New Orleans' Renewable Portfolio Standard: Affordable, Reliable, Resilient

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Applied Economics Clinic

Prepared on behalf of
Alliance for Affordable Energy

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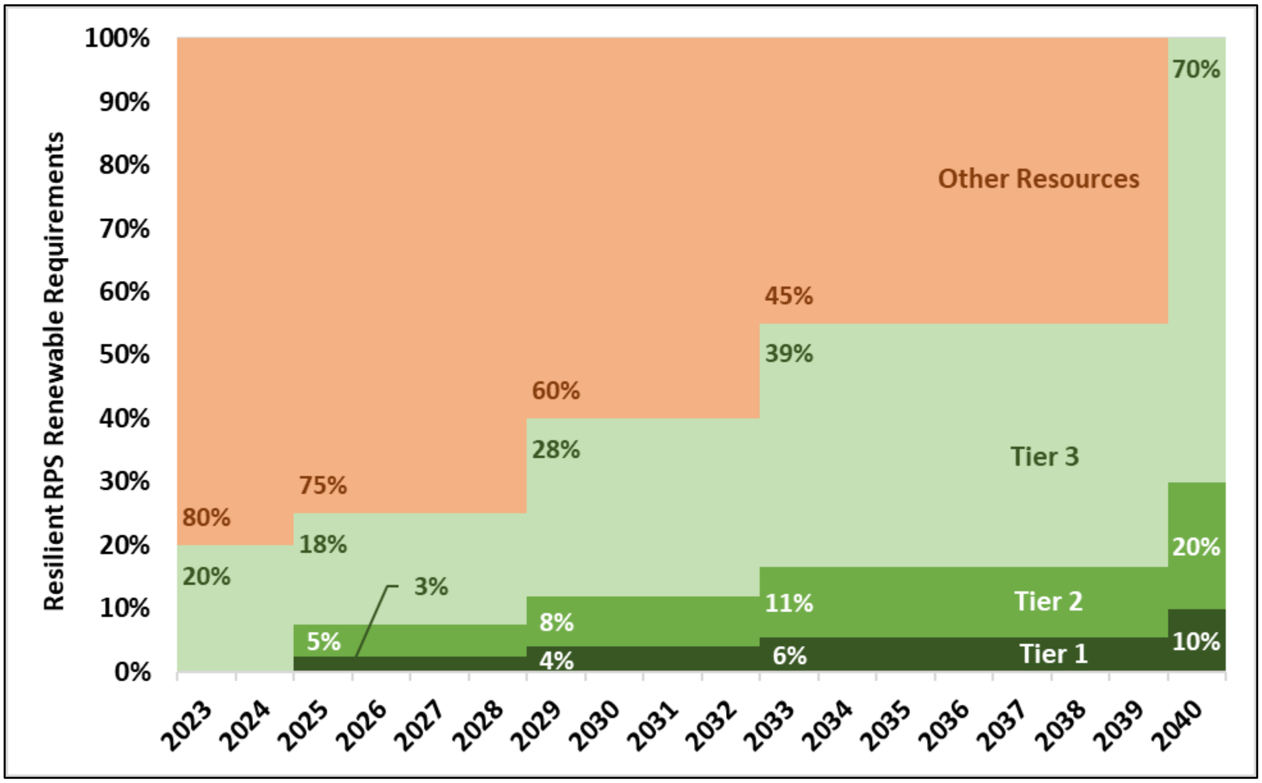
Executive Summary

This Applied Economics Clinic report, prepared on behalf of the Alliance for Affordable Energy, addresses Entergy New Orleans' (ENO) critiques of the Energy Future New Orleans Coalition July 2019 Resilient Renewable Portfolio Standard (R-RPS) proposal to achieve a 100 percent renewable electric generation by 2040 (see Figure ES-1 below). AEC's analysis of the R-RPS found the plan to be affordable, while providing both grid reliability and resilience benefits to customers.

Figure ES-1. ENFO New Orleans R-RPS



ENO incorrectly claims that the R-RPS would:

- Be prohibitively costly,
- Harm grid resiliency, and
- Harm grid reliability.

AEC's research and analysis concludes that the R-RPS would be less costly than firm capacity resources and reduce the cost of balancing the grid, would provide substantial resiliency benefits, and would reliably provide New Orleans' energy needs (see Table ES-1 below).

Table ES-1. ENO critiques and responses

ENO Claim	Reality
Unaffordable: ENO claims that the R-RPS proposal would greatly increase customer costs	**Affordable:** Renewable energy does not require firm capacity in order to be cost-effective, in fact, the most reliable, resilient and affordable option would be to pair renewable energy with load flexibility resources
Not resilient: ENO claims that the enhanced resilience that EFNO asserts is a benefit of battery storage and microgrids is "unsubstantiated"	**Resilient:** Renewable energy and load flexibility resources allow the grid to better withstand extreme weather events and—if needed—to isolate themselves and continue to operate in "island" mode when the larger grid is unable to provide electricity
Unreliable: ENO claims that without large amounts of battery storage, the R-RPS would negatively impact grid reliability	**Reliable:** Paired with load flexibility resources, 100 percent renewable electricity can successfully provide grid reliability to New Orleans families and businesses

The R-RPS would be more affordable than reliance on firm capacity resources

Renewable energy and load flexibility resources like demand response, energy efficiency, and battery storage are currently available and cost competitive. At 0.2 to 1.3 cents per kilowatt-hour, demand response is cheaper than any other resource on a levelized basis. Wind, solar and energy efficiency prices are 17 to 70 percent lower than ENO's Grand Gulf nuclear plant (a key component of ENO's Clean Energy Standard proposal, which the utility falsely claims is necessary to keep customer rates low) and existing coal elsewhere in ENO's grid connected region—the Midcontinent Independent System Operator (MISO).

The R-RPS would enhance the resilience of New Orleans' grid

Resilience benefits are well known and well understood—states, cities and utilities are increasingly acknowledging the important and valuable resiliency benefits of storage and other load flexibility technologies. Resilience ensures that critical loads like hospitals, military bases, and telecommunications (essential for meeting basic human needs and ensuring safety) will always be provided, even during a severe weather event like Hurricane Katrina.

The R-RPS would reliably provide New Orleans' energy needs

New Orleans is not an electrical island; ENO has the benefit of interconnection with the larger MISO region, which helps to balance supply and demand. ENO's interconnection in the MISO energy system means that ENO can sell energy and capacity when it generates more than it needs to serve demand, and purchase these services when it faces a shortfall. MISO also has an abundance of cheap wind energy available.

The R-RPS would reduce the cost of balancing the grid

Today's energy resource planning revolves around how to meet peak load, and a very high share of customer costs comes from resources that may only run a few hours a year. Tomorrow's energy system will avoid these costs through investment in load flexibility resources that enable more renewables on the grid, maintain reliability, enhance resiliency, and are already cost-competitive with firm resources (with prices that are predicted to drop further).

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Introduction

In March 2019, the New Orleans City Council approved resolution R-19-109 opening rulemaking UD-19-01 to consider proposals to establish a Renewable Portfolio Standard (RPS) for the City of New Orleans.[1,2] If adopted, an RPS would require Entergy New Orleans (ENO) to supply a growing share of its energy from renewable sources like solar and wind. Currently, ENO has no wind capacity and its solar capacity accounts for just 0.4 percent of its electric generating resource portfolio (see Table 1).

Table 1. ENO current resource portfolio

Resource	MW	%
Solar	5	0.4%
Demand Response/Energy Efficiency	22	1.9%
Coal	32	2.8%
Gas	685	59.6%
Nuclear	422	36.7%
Third Party PPAs	11	1.0%
Total	**1,150**	**100%**

Note: This capacity does not include the approved, but not yet built, 128 MW natural gas-fired New Orleans Power Station (New Orleans Council Docket UD-16-02) or the 90 MW of utility-scale solar (Council Docket R-19-293) which is planned to go online in 2021. ENO uses the term "load modifying resources" to describe what we assume refers to demand response and energy efficiency.
Source: Entergy New Orleans, LLC. 2019. 2018 Integrated Resource Plan. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

In July 2019, the Energy Future New Orleans Coalition (EFNO) filed their Resilient RPS (R-RPS) proposal to achieve a 100 percent renewable electric generation by 2040.[3] EFNO's R-RPS allows renewable resources from three "tiers" (see Table 2 below). The proposed R-RPS is introduced gradually with total renewables requirements starting at 20 percent by 2023, up to 100 percent by 2040 (see Figure 1 below).

