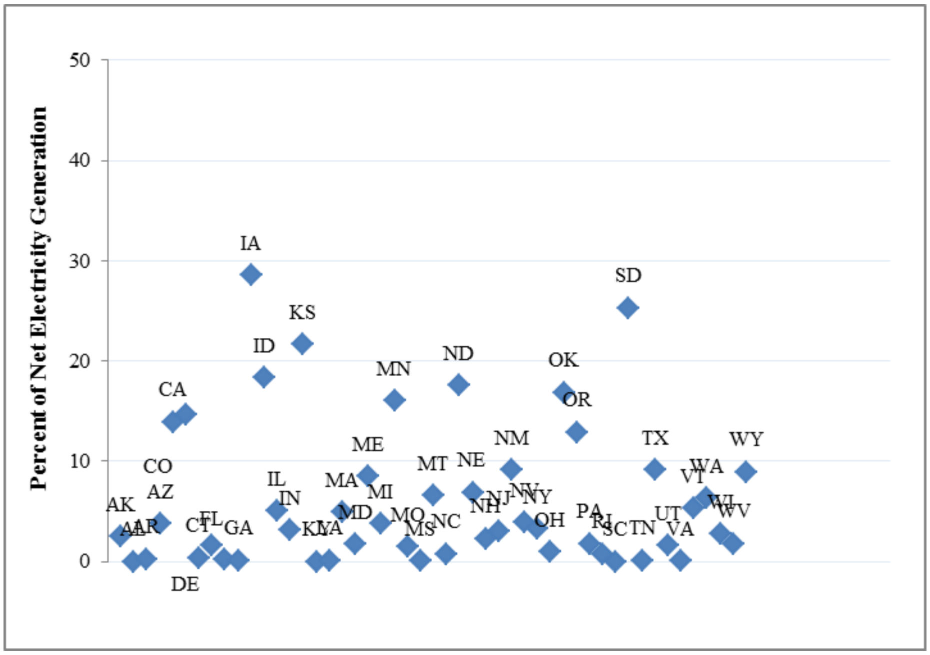
Source: NewWorld calculations, based on data from the EIA and IREC.

Distributed Generation of Renewables

The top ten states by share of renewable generation collectively had roughly 3,000MW of distributed generation renewable capacity in 2013, while the bottom ten together had just over 200MW.[28]

[24] NewWorld calculations, based on data from the EIA and IREC.
[25] Solar Energy Industries Association and GTM Research, *U.S. Solar Market Insight 2014 Year in Review*, March 2015.
[26] Solar Energy Industries Association and GTM Research, *U.S. Solar Market Insight 2014 Year in Review*, March 2015.
[27] NewWorld calculations, based on data from the EIA and IREC.
[28] NewWorld calculations, based on data from the EIA and IREC.

Figure 4. Share of Electricity Generation from Wind and Solar (Utility-scale, Distributed Generation, and Residential-scale), 2014