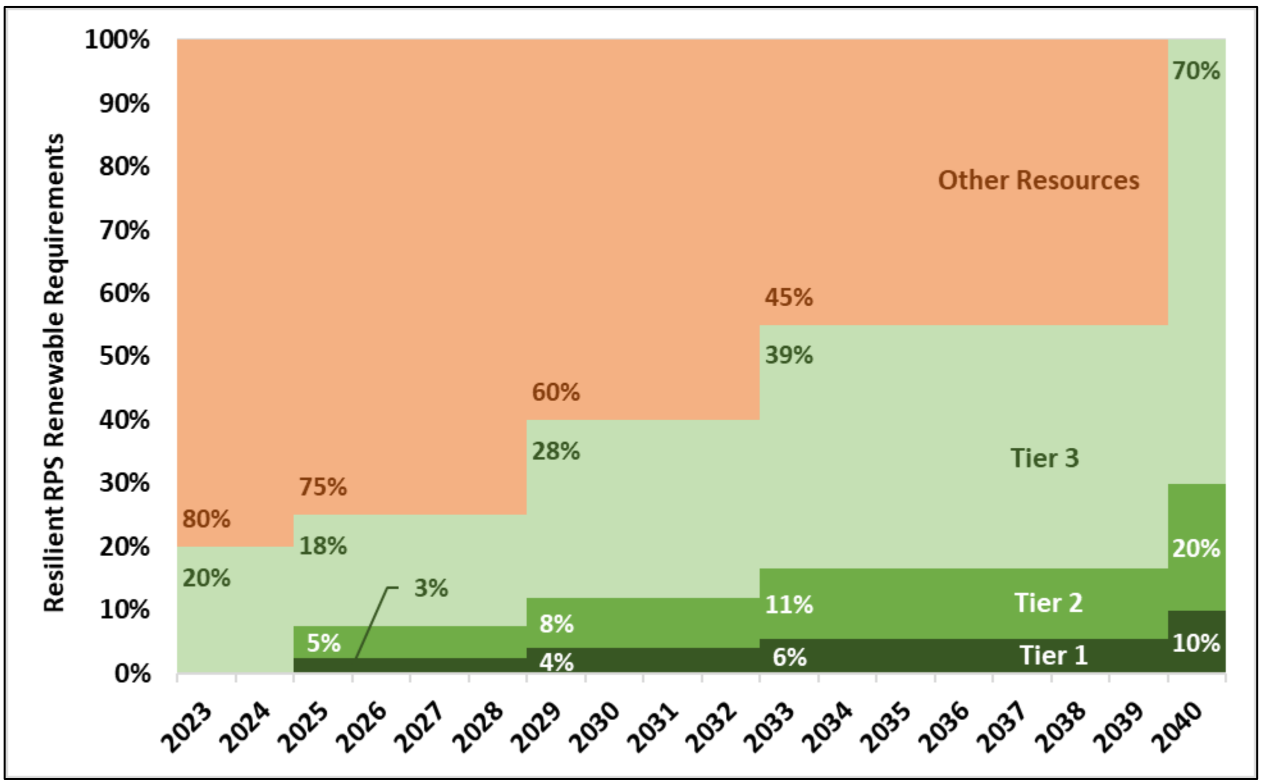
[1] Council for the City of New Orleans. Docket No. UD-19-01. June 2019. *The alliance for affordable energy's first comments responsive to resolution R-19-109*. Submitted by Alliance for Affordable Energy. Available at: https://www.ucsusa.org/sites/default/files/attach/2019/05/2019-06-03-UD-19-01-AAE-Comments-FINAL.pdf.
[2] Council for the City of New Orleans. n/d. "Meetings". Available at: https://council.nola.gov/committees/utility-cable-telecommunications-and-technology/dockets/establishing-a-docket-and-opening-a-rulemaking-pro/.
[3] EFNO's definition of renewable energy under the R-RPS proposal includes solar PV, solar thermal, wind, run-of-the-river hydroelectric, geothermal, or tidal and wave energy.

Table 2. ENFO renewable energy classifications under the New Orleans R-RPS

Tier 1	**PV+Flexibility:** 10 percent of electric supply sales to come from local rooftop solar paired with load flexibility resources like distributed small-scale batteries.
Tier 2	**Local Non-Thermal:** 20 percent of electric sales to come from local rooftop solar, new energy efficiency or demand response (which may include excess Tier 1 resources).
Tier 3	**Utility-scale renewables:** 70 percent of electric sales to come from any MISO-connected renewable energy generation resource (which may include excess Tier 1 and Tier 2 resources).

Source: Burke, L.A. Joint Reply of EFNO Proposing a Draft Resilient and Renewable Portfolio Standard for the City of New Orleans. Energy Future New Orleans Coalition. Docket No. UD-19-01. p. 8.

Figure 1. ENFO New Orleans R-RPS



Source: Burke, L.A. Joint Reply of EFNO Proposing a Draft Resilient and Renewable Portfolio Standard for the City of New Orleans. Energy Future New Orleans Coalition. Docket No. UD-19-01. p. 8-9.

ENO responded to EFNO's R-RPS by filing a 22-page critique with the City Council in July 2019.[4] ENO finds fault with EFNO's R-RPS proposal, and offers its own plan to purchase renewables and other clean energy sources like nuclear and hydro from the greater MISO region in October 2019.[5] ENO's overarching concerns were that the R-RPS is overly restrictive and infeasible:

> *"[EFNO's R-RPS] represents a narrow and restrictive approach that seeks to give preferences and subsidies to specific technologies at the expense of ENO's customers and to the detriment of the Council's ability to simultaneously achieve its overarching goals of lowering carbon emissions, fighting climate change, maintaining reliability, and keeping rates low…Given the infeasibility of…[EFNO's R-RPS], ENO believes the path forward is clear: the Council should decline the invitation to establish a mandatory RPS framework"*[6]

ENO provides three specific critiques of the R-RPS:

ENO Claim #1: The R-RPS would harm reliability:

> *"The net effect of [ENFO's R-RPS] suggestions would be to…jeopardize the reliability of the electric grid in New Orleans"*[7]

Reality: When paired with load flexibility resources, 100 percent renewable electricity can reliably provide all New Orleans families and businesses' energy needs.

ENO Claim #2: The R-RPS would harm resiliency:

> *"The EFNO [R-RPS] proposal…introduces an unsubstantiated notion that intermittent renewable resources tied to small residential battery storage systems somehow provide added "resilience" to the distribution grid during storms or other events that can cause outages."*[8]

Reality: Renewable energy, particularly when paired with battery storage, provides substantial resiliency benefits that ensure that energy for critical uses (like hospitals and emergency shelters) will always be provided, even during a natural disaster or severe weather event.

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[4] Council for the City of New Orleans. Docket No. UD-19-01. July 2019. *Entergy New Orleans, LLC's reply comments in response to Council resolution R-19-109 concerning the establishment of renewable portfolio standards*.
[5] Council for the City of New Orleans. Docket No. UD-19-01. October 2019. *Entergy New Orleans, LLC's comments in response to the Advisors' report and proposed alternative frameworks concerning renewable portfolio standards*.
[6] Council for the City of New Orleans. Docket No. UD-19-01. July 2019. *Entergy New Orleans, LLC's reply comments in response to Council resolution R-19-109 concerning the establishment of renewable portfolio standards*. p.2.
[7] Ibid. p.4.
[8] Ibid. p.14.