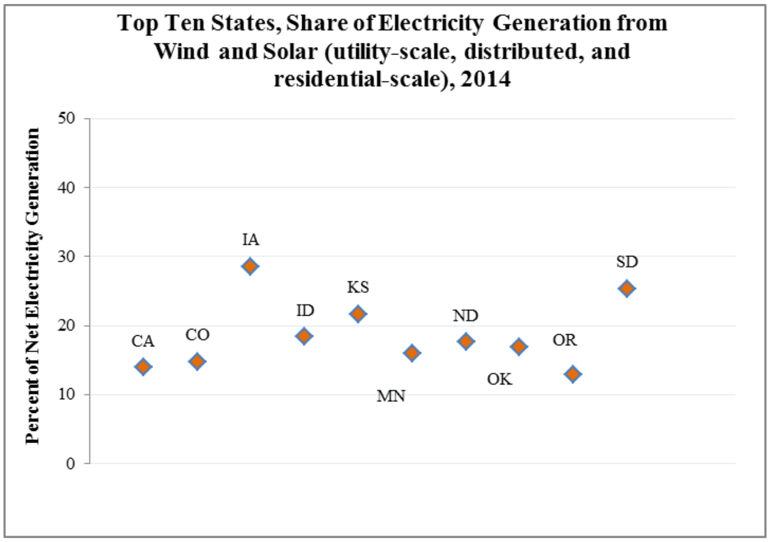


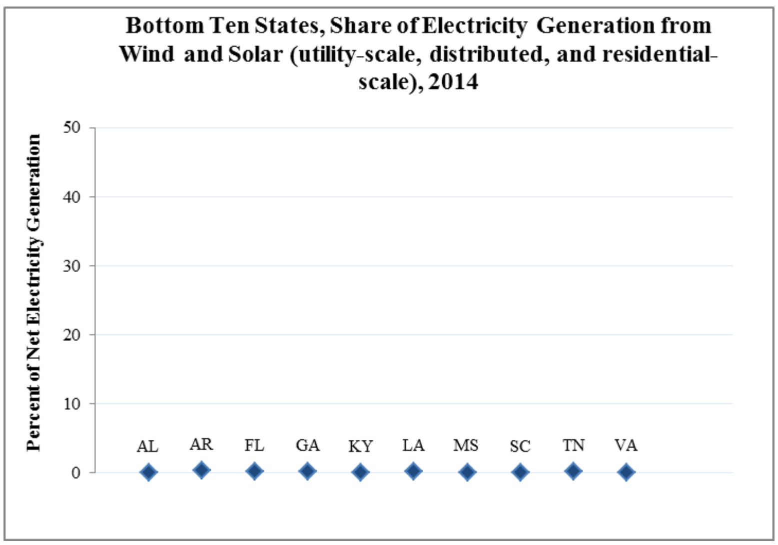
Source: NewWorld calculations, based on data from the EIA and IREC.

State(s) of the Union: Renewable Energy in the Top and Bottom Ten States

The share of electricity generation from renewables (including utility-scale, distributed generation, and residential solar) varies tremendously across the United States, ranging from a high in Iowa of nearly 30 percent to states with essentially 0% share of electricity generated from renewable sources.

Figure 7. Share of Electricity Generation from Wind and Solar





Source: NewWorld calculations, based on data from the EIA and IREC.

Distributed generation has been a strong contributor to states' growing renewable power. Setting aside residential solar, renewable distributed generation capacity increased by roughly 340x over the 2004 total for solar and 14x for wind in the top ten states. In the bottom ten states, renewable distributed generation capacity rose 330x for solar and 5x for wind by 2014. But the starting point in 2004 for the bottom ten states was close to 0MW. In contrast, in the top ten states, the starting point was roughly 12MW. It took the bottom ten states until 2011 to reach that level of distributed generation of renewables.

The fact that renewables have seen such rapid growth in many U.S. states over the past decade is a testament to the market's potential. But it is important to remember that this growth began from a very low starting point. To the extent that renewables, let alone distributed generation of renewables, has any certain effect—either positive or negative—on the broader electricity grid or electricity prices, it is range-bound by the still-modest scale of renewables in the U.S. electricity mix.

Are Renewables Driving Up Electricity Prices?

Determining the cause of increasing electricity prices or the price effects of renewable power generation is a complex task, which is beyond the scope of this essay. But given the claims about renewables causing rapid growth in electricity prices, it is still useful to compare retail electricity prices in states with higher shares of renewable power generation to retail electricity prices in states with little—if any—electricity generation from renewable sources.

Targeting Renewables

Many voices still contend that more renewables mean higher energy prices for customers.[29] Residential solar, which has seen particularly rapid annual growth, has in particular come under fire.

For example, a March 2014 memorandum from the lead utility analyst at Bernstein Research, stated: "…distributed solar generators enjoy a parasitic relationship with their host, relying on the utilities for grid access and backup power supplies while eroding utilities' power sales and revenues."[30] This argument rests on the idea of an 'inherent subsidy' for distributed generation of solar, and though such an idea can be easily defended in theory, there is a lack of context in both absolute scale (just how big a cost is shifted to the 'victim'?) and relative to other institutionalized subsidies (*e.g.*, rural electrification, special rates to induce industrial relocation, stranded asset payments).

Even so, a common refrain (often from utilities) is that, since they are required to purchase electricity from residential solar generation at the same price they resell to other consumers, utilities earn nothing to cover their fixed costs. Rates, they argue, should be raised to make up the difference, thus leading to higher electricity prices for all.[31] As the conventional wisdom goes, as more homes install residential solar, there is more grid 'defection' and fewer customers to cover the fixed costs associated with transmitting and distributing energy, leading to higher electricity prices for everyone else. That same 2014 memo from Bernstein Research went on: "As distributed generation grows, utilities will face ongoing pressure to raise rates to preserve

[29] See for example, Kenneth P. Green, "Renewable Energy Sources Mean Higher Electricity Bills," *Huffington Post*, June 27, 2015, http://www.huffingtonpost.ca/kenneth-p-green/renewable-energy-higher-bills_b_7155666.html ("But if national and international experiences can teach us anything, it's that so far, more renewable generation leads to one thing -- higher prices."); Robert Bryce, "More Energy Mandates Mean Higher Prices," *Manhattan Institute for Policy Research*, March 9, 2012, http://www.manhattan-institute.org/html/miarticle.htm?id=7940#.VcS1jvlrnL8 ("There is growing evidence that the costs may be too high that the price tag for purchasing renewable energy, and for building new transmission lines to deliver it, may not only outweigh any environmental benefits but may also be detrimental to the economy, costing jobs rather than adding them."); Christine Harbin Hanson, "Bureaucrats Are Boosting Your Utility Bill," *Forbes*, April 7, 2014, http://www.forbes.com/sites/realspin/2014/04/07/bureaucrats-are-boosting-your-utility-bill/ ("However well-intentioned they are, states with RPS mandates have residential electricity prices nearly 30 percent higher than states without such mandates. This cannot be completely attributed to RPS laws, but it's undeniable that such mandates increase the cost of electricity.").

[30] As quoted in "The Power Industry in Transition – Distributed Generation, Rooftop Solar, Utility Regulation, Disruptive Technologies, Back-Up Charges, Net Metering, David Crane, Value-Based and Rate-Based Solar," *Chadbourne Insight*, June 2014. http://www.chadbourne.com/power_industry_june2014_projectfinance/.

[31] For example, see SCE in 2012: Christopher Martin and Mark Chediak, "California Utilities Say Solar Raises Costs for Non-Users," *Bloomberg Business*, December 17, 2012, http://www.bloomberg.com/news/articles/2012-12-17/california-utilities-say-solar-raises-costs-for-non-users.

revenues, only adding to the attractive[ness, sic] of distributed solar and accelerating revenue losses."[32]

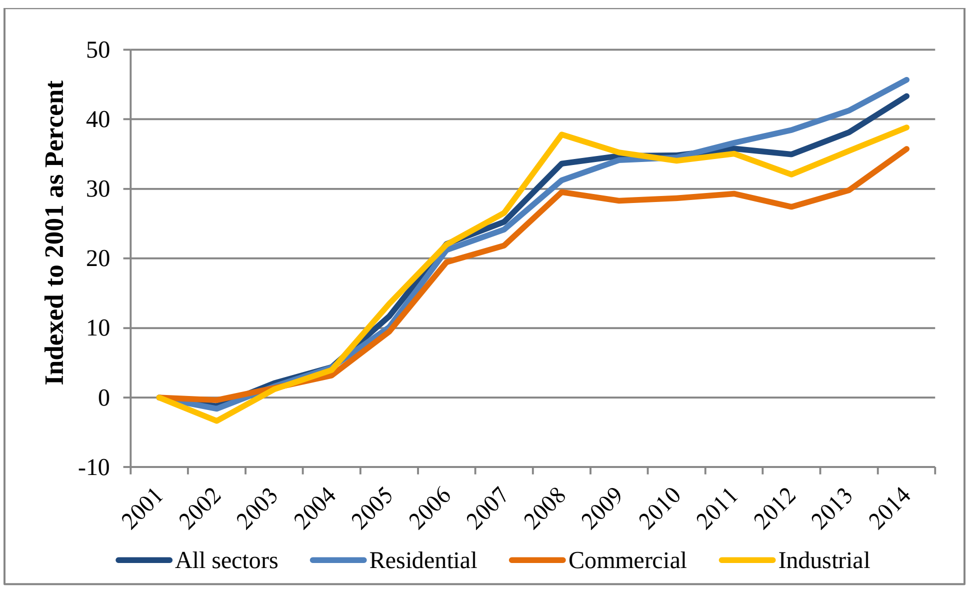
But the story is not that simple. It is worth keeping in mind that residential solar is a small piece of an already modest share of electricity generation. Indeed, market penetration of residential solar is still only a modest portion of the overall energy capacity mix, even in states like California (where residential solar is roughly 0.6% of electricity capacity) or Arizona (where residential solar is roughly 0.5%), as of 2013.[33]

Observing retail electricity prices and renewable electricity generation at the national- and state-level over the past decade makes it clear: conclusive claims about renewables driving electricity prices—in either direction—should be viewed with skepticism, on the basis of renewable power generation's scale at a minimum.

Increasing Electricity Prices

End users have seen a remarkable increase in electricity prices over the past decade—and more. Retail electricity prices for the residential, commercial, and industrial sectors have increased by more than 30 percent since 2001 (in real terms)—a total average price increase across all consumer segments exceeding 40 percent.

Figure 6. Annual Average Retail Price of Electricity for the United States



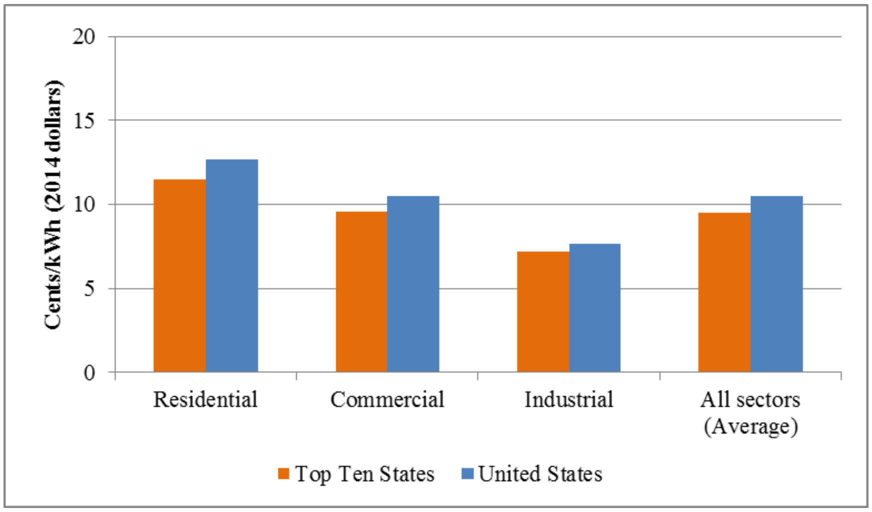
Source: based on data from the U.S. Energy Information Administration, *Electric Power Monthly*, July 2015, http://www.eia.gov/electricity/monthly/. Accessed October 2015.