ENO Claim #3: The R-RPS is prohibitively costly:

> *"The net effect of [ENFO's R-RPS] suggestions would be to…significantly increase the costs borne by ENO's customers"*[9]

Reality: The assumption that 100 percent renewable electricity will be costly rests on the notion that firm capacity is the only way to balance intermittent renewable resources. However, flexible load resources also balance the grid, and can be less expensive than firm capacity resources.

The remaining sections of this report address ENO's three critiques of the R-RPS proposal together with evidence supporting AEC's rebuttal of these critiques: Section 1 addresses the reliability critique; Section 2 addresses the resiliency critique; and Section 3 addresses the cost critique.

1. 100 Percent Renewable Electricity is Reliable

ENO's claim: Without large amounts of battery storage, the feasibility of which is unknown, the New Orleans R-RPS would negatively impact grid reliability.

Reality: Paired with load flexibility resources, 100 percent renewable electricity can successfully provide grid reliability to New Orleans families and businesses.

What is "Reliable" Electric Service?

Reliable electric service keeps the lights on and makes sure critical needs are served, including:

- insulin refrigeration
- oxygen pumps
- avoiding food spoilage
- hospitals and emergency shelters lit and cooled

ENO claims that:

> *The EFNO [R-RPS] proposal would force ENO to rely on only five kinds of intermittent resources, which would make ENO's generation portfolio inherently less reliable. The emphasis on localized requirements for siting a large portion of this renewable generation would also undermine reliability.*[10]

[9] Ibid. p.4.
[10] Ibid. p.16.

ENO's claim that EFNO's R-RPS proposal would "jeopardize the reliability of the electric grid in New Orleans"[11] rests on the claim that a large share of intermittent renewables in its resource portfolio would create challenges for maintaining a reliable grid. ENO acknowledges that energy storage would overcome these challenges, but questions the feasibility of acquiring battery capacity sufficient to New Orleans needs: "Not only would batteries need to be sized to transfer large quantities of energy from mid-day hours to evening peak and overnight hours, but sufficient capacity would also be needed to store energy over weeks or even months to account for seasonal generation and usage differences. The feasibility of such a scheme is unknown and untested".[12]

New Orleans' R-RPS is in good company

Six U.S. states (California,[13] Colorado,[14] Hawaii,[15] New Mexico,[16] Rhode Island,[17] Washington[18]) and the District of Columbia have announced or adopted 100 percent renewable polices (see Figure 2 below). Washington D.C. has set ambitious renewable energy and emission reduction goals: the District aims to achieve 100 percent renewable electric generation and carbon neutrality by 2032.[19] Similarly to ENFO's R-RPS proposal, D.C. mandates that a certain share of its renewable energy generation must come from solar resources: 2.5 percent of electric sales must be supplied by solar sources by 2023, 5.5 percent by 2032 and 10 percent by 2041.[20]

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[11] Ibid. p.4.

[12] Ibid. p. 8.

[13] California Public Utilities Commission. July 2018. Docket No. R.18-07-003. *Order Instituting Rulemaking to Continue Implementation and Administration, and Consider Further Development, of California Renewables Portfolio Standard Program*. Available at: https://www.cpuc.ca.gov/RPS_Decisions_Proceedings/.

[14] Colorado Energy Office. 2004. "Renewable Energy Standard". RES Statute S40-2-124. C.R.S. Available at: https://energyoffice.colorado.gov/renewable-energy-standard.

[15] Hawaii Public Utilities Commission. December 2018. *Report to the 2019 legislature on Hawaii's Renewable Portfolio Standards*. Section 269-95(5). Available at: https://puc.hawaii.gov/wp-content/uploads/2018/12/RPS-2018-Legislative-Report_FINAL.pdf.

[16] New Mexico Public Regulation Commission. March 2007. "Utility - Renewable Energy". Available at: http://www.nmprc.state.nm.us/utilities/renewable-energy.html.

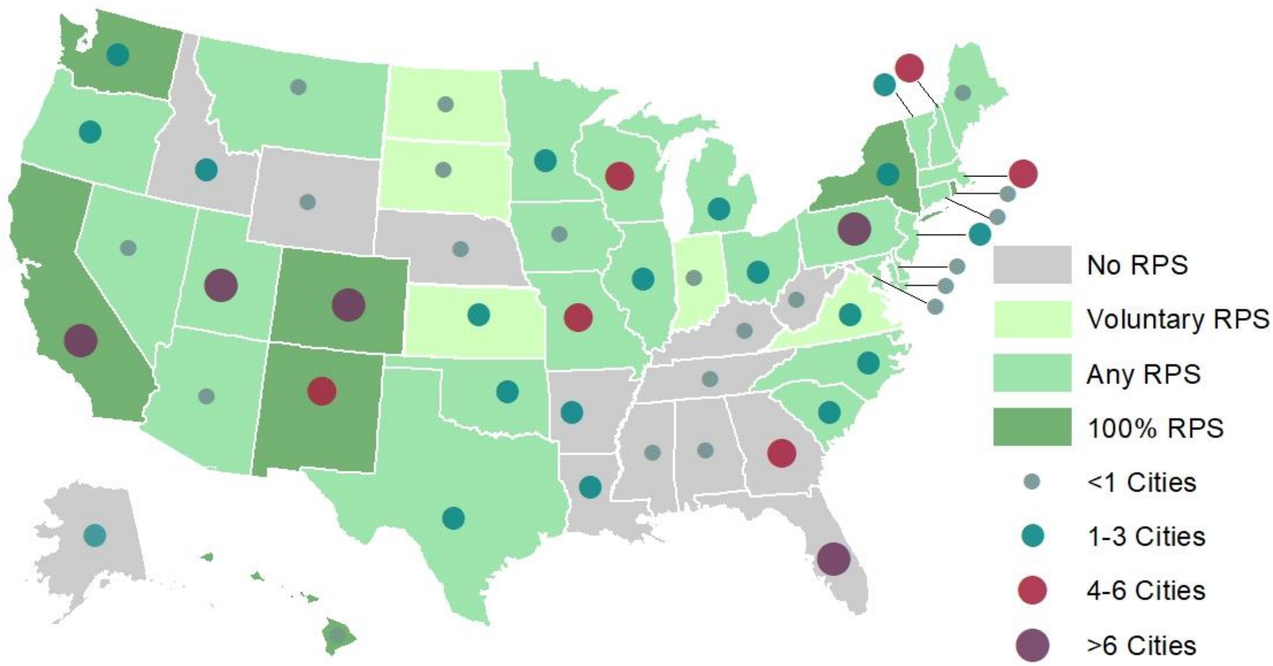
[17] Office of the Governor of Rhode Island. January 2020. "Raimondo Sets Goal for 100% Renewable Electricity by 2030". Press Release. Available at: https://www.ri.gov/press/view/37527.

[18] Washington State Department of Commerce. 2019. Docket No. E2SSB 5116. *Clean Energy Transformation Act (CETA)*. Available at: https://www.commerce.wa.gov/growing-the-economy/energy/energy-independence-act/.

[19] DC Office of the Mayor. December 4, 2017. "Mayor Bowser Commits to Make Washington, DC Carbon-Neutral and Climate Resilient by 2050". Available at: https://mayor.dc.gov/release/mayor-bowser-commits-make-washington-dc-carbon-neutral-and-climate-resilient-2050

[20] Council of the District of Columbia. July 2018. *Clean Energy DC Omnibus Amendment Act of 2018*. Legislation No. B22-0904. Act No. A22-0583. Law No. L22-0257. Available at: http://lims.dccouncil.us/Legislation/B22-0904?FromSearchResults=true

Figure 2. U.S. states and cities with renewable portfolio standards (RPS)



Sources: 1) DSIRE. 2020. Programs: Renewables Portfolio Standard. Available at: https://programs.dsireusa.org/system/program; 2) State agency data; and 3) Sierra Club. 2020. 100% Commitments in Cities, Counties, & States. Available at: https://www.sierraclub.org/ready-for-100/commitments.