[32] As quoted in "The Power Industry in Transition – Distributed Generation, Rooftop Solar, Utility Regulation, Disruptive Technologies, Back-Up Charges, Net Metering, David Crane, Value-Based and Rate-Based Solar," *Chadbourne Insight*, June 2014. http://www.chadbourne.com/power_industry_june2014_projectfinance/.
[33] NewWorld calculations, based on data from the EIA and IREC.

Renewables and Electricity Prices

We examined data on renewable generation[34], electricity generation, and electricity prices since 2004, including distributed generation of renewables.[35] We observed from this analysis that the top ten states with higher shares of renewable power generation had lower retail electricity prices in 2014 than the U.S. national average retail price, for all customer segments (residential, commercial, and industrial).

Figure 8. Average Retail Electricity Price by Segment for 2014 (in 2014 dollars)

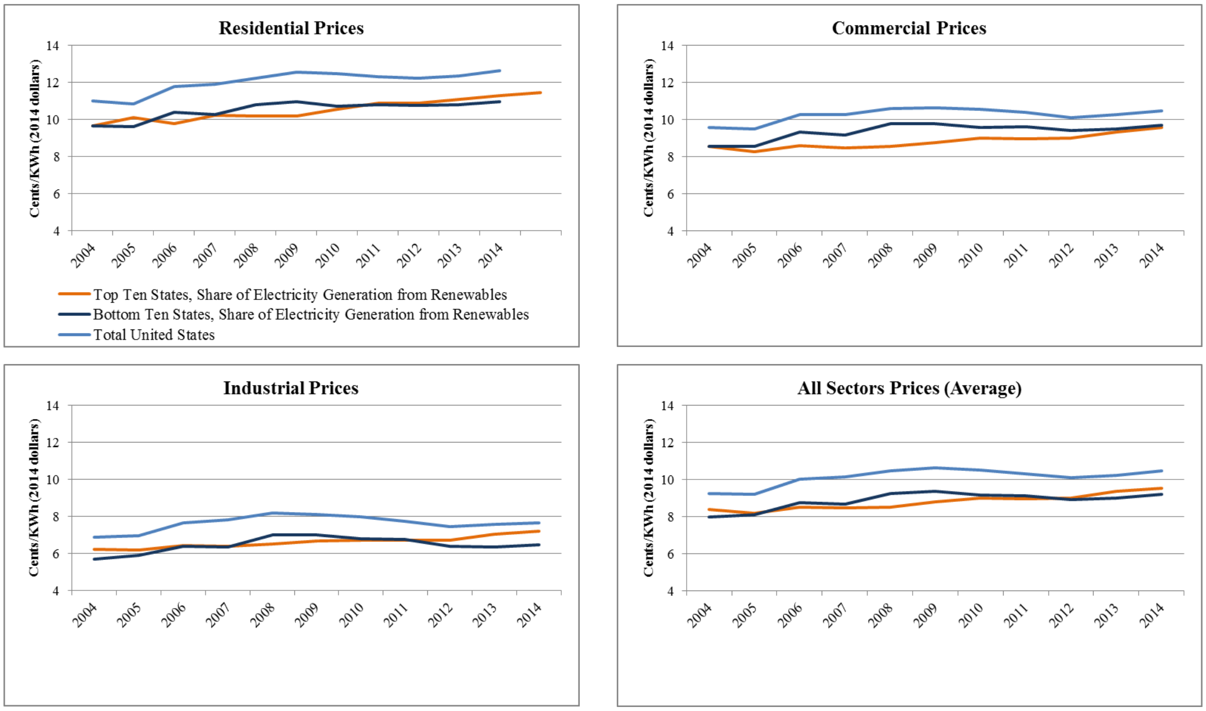


Source: NewWorld calculations, based on data from the EIA and IREC.

This observed trend appeared to hold consistent over time. Indeed, for the most part over the last decade, we observed that states with higher shares of renewable power generation annually saw retail electricity prices that were lower than the prices seen in the lagging ten states for renewable power generation. In addition, the top ten states for renewables saw lower prices across the board than the national averages, across all retail segments.

[34] We exclude hydroelectric from the definition of "renewable energy", following the EIA's convention.
[35] Again, we exclude Hawaii from this analysis because, unlike other U.S. states, a large portion of its electricity is generated from oil, and therefore its retail electricity prices should differ substantially.

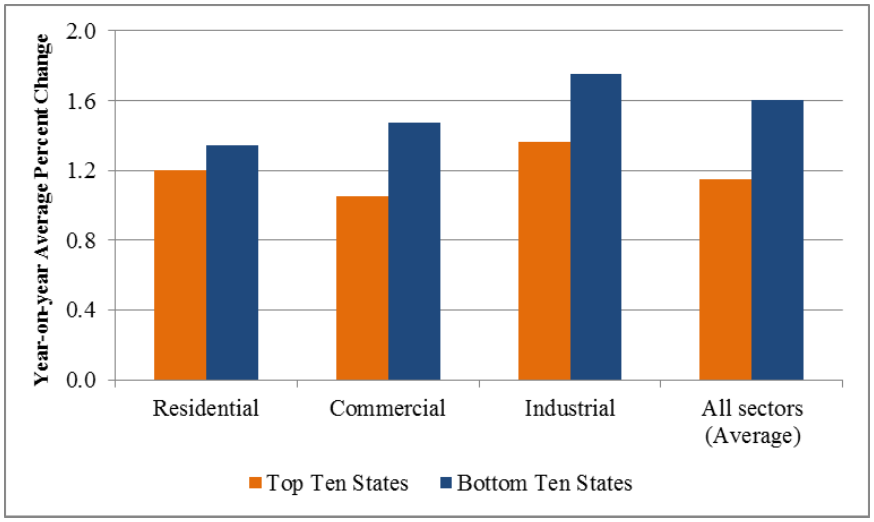
Figure 9. Retail Electricity Prices Over Time, 2004-2014 (in 2014 dollars)



Source: NewWorld calculations, based on data from the EIA.

Overall, we also observed that states with more renewable power generation saw retail electricity prices grow more slowly over the past decade than retail prices in states with the least renewable generation, again across the residential, commercial, and industrial segments.

Figure 8. Average Annual Percent Change in Price, 2004-2014 (in 2014 dollars)



Source: NewWorld calculations, based on data from the EIA and IREC.

Average Annual Percent Change in Price, 2004-2014 (2014 dollars)			
	Top Ten States	Bottom Ten States	United States
Residential	1.2	1.3	1.4
Commercial	1.1	1.5	1.0
Industrial	1.4	1.8	1.3
All sectors (Average)	1.2	1.6	1.3

Source: NewWorld calculations, based on data from the EIA and IREC.

In no way does this analysis conclusively prove that renewables lead to lower or higher retail electricity prices in the United States. By observing price movements relative to trends in renewable power generation, we are not claiming to demonstrate cause and effect. There are likely a range of other complex factors at work in the top ten or bottom ten states that play a role in determining the price of electricity for consumers and that may make the top ten or bottom ten states different in one way or another.

Still, these trends illustrate that it is possible to observe lower electricity prices along with higher shares of renewables, casting doubt along the way on any conclusive assertion that renewable energy—specifically, distributed generation of renewables such as rooftop solar—causes higher retail electricity prices for consumers.

Renewable Power Generation and Grid Benefits

How could generating electricity from renewable sources help the grid and possibly even help stabilize electricity prices? The story is rather complex. Focusing on price effects from renewable power generation can obscure an important discussion about broader benefits of renewable power generation, particularly distributed generation, for just as renewable power generation can pose challenges to the grid, they also offer important benefits.

A large part of what a customer pays for electricity has to do with reliability and capacity ("as much electricity as you want, whenever you want it"). The actual cost of energy supply that a customer is paying for, in fact, is relatively small. Capacity, taxes, transmission, and distribution (the non-energy functions of the grid) make up the majority of the price the end user pays (about two-thirds, depending on geographic location). For example, for a National Grid customer in New York, the energy supply costs roughly 3 cents of the 10 cents/kWh rate.[36] As an example, this intuition played out dramatically in the United States in recent years with the shale gas boom, which shoved natural gas prices downward as supply expanded and more electricity was generated from natural gas—but without any material effect on electricity prices that customers

[36] Sara Asserud, "Understanding Your Utility Bills: Homeowner's Edition (Part 2)," Antares Group, May 11, 2012, http://antaresgroupinc.com/understanding-your-utility-bills-homeowners-edition-part-2/.

experienced. In general, the cost of the fuel source for electricity generation matters less to the price a customer pays than the cost of everything else that the safe and reliable provision of electricity entails.

This point is important: although renewable distributed generation (like rooftop solar) might not be drawing upon non-energy functions of the grid while it is producing power, it will still be providing other valuable, grid-related functions, such as load reduction or peak shaving.

Indeed, the 'last mile' of transmission and distribution of electricity is a relatively small portion of the benefits provided by the grid and, therefore, what consumers are purchasing. As an example, consider a house on a street in the U.S. connected to the grid. If the house burns down and the family moves away permanently, and therefore requires no energy from the grid, does that increase the cost of electricity for everyone else on the street? Importantly, are rate changes or increases in electricity prices blamed on such a move? No. Why? Because the electricity lines in the neighborhood were laid long ago and other associated costs are sunk.