Six U.S. cities are powered by 100 percent renewable energy already, and another 153 have adopted 100 percent renewable policies.[21] Cities already powered by 100 percent renewables represent diverse geographies—from Kodiak Island, Alaska[22] to Georgetown, Texas[23]—and diverse resources mixes—from

[21] Sierra Club. 2020. "100% Commitments in Cities, Counties, & States". Available at: https://www.sierraclub.org/ready-for-100/commitments.

[22] Kodiak Electric Association, Inc. 2018. *2018 Annual Report*. Available at: https://kodiakelectric.com/wp-content/uploads/2019/04/2018-Annual-Report.pdf. p. 1.

[23] Georgetown Texas. No Date. "Renewable Energy FAQs". Georgetown Utility Systems. Available at: https://gus.georgetown.org/renewable-energy/.

majority biomass in Burlington, Vermont[24] to 100 percent wind in Greensburg, Kansas[25] and Rock Port, Missouri.[26] Similarly, cities that have committed to 100 percent renewable energy represent a range of geographies, sizes, and target years: from Abita Springs, Louisiana[27] with a population of less than 3,000 aiming for 100 percent renewable energy by 2031 to Chicago, Illinois[28] with a population of more than 2.7 million aiming for 100 percent renewable energy by 2035.

New Orleans has special advantages in load balancing

New Orleans has several key advantages that will smooth its way and lower costs in achieving 100 percent renewables, including:

Interconnection with the larger MISO region helps to balance supply and demand

New Orleans is not an electrical island. ENO has participated in the Midcontinent Independent System Operator (MISO) since December 2013. MISO—like all independent system operators—works to provide efficient, reliable and nondiscriminatory operation of its regional energy system. By way of this strong regional interconnection in the MISO energy system, ENO can sell energy and capacity when it generates more than it needs to serve demand, and purchase these services when it faces a shortfall. MISO currently has 193 GW of installed generating capacity and 479,460 GWh of generation. ENO accounts for 0.6 percent of MISO's total capacity (1.2 GW) and 1.6 percent of MISO's total generation (7,712 GWh).[29]

ENO's 2018 Integrated Resource Plan (IRP)—a plan that utilities put together every 2 or 3 years that outlines resources needed to meet expected demand over a long-term planning horizon—notes that "ENO is expected to remain a net seller in MISO's energy markets" through 2028 (meaning that ENO produces more energy than it needs to meet demand).[30] Between 2029 and 2038, ENO's 2018 IRP finds that an

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[24] Burlington Electric Department. 2018. "Our Energy Portfolio". Available at: https://www.burlingtonelectric.com/our-energy-portfolio.

[25] Greensburg, KS. No Date. "5 Ways We Put the 'Green' in Greensburg". Available at: https://www.greensburgks.org/sustainability/how-we-put-the-green-in-greensburg.

[26] Rock Port. No Date. "Loess Hills Wind Farm". Available at: http://www.rockportwind.com/.

[27] Sierra Club. No Date. "Say thank you to Mayor Lemons and Abita Springs Town Council for committing to 100% clean and renewable energy by 2030". Available at: https://sierra.secure.force.com/actions/National?actionId=AR0074363.

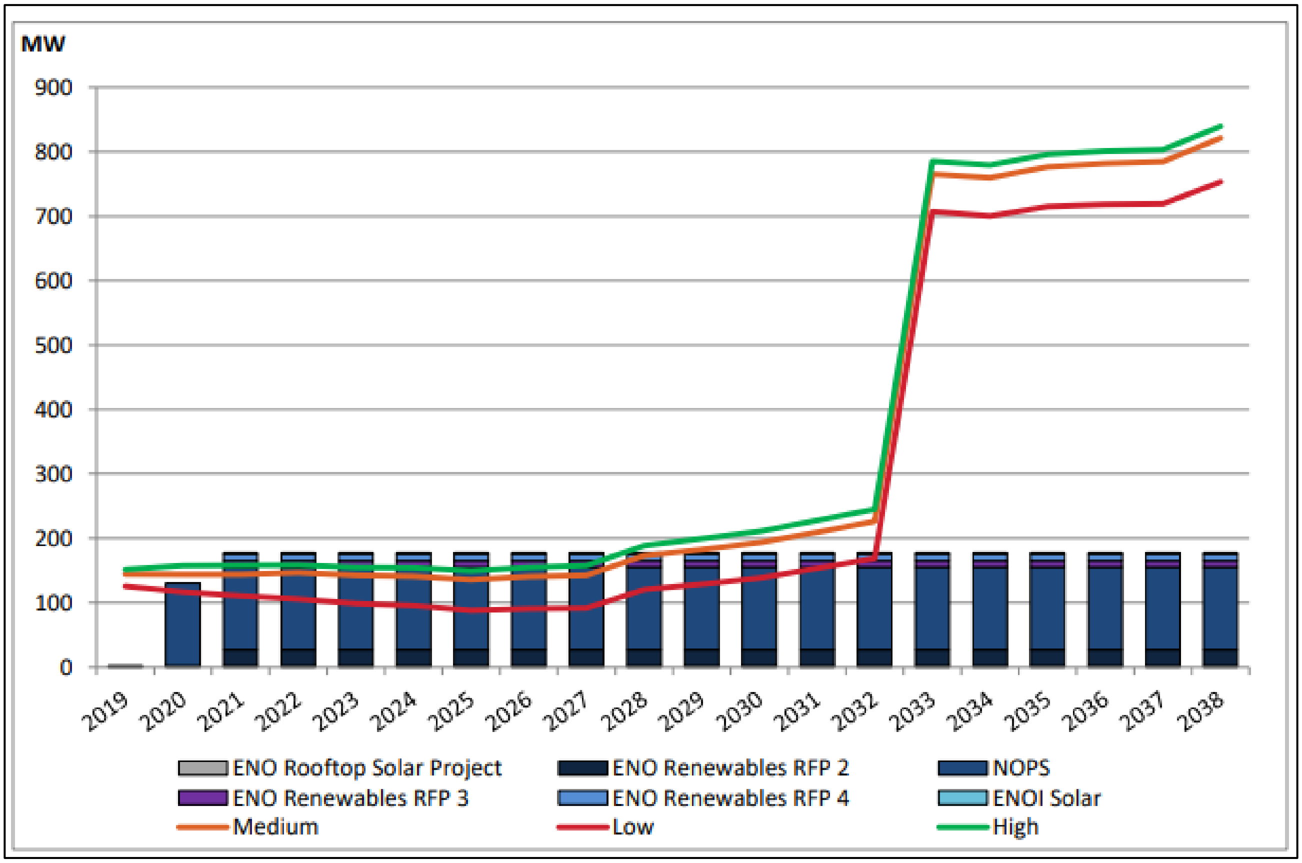
[28] Patil, Mukta. April 10, 2019. "Chicago Commits to 100 Percent Clean Energy". Sierra Club. Available at: https://www.sierraclub.org/sierra/chicago-commits-100-renewable-clean-energy.

[29] Note that both ENO's capacity and generation are 2021 forecasts. Current data is unavailable in ENO's 2018 IRP. ENO's total capacity is taken from: Entergy New Orleans, LLC. 2019. *2018 Integrated Resource Plan*. Table 1: ENO's 2021 Resource Portfolio – Fuel Mix. Available at: https://www.entergy-neworleans.com/irp/2018_irp/, ENO's total generation is taken from: Entergy New Orleans, LLC. 2019. *2018 Integrated Resource Plan*. Figure 3: ENO's Expected Energy Coverage. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

[30] Entergy New Orleans, LLC. 2018. *2018 Integrated Resource Plan*. p.21. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

additional 600 MW of capacity would be needed to meet peak capacity needs;[31] this additional capacity could be purchased as peaker facilities, secured with incentive payments for load flexibility resources like demand response, or purchased in the MISO capacity market.

Figure 3. ENO's projected long-term resource requirements



Source: Entergy New Orleans, LLC. 2019. 2018 Integrated Resource Plan. Figure 2. p.20. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

When ENO finds itself in a capacity or energy shortfall position (a situation that the utility does not expected to experience before 2030—see Figure 3), its interconnection with MISO enables it to assess—at that time—whether it is more cost-effective to build new generation capacity, create incentive programs, or purchase energy and capacity from the MISO market.

Interconnection with MISO provides a source of abundant cheap wind

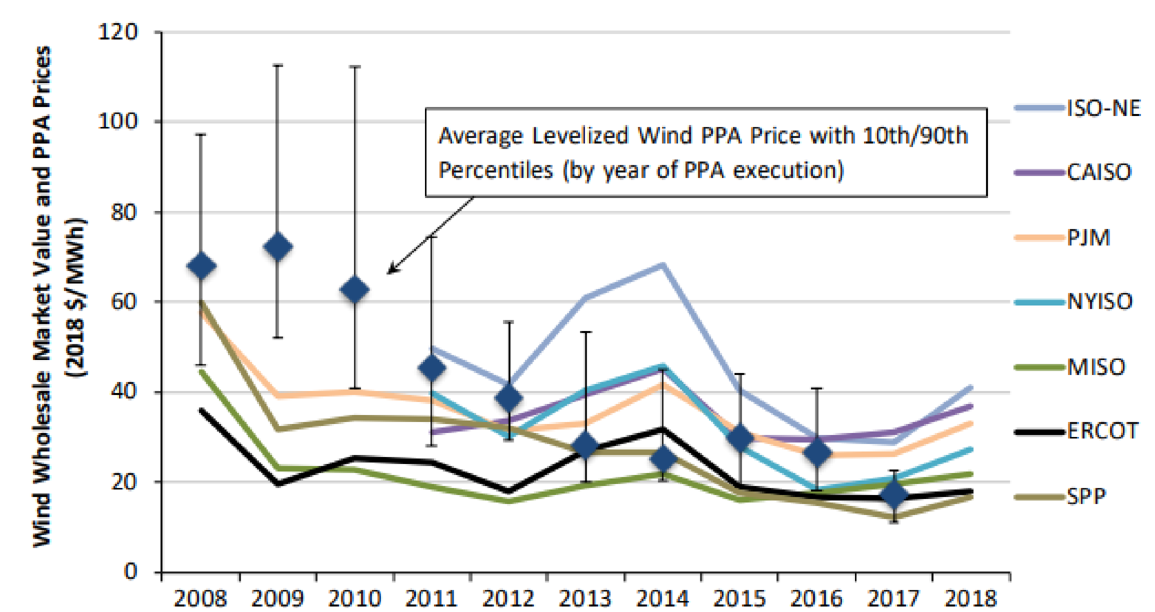
The MISO region has an abundance of cheap wind capacity and potential: in its most recent wind capacity report, MISO notes that existing wind capacity totaled nearly 17 GW at the end of June 2017.[32] S&P Global

[31] Ibid. p.20.

[32] MISO. 2017. *Planning Year 2018-2019 Wind Capacity Credit*. Available at:

reports that between 2019 and 2021, 6.2 GW of new wind capacity is expected to come into operation in MISO.[33] In September 2019, daily wind output averaged 146 GWh and wind energy sold for 2.2 cents/kWh in the Minnesota Hub (one of MISO's eight price Hubs—the others include Michigan, Indiana, Illinois, Arkansas, Texas, Mississippi and Louisiana[34])—a 23 percent reduction in price from one year prior.[35] The U.S. Department of Energy reports that MISO has some of the lowest wholesale wind prices in the country, and that the average levelized price of wind in MISO has held steady at approximately 2 cents/kWh since 2009 (see Figure 4).

Figure 4. Regional wholesale wind market value and average levelized long-term wind PPA prices



Note: Hourly wind output profiles and wholesale prices are not available for all historical years for all regions; as such, estimates of the wholesale value of wind are not available for all years for all regions.

Sources: Berkeley Lab, ABB, ISOs

Source: Reproduced from U.S. Department of Energy. August 2019. 2018 Wind Technologies Market Report. Figure 58, p. 65. Available at: *https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Wind%20Technologies%20Market%20Report%20FINAL.pdf.*

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https://cdn.misoenergy.org/2018%20Wind%20Capacity%20Report97278.pdf.

[33] Watson, M. October 2019. "Analysis: MISO to see 1.7 GW of renewables capacity come online by end of 2019: report". S&P Global Platts. Available at: https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/102119-analysis-miso-to-see-17-gw-of-renewables-capacity-come-online-by-end-of-2019-report.

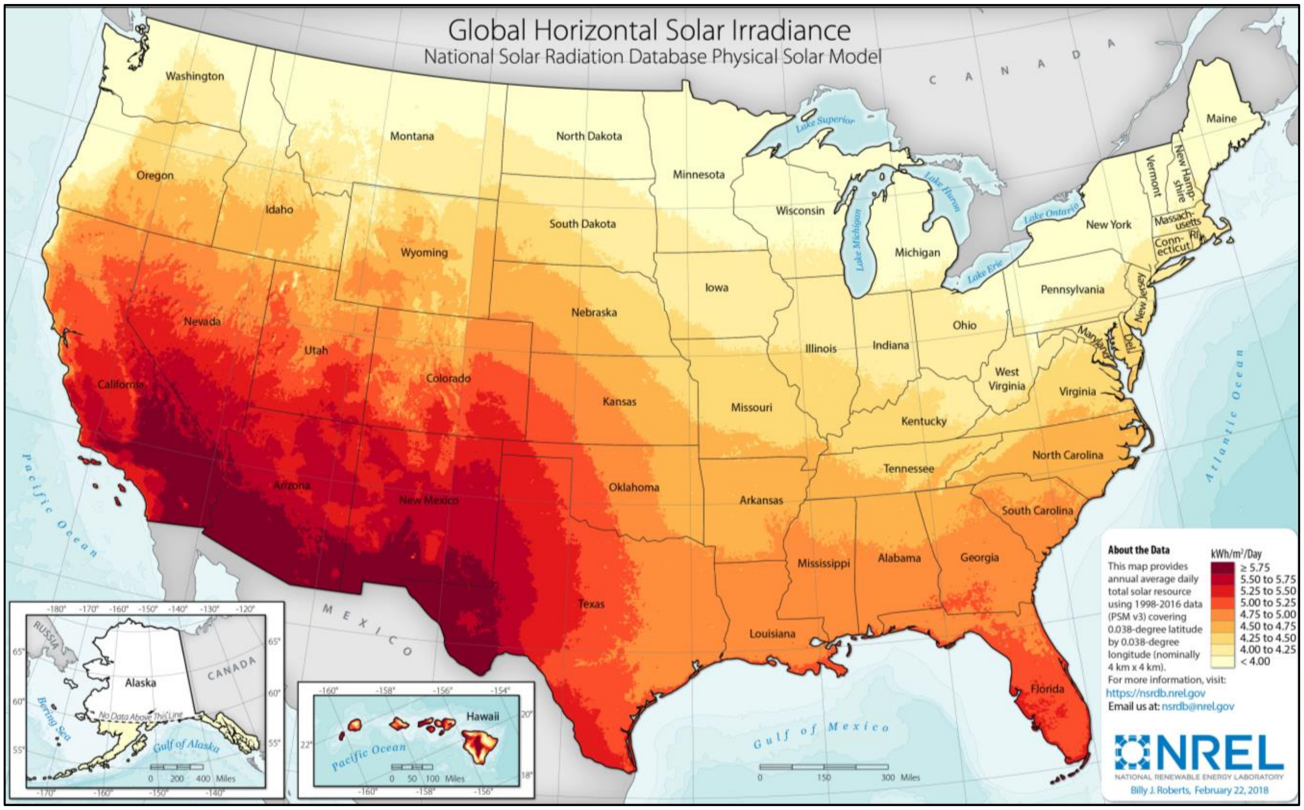
[34] MISO. 2020. "Real-Time Total Load". Available at: https://api.misoenergy.org/MISORTWD/lmpcontourmap.html.