The contention that rooftop solar is subsidized by others is likewise flawed. Because electrical utilities provide public services, all residential connections are subsidized to some degree, some much more so than others (for example, rural neighborhoods versus urban ones). Consider another example: A family lives in a single family dwelling that is connected to the grid, while down the street there is a multi-tenant apartment complex, which has over one hundred residents and is also connected to the grid. In this case, each party pays the same rate for power—which means that the electricity consumed by the single family that can afford to live in their own house is substantially subsidized, relative to the hundred people who are all living in one building and sharing the same stretch of wire. Subsidies are relative—and everywhere—in electricity.

Now consider a house on a street with a solar panel array connected to the grid. Like the other house that burned down, it requires no energy from the grid (on average). Unlike the other building, it is also contributing electricity into the grid for others, expanding grid capacity without drawing on load. By contributing electricity into the grid, not only is the residential system adding to the grid's capacity, but it is also helping to shave overall peak demand in the system. This is because of the nature of the residential consumer segment and peak demand. In the residential segment, peak output from solar occurs during the day, while peak demand tends to occur at night. That means that during the day, residential systems tend to contribute electricity into the grid, which can meet peak electricity demand elsewhere (such as in the commercial and industrial space, which is most active during the workday). This peak shaving function is worth noting in context of supposed rate hikes attributed to renewables generation. Moreover, it is worth recalling the current scale of residential solar, even in some of the leading states (less than 1%).

So while solar panels on houses are generating peak output when the load is not there (because no one is home), it is not necessarily as efficient as C&I distributed solar, which co-locates peak supply and peak demand. However, it is also worth noting that many utilities build natural gas power plants to meet peak demand (often called gas "peakers") geographically in places where the load is not—often even hundreds of miles away from peak demand. So while solar panels on houses may not be the optimum solution, it is still a fairly attractive one.

Furthermore, distributed generation, whether at the residential or C&I level and whether net metered or not, is also a load reduction.[37] This is because customers, who have their own generation facilities provide much of their own energy needs, and, therefore, utilities that must purchase capacity and power to meet their load need to purchase less power than they otherwise would. To the extent that distributed generation in effect reduces load, it also reduces the need for associated grid support or ancillary services that would otherwise be required (such as spinning, non-spinning, and capacity reserves, which are used to stabilize frequency and meet demand during unforeseen load swings or other emergency situations).[38]

The value proposition for both end user and the grid alike gets even better. Non-residential distributed generation (such as C&I) not only serves the same grid capacity function that residential solar does, but also helps shave peak demand even more efficiently by generating peak output (sun in the middle of the day) alongside local peak consumption (e.g., a manufacturing facility that runs during the workday that is the end user of electricity), without transmission constraints or costs. Looking narrowly at energy efficiency only, the U.S. EIA calculates that transmission and distribution losses come to 6% of the total electricity in the United States generated annually (on average).[39] Other transmission constraints (the capacity of transmission wires, for example) can also increase costs. Co-locating peak supply and peak demand minimizes line or transmission and distribution costs, and thus also reduces overall load (because less energy is required to be produced at the central source by avoiding transmission constraints).

Given all these grid benefits, renewable distributed generation illustrates why the cost/benefit analysis of renewable energy distributed generation requires a more nuanced review. It is no wonder that renewable C&I distributed generation has grown by 100-fold since 2004 across the United States.[40]

What to Count and What to Value?

The critical question thus becomes: to the extent that a distributed renewable energy generation system might provide countervailing benefits to the larger distribution system and grid capacity, what is the net value? More specifically, to what extent do peak shaving services from distributed generation outweigh marginal increases in rates for other customers? In recent years, there have been a number of studies to give weight to this approach. Indeed, these studies have found the benefits of residential distributed generation significantly outweigh the costs.

A January 2013 report on California's market found, "[Net Energy Metering, or NEM] does not produce a cost shift to non-participating ratepayers; instead it creates a small net benefit on

[37] Public Service Department, *Evaluation of Net Metering in Vermont Conducted Pursuant to Act 125 of 2012*, State of Vermont, January 15, 2013.
[38] Electricity Innovation Lab, *A Review of Solar PV Benefit & Cost Studies*, Rocky Mountain Institute, Second Edition, September 2013); http://www.nrel.gov/electricity/transmission/glossary.html.
[39] U.S. Energy Information Administration, "How much electricity is lost in transmission and distribution in the United States?," July 10, 2015, http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3. Based on average annual losses from 2004-2013.
[40] U.S. Energy Information Administration, *Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files*, 2001-2014, http://www.eia.gov/electricity/data/eia861/.

average across the [investor owned utilities'] residential markets. NEM is even more cost-effective for non-participants in the commercial, industrial and institutional (C&I) market."[41]

Similarly a Vermont study from the same year concluded, "The analysis presented in the preceding sections indicates that net metered systems do not impose a significant net cost to ratepayers who are not net metering participants….Impacts on transmission and distribution infrastructure costs are a significant component of the value of net-metered systems. Solar PV has much greater coincidence of generation with times of peak demand than does wind power; this results in more net benefits for solar PV than for wind."[42]