[35] Watson, M. October 2019. "MISO POWER TRACKER: Prices fall on year on stronger wind output, weaker gas prices". S&P Global Platts. Available at: https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/100319-miso-power-tracker-prices-fall-on-year-on-stronger-wind-output-weaker-gas-prices.

Abundant local solar energy

New Orleans is well-suited to develop renewable solar capacity. Of all U.S. states, Louisiana ranks twelfth in terms of its solar potential.[36] Data from the National Renewable Energy Laboratory show that New Orleans has a solar radiance between 4.75 and 5.25 kWh/m^2/day (see Figure 5 below).

Figure 5. Solar irradiance in the United States



Source: Reproduced from Roberts, B.J. February 22, 2018. Global Horizontal Solar Irradiance: National Solar Radiation Database Physical Solar Model. National Renewable Energy Laboratory (NREL). Available at: https://www.nrel.gov/gis/assets/images/solar-annual-ghi-2018-usa-scale-01.jpg.

Multiple analyses from well-respected research institutes agree that New Orleans's potential for rooftop solar is substantial. An April 2018 study by Frontier Group and Environment America Research and Policy Center found that New Orleans has the potential to install 1,277 MW of rooftop solar on small buildings.[37] A U.S. Department of Energy analysis found that 95 percent of the city's small buildings are suitable for

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[36] Nebraska Department of Environment and Energy. March 2010. "Comparison of Solar Power Potential by State". Available at: http://www.neo.ne.gov/programs/stats/inf/201.htm.

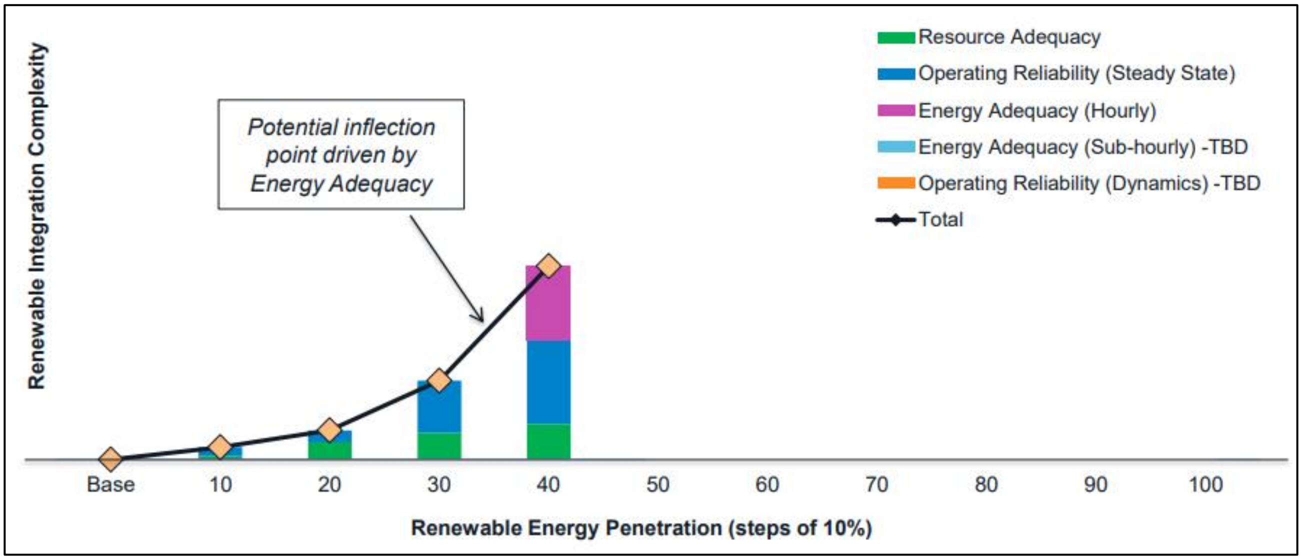
[37] Bradford, A., Fanshaw, B. April 2018. *Shining Cities 2018*. Prepared by Environment America and Frontier Group. Available at: https://environmentamerica.org/sites/environment/files/reports/EA_shiningcities2018_scrn%20%282%29.pdf.

rooftop solar, estimating that New Orleans has the potential to install nearly 1,300 MW of rooftop solar that could produce nearly 1,500 GWh of generation[38]—equal to approximately one-quarter of ENO's 2018 annual demand of 5,900 GWh.[39] Google's Project Sunroof tool provides a higher estimate: New Orleans could install 2,700 MW of capacity on 94 percent of its roofs, resulting in 3,500 GWh of generation.[40]

Large amounts of renewable energy can be integrated reliably

MISO's 2018 renewable integration impact study showed that the region's electric system can absorb renewable wind and solar resources up to 30 to 40 percent of supply before some combination of transmission infrastructure expansion and battery storage are needed to accommodate the addition of more renewables and maintain reliability (see Figure 6).[41]

Figure 6. MISO's renewable energy integration inflection points



Source: Reproduced from MISO. November 14, 2018. Renewable Integration Impact Assessment: Finding integration inflection points of increasing renewable energy. p.3. Available at: https://cdn.misoenergy.org/20181114%20PAC%20Item%2005a%20RIIA%20Update292120.pdf.

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[38] Energy Efficiency & Renewable Energy. No Date. "Small Building Rooftop PV Potential for New Orleans, Louisiana". U.S. Department of Energy. Available at: https://www.eere.energy.gov/sled/#/.

[39] Entergy New Orleans, LLC. 2019. *2018 Integrated Resource Plan*. Appendix B. p.99. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

[40] Google Project Sunroof. No Date. "Explore estimated solar potential of your community". Available at: https://www.google.com/get/sunroof/data-explorer/.

[41] EnerNex Corporation. February 2011. "Eastern Wind Integration and Transmission Study." Prepared for The National Renewable Energy Laboratory (NREL). Available at: https://www.energy.gov/eere/wind/downloads/eastern-wind-integration-and-transmission-study-ewits-revised.

Renewable wind and solar in MISO currently account for 3.6 percent of MISO's total generation (17,189 GWh) and 11 percent of MISO's total generating capacity (20 GW). This means that no additional investments will be necessary to integrate any MISO-interconnected resources until another 174,600 GWh of renewables are added to MISO's grid—that's more than 20 times ENO's total customer demand. Additional investments within the New Orleans service territory may be required when the R-RPS requirement rises to 40 percent in 2029, but currently, renewable solar energy only accounts for 0.4 percent of ENO's total installed generating capacity and 2 percent of ENO's total generation,[42] (ENO has no wind capacity or generation.) That means ENO could add 2,943 GWh of wind and solar generation before the 40 percent inflection point should be expected. In addition, ENO accounts for only 1.6 percent of MISO's total generation. That means that ENO—depending on the specifics of its transmission system and the degree to which battery storage resources are pursued—may be able to costlessly integrate renewable energy to a share greater than 40 percent of its own supply while maintaining reliable supply and integration with the larger MISO grid.

Nonetheless, investing in load flexibility resources can provide cost savings to New Orleans by shrinking and flattening load to reduce capacity and reserve costs in the near-term. In the longer-term—where action need not be taken until 2029 or later—load flexibility resources will allow higher levels low-cost renewables to supply electric needs in all hours of the day.

What are load flexibility resources?

The cost of producing electricity varies significantly throughout the year and the time of day, and depends on the demand and supply for electricity at each point in time. "Peak" demand refers to the highest level of electric consumption in the course of a year. Today, peak demand is met by turning on the most expensive power plants (which are unused most of the time). The length (number of hours) and shape of peak demand determines the optimal mix of resources to meet it. For example, if peak demand is much higher than non-peak demand, and only occurs for one hour, the optimal mix of resources to meet it will be different than if peak demand is only marginally higher than non-peak demand and occurs for five hours.

System operators require some flexibility to successfully supply customers as the level of aggregate demand changes. As intermittent resources increase as a share of the energy mix, however, additional flexibility will be necessary to balance the grid. Inflexible resources—those that are not quick, easy, or cheap to scale up and down in response to demand—make meeting peak demand more difficult and more costly. The more flexible resources available on a system, the easier and less expensive it is to meet peak demand. In a fully flexible system, low-cost generation plus demand response and storage meet efficient

[42] ENO's 2018 IRP does not provide current generation by resource type. Two percent of generation is projected to come from solar resources in 2020—we have used this figure. Source: Entergy New Orleans, LLC. 2019. *2018 Integrated Resource Plan*. Appendix B. Figure 3. p.99. Available at: https://www.entergy-neworleans.com/irp/2018_irp/.

customer demand in every hour of the year. Measures to shrink and shift customer demand away from peak times are critical to the reliable and affordable operation of electric systems.

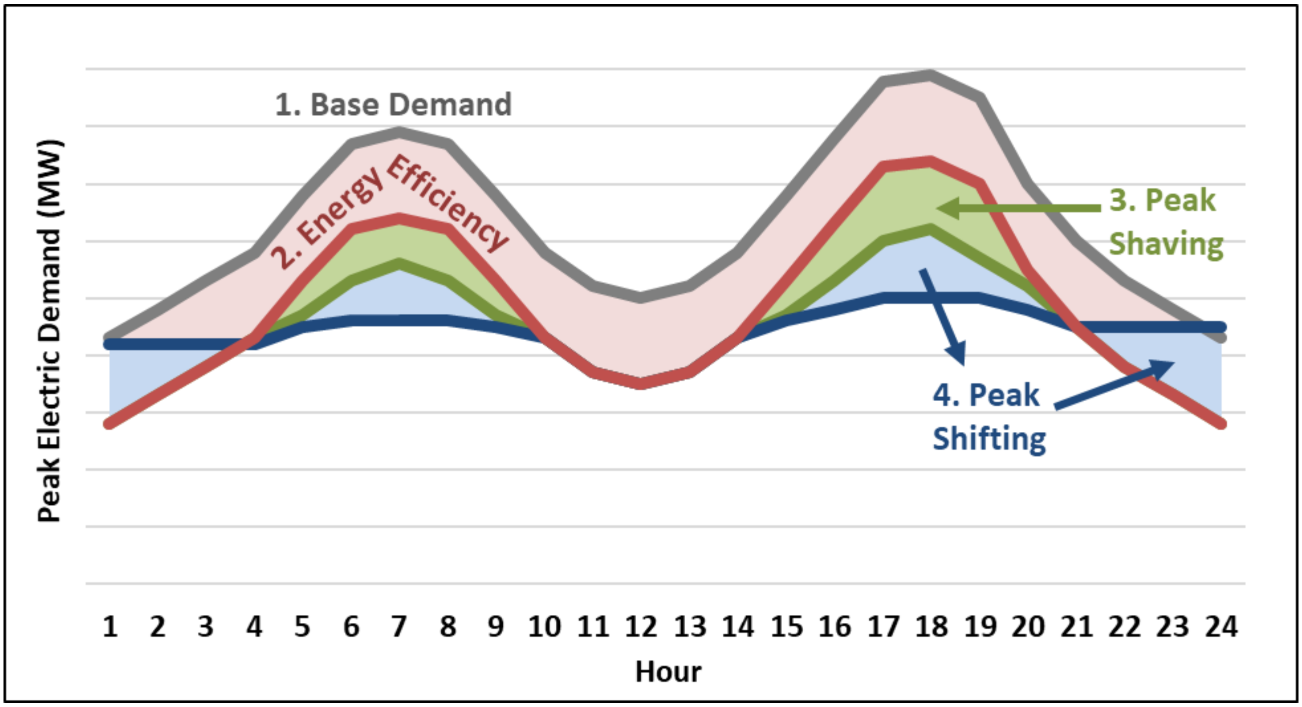
Table 3. Types of load flexibility resources

Load Flexibility Resources	How it works	Dispatchable?
Energy efficiency:		
Efficient lighting, equipment, heating and cooling, operations and maintenance	Reduces energy use on-peak and off-peak	No
Load shaping:		
Incentives, outreach, education	Measures that shift energy use to flatten electric demand across time	No
Building appliance design	Appliances in buildings that are designed to move load as they draw energy	No
Demand response:		
Time-of-use rates (residential, commercial & industrial)	Provide incentives customers to use energy by offering lower rates during off-peak times	Yes
Interruptible rates (commercial & industrial)	Customers pay a lower rate and, in exchange, the utility is allowed to cut electric use as needed during peak	Yes
Smart appliance control (residential)	Customers pay a lower rate or receive an incentive payment and, in exchange, the utility is allowed to cut electric use as needed during peak	Yes
Smart thermostats (residential & commercial)	Smart thermostats pre-heat/pre-cool a building before peak occurs and can be controlled by utilities in exchange for a lower rate or incentive payment	Yes
Virtual power plants:		
Network of distributed generating units	Aggregates a large set of behind-the-meter resources and dispatch them the same way a utility-scale plant is dispatched in exchange for incentive payments	Yes
Pumped storage:		
Uphill reservoirs	Utilities pump water uphill into reservoirs when prices are low and then run the water downhill to generate energy when prices are high	Yes
Batteries:		
Electric vehicles	Utilities call on the energy stored in electric vehicles that are plugged into public chargers and "smart" homes when prices are high	Yes
Distributed	Connects to the larger grid and called upon when the price of marginal generation is high	Yes
Utility-scale	Charged when prices are low and dispatched when prices are high	Yes

Load flexibility resources refer to capacity resources that utilities or grid managers can call on to meet peak loads (and/or shift peak through time) and enhance grid reliability in exchange for a lower rate or an incentive payment (see Table 3 above). Flexibility resources include tried-and-true measures like energy efficiency and cutting-edge measures like residential smart devices and drawing on distributed batteries.

Load flexibility resources that are dispatchable—including aggregations of resources called "virtual power plans"—are indistinguishable from demand response from the point of view of the utility or balancing authority. (Dispatchable resources can be called on by grid operators to run as needed.) Resource providers enter into contracts to provide either reduced demand or increased supply when called upon, and they receive compensation for that service. Together, load flexibility resources allow utilities to meet, shift and shave peak customer demand, lower peak and, with it, customer costs (see Figure 7 for an illustration).

Figure 7. Illustrative peak shaping = peak reduction, peak shaving and peak shifting



While energy efficiency and some load shaping measures are not dispatchable, a variety of demand response measures are: in addition to residential device control, there are interruptible rates for commercial and industrial customers that offer a lower overall rate in exchange for the right to cut energy use during times of peak; smart appliance control that allows customers to pay a lower electric rate in exchange for allowing the utility to cut electric use as needed during times of peak demand; and smart thermostats that pre-heat/pre-cool a building before peak occurs and can be controlled by utilities in exchange for a lower electric rate or incentive payment. Other dispatchable flexibility resources include pumped storage and battery storage.

Together, load flexibility resources serve to reduce, shave and/or shift demand—and when all three modifications are taken together, facilitate the practice of "load shaping" or "load flattening" (see Figure 7 above). It is easier and less expensive to meet peak when demand is reduced (via energy efficiency), peak is shaved (via smart appliance control, interruptible rates, and/or on-site generation that provides power at peak times without using energy from the grid), or peak is shifted (via demand response measures and/or battery storage).

Today's energy resource planning revolves around how to meet peak load, and a very high share of customer costs comes from resources that may only run a few hours a year. Tomorrow's energy system will avoid these costs through investment in low-cost load flexibility resources. As transportation and heating electrification evolves over the next few decades, load shaping these new electric demands to flatten customer load as a whole will be critical to overall efforts to keep customer rates and bills low.

How do load flexibility resources enhance reliability?