Another 2013 study on Arizona determined that "…the benefits of DG [distributed generation] on the APS system exceed the cost, such that new DG resources will not impose a burden on APS's ratepayers….The benefits exceed the costs by more than 50%....each dollar of cost DG provides $1.54 worth of benefits to APS customers….The benefits also exceed the costs in both the residential and commercial markets considered individually."[43]

More broadly, the National Renewable Energy Laboratory found that distributed generation has the ability to "mitigate congestion in transmission lines, reduce the impact of electricity price fluctuations, strengthen energy security, and provide greater stability to the electricity grid."[44] The California Public Utilities Commission found in 2013 that "net-metering avoids costs in six separate components: power generation, system capacity, ancillary services, transmission [and] distribution capacity, carbon emissions, and Renewable Portfolio Standard compliance."[45]

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In this essay, we aim to showcase the true role played by renewables (including distributed generation) in the U.S. electricity mix while also illustrating how renewables may also be observed along with lower electricity prices, in contrast to claims that renewables cause higher electricity prices.

We also considered how distributed generation of renewables could contribute to the grid by showcasing the role that renewables play in the United States. Some government policy leaders are taking a more holistic look at renewable energy and specifically distributed generation of renewables. One alternate view worth considering is that when a customer installs a distributed generation project, they are undertaking upfront capital expenditures that the utility might otherwise need to do. In exchange, the net metered customer perhaps should receive lower electric bills as compensation for expending the capital for the generating project instead of the utility.

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[41] R. Thomas Beach and Patrick G. McGuire, *Evaluating the Benefits and Costs of Net Energy Metering in California*, Crossborder Energy, January 2013. IB rate means charging more for additional kilowatt-hours as a household consumes more over the billing period.

[42] Public Service Department, *Evaluation of Net Metering in Vermont Conducted Pursuant to Act 125 of 2012*, State of Vermont, January 15, 2013.

[43] R. Thomas Beach and Patrick G. McGuire, *The Benefits and Costs of Solar Distributed Generation for Arizona Public Service*, Crossborder Energy, May 8, 2013.

[44] "NREL, December 2012, http://1.usa.gov/1kifV5m." As quoted in American Council on Renewable Energy, "Energy Fact Check," http://reffwallstreet.com/efc_bkup/slideshow/distributed-generation-and-net-metering-policies-harm-utilities-and-provide-no-benefits-to-ratepayers/. Accessed October 2015.

[45] California Public Utilities Commission Energy Division, *California Net Energy Metering Ratepayer Impacts Evaluation*, October 2013, http://www.cpuc.ca.gov/NR/rdonlyres/D74C5457-B6D9-40F4-8584-60D4AB756211/0/NEMReportwithAppendices.pdf. As cited and quoted in American Council on Renewable Energy, "Energy Fact Check," http://reffwallstreet.com/efc_bkup/slideshow/distributed-generation-and-net-metering-policies-harm-utilities-and-provide-no-benefits-to-ratepayers/. Accessed October 2015.

A member of the Maryland Public Service Commission recently described how a state might better evaluate rooftop solar. The state would hold a proceeding to determine the fair value of what the customer is providing to the grid, asking a series of guiding questions: "Is it the wholesale power rate or is there some other benefit? For example, is there a benefit through reduced transmission expense? Is there a benefit through greenhouse gas impact? On the other side of the ledger, the customer would continue to pay for the electricity he takes off the grid. That takes away the idea that customers are unfairly using the network or shifting a burden. The customer can be paid for what she generates, and she can pay for her use of the network."[46]

Another example is Hawaii, where the state has been not only looking at net metering, but also the value of all distributed generation and characteristics that are needed to stabilize the grid, focused by the idea that "…you pay for the services that you receive from the grid, and you are fairly compensated for services that you provide that help the grid."[47] As of October 2015, though Hawaiian Electric (HECO) will not accept new customers under its original net metering program, it will seek to put into place two new tariffs to bridge between continued deployment of renewables and grid stability.[48]

Meanwhile, electricity rates seem to just keep on rising, echoing trends for other utilities. Utilities, such as water and natural gas, overall have roughly doubled (if not more) their prices since the 1980s.[49]