ENO maintains that the R-RPS would jeopardize grid reliability. Our review of the literature found many analysts and experts who disagree. A 2018 Harvard/NERA Economic Consulting/Energy Innovation Research Project review of 40 high renewable integration studies[43] noted that there are three main ways these analyses propose reaching very high (80 to 100 percent) renewable energy while maintaining grid reliability: the first is by extensive overbuilding of generation capacity; the second, by utilizing untested technologies like carbon capture and storage, or power-to-gas, or by using uneconomic resources like new nuclear or legacy gas resources; and the third, by combining renewable capacity with load flexibility resources. This review also found that for any jurisdiction in isolation (that is, without extensive interconnections to a larger grid), reaching 100 percent renewable penetration is substantially more difficult (and costly) than reaching 80 or even 95 percent renewables.

Another 2019 review by researchers in Finland and Germany of 18 renewable energy plus load flexibility resource studies similarly found that renewable energy is best utilized when it is paired with load flexibility resources, including energy storage of all types—not just battery storage but also adiabatic compressed air energy storage and thermal energy storage—and is most cost-effective when pursued alongside greater grid integration and expansion.[44] They project that the costs of 100 percent renewable systems will fall from approximately 7.4 cents/kWh today down to 5.5 cents/kWh in 2050 and that these systems "lead to reliable, affordable and sustainable power in an hourly resolution for an entire year."[45]

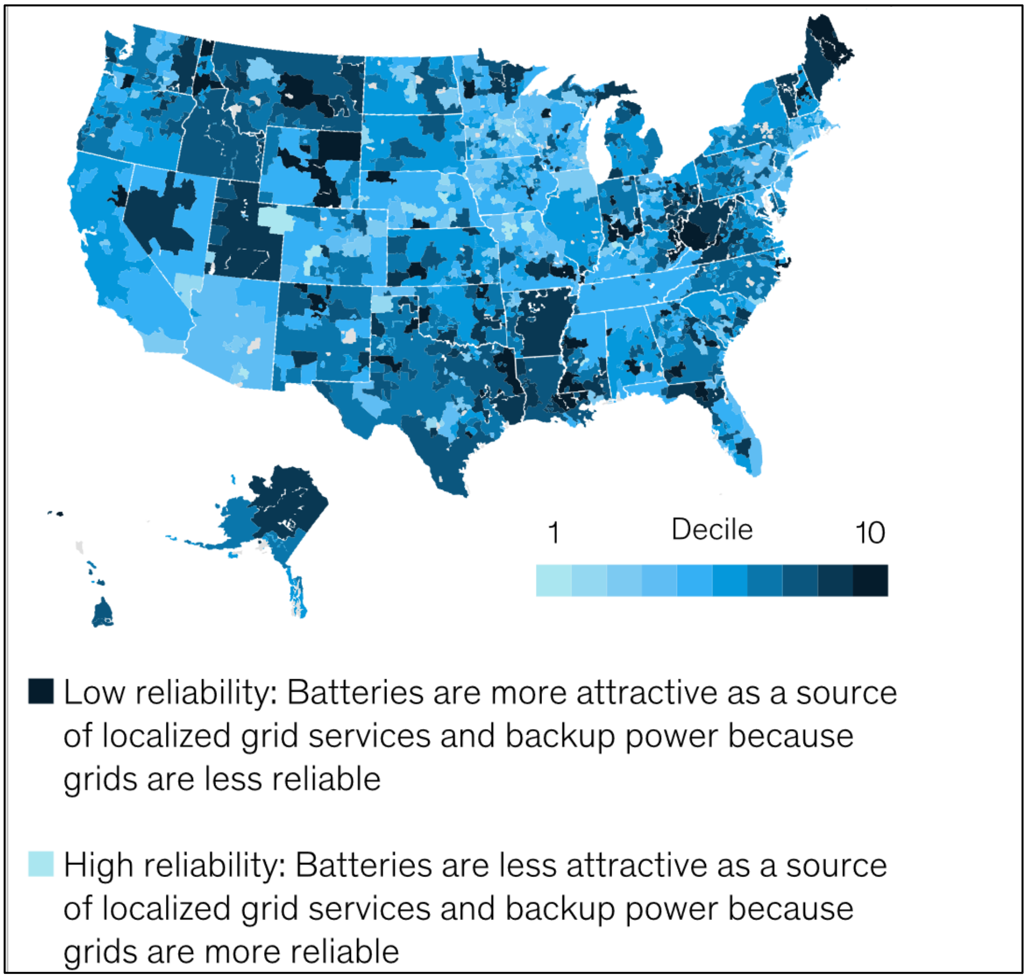
While all of the solutions identified in the European review achieve load balancing, only one approach does so in a cost-effective and realistic manner: pairing very low-cost wind and solar with load flexibility

[43] Jenkins, J.D., Luke, M. and Thernstrom, S. December 2018. "Getting to Zero Carbon Emissions in the Electric Power Sector". *Joule*, 2(12), 2498-2510.
[44] Child, M., Kemfert, C., Bogdanov, D. and Breyer, C. 2019. "Flexible electricity generation, grid exchange and storage for the transition to a 100% renewable energy system in Europe". *Renewable Energy*, 139, 90-101.
[45] Ibid. p.99.

resources (including battery and seasonal storage technologies, demand response and virtual power plants) and conducting grid balancing cooperatively across large, closely integrated regions (like MISO). It is important to note that the need for seasonal storage is greater in regions with widely varying weather across the year. Because New Orleans weather remains within a narrow band of temperatures year-round, its need for seasonal storage is smaller.

Developing load flexibility resources is key to achieving reliable electric supply in New Orleans. The ability of these flexible resources to reduce, shave and/or shift peak demand make the grid easier to balance and, therefore, more reliable. When demand is lower and flatter (i.e. fewer and smaller peaks in demand), reliable grid operation becomes a simpler task.

Figure 8. Reliability opportunities from battery storage across the United States



Source: Reproduced from Finkelstein, J., Kane, S. & Rogers, M. March 2019. How residential energy storage could help support the power grid. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.

While battery storage is not the only kind of flexibility resource, it is one of the most well-documented.

Research by McKinsey & Company indicates that residential storage systems were already cost-effective for more than 20 percent of U.S. households in 2019, and would provide significant reliability benefits across the country—with the New Orleans area among the regions that would reap the greatest reliability benefits (see Figure 8 above).[46] The value of the load flexibility resources is greater when it serves the customer as well as the grid.

European cities are leading the way on flexible grid balancing

Utilizing load flexibility resources to balance the grid while maintaining grid reliability is not theoretical—multiple European cities are already doing so and are on the cutting edge of modernized energy systems.

- In Denmark, a large-scale smart grid project involving approximately 2,000 customers (as of 2015) utilized a real-time market for demand response that allowed for flexible consumption and reduced peak load by 1.2 percent, or 670 kW.[47] Eighty-seven percent of the peak load reduction was accomplished from household heating equipment that responded immediately to price signals.[48]
- Starting in 2018, and continuing through 2022, the "Compile" project is working to transition local energy systems in five remote or weakly grid-connected areas in Spain, Portugal, Greece, Slovenia and Croatia into flexible and secure decentralized networks using optimal integration and storage to maximize decarbonization and save energy.[49]
- In Denmark, Portugal and the UK, the Smart Islands Energy Systems (SMILE) project has implemented three large-scale smart grid pilot projects reaching nearly 300,000 people. The SMILE project aims to transition to a cleaner, more affordable and reliable energy system by utilizing demand response, power to heat, power to fuel, electric vehicles, and energy storage plus grid balancing and frequency control mechanisms that also increase grid resiliency.[50]
- In Cyprus, Germany and Switzerland, the GOFLEX project is developing regional markets for energy and flexibility, microgrids, and demand response by focusing on technology solutions to better enable distributed, flexible resources like automated dynamic pricing, intelligent measuring

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[46] Finkelstein, J., Kane, S. & Rogers, M. March 2019. *How residential energy storage could help support the power grid*. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.
[47] EcoGrid. 2015. EcoGrid *EU: Findings and Recommendations*. EcoGrid. Available at: http://www.eu-ecogrid.net/images/Documents/150917_EcoGrid%20Findings_Recommendations.pdf.
[48] Trong, M. D., Salamon, M., and Dogru, I. 2016. *Experience with Consumer Communications and Involvement in Smart Grid*. EcoGrid