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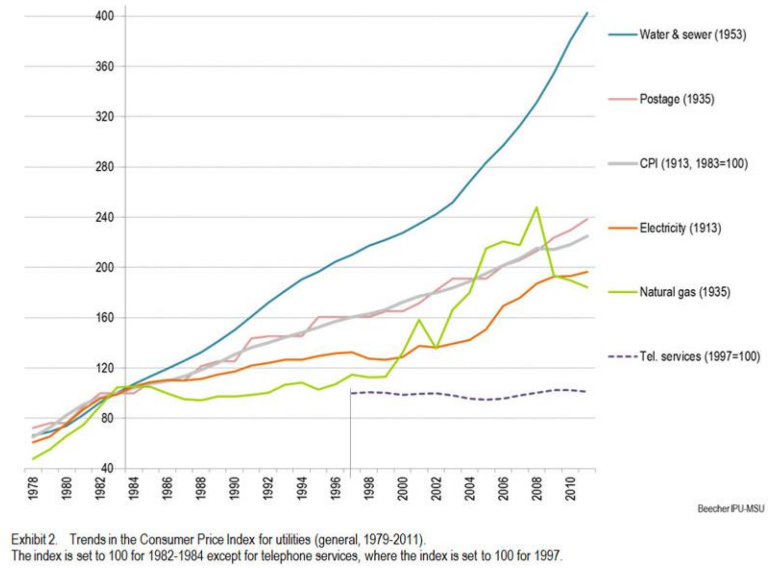
[46] Anne Hoskins, a member of the Maryland Public Service Commission. As quoted in "The Power Industry in Transition – Distributed Generation, Rooftop Solar, Utility Regulation, Disruptive Technologies, Back-Up Charges, Net Metering, David Crane, Value-Based and Rate-Based Solar," *Chadbourne Insight*, June 2014, http://www.chadbourne.com/power_industry_june2014_projectfinance/.

[47] Hermina Morita, chairwoman of the Hawaii Public Utilities Commission. As quoted in "The Power Industry in Transition – Distributed Generation, Rooftop Solar, Utility Regulation, Disruptive Technologies, Back-Up Charges, Net Metering, David Crane, Value-Based and Rate-Based Solar," *Chadbourne Insight*, June 2014, http://www.chadbourne.com/power_industry_june2014_projectfinance/.

[48] Julia Pyper, "Hawaii Regulators Shut Down HECO's Net Metering Program," *Greentech Media*, October 14, 2015, http://www.greentechmedia.com/articles/read/hawaii-regulators-shutdown-hecos-net-metering-program.

[49] Institute of Public Utilities/Michigan State University, "Trends in Consumer Prices (CPI) for Utilities through 2011," *IPU Research Note*, March 2012, http://ipu.msu.edu/research/pdfs/IPU-Consumer-Price-Index-for-Utilities-2011-2012.pdf.

Figure 10. Trend in Consumer Prices for Utilities Over Time



Source: Reproduced from Institute of Public Utilities/Michigan State University, "Trends in Consumer Prices (CPI) for Utilities through 2011," *IPU Research Note,* March 2012, http://ipu.msu.edu/research/pdfs/IPU-Consumer-Price-Index-for-Utilities-2011-2012.pdf.

Yet electric utilities around the United States are taking aim at distributed generation of renewables. According to an August 2015 report from the North Carolina Clean Energy Technology Center, there were 23 examples of utilities seeking to increase residential customers' monthly fixed charges by 10 percent or more in Q2 2015—and these charges do not only affect solar customers.[50] As a member of the Maryland Public Service Commission put it, "One thing that will come into play as we get the repeated requests for rate increases is the issue of affordability….We have so many investments that need to be made both in our natural gas infrastructure and our electricity infrastructure, but we also have rules that do not allow us to charge people differently based on income. Will the limited rate at which general wage levels are increasing become a cap on what we are able to invest in, even though these investments produce an overall social benefit? The issue of balancing affordability with reliability is going to become a significant challenge for us."[51]

Maryland is not an isolated example. Our aim in this analysis is both to broaden the national discussion by putting renewable energy generation in context and to provoke thinking about the many ways in which distributed generation from renewables can complement and augment traditional energy production in many regions of the United States.

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[50] According to a report by the North Carolina Clean Energy Technology Center, there were 18 instances in 16 states of proposed or enacted changes to net metering policies during the second quarter of 2015 (NC Clean Energy Technology Center, *The 50 States of Solar: A Quarterly Look at America's Fast-Evolving Distributed Solar Policy Conversation: Q2 2015*, August 2015). As described in Julia Pyper, "The Politics of Net Metering Get Picked Up in the Presidential Campaign," *Greentech Media*, August 19, 2015, http://www.greentechmedia.com/articles/read/The-Politics-of-Net-Metering-Get-Picked-Up-in-the-Presidential-Campaign.

[51] Anne Hoskins, a member of the Maryland Public Service Commission. As quoted in "The Power Industry in Transition – Distributed Generation, Rooftop Solar, Utility Regulation, Disruptive Technologies, Back-Up Charges, Net Metering, David Crane, Value-Based and Rate-Based Solar," *Chadbourne Insight*, June 2014, http://www.chadbourne.com/power_industry_june2014_projectfinance/.

To properly understand the impact of increasing distributed generation of renewable energy, it stands to reason that we need to continue to consider the potential benefits to the network along with potential costs. The exact magnitude of the benefits and costs of distributed generation from renewables may not be easily quantified. But at a minimum, considering renewable distributed generation in a broader context makes it apparent that distributed generation of renewables does not automatically mean higher electricity prices or more cost for everyone. Moreover, to the extent that capacity and peak shaving benefits from distributed generation at least matches, or outweighs, any marginal increases in rates, distributed generation of renewables will continue to make sense—and cents—for many Americans.

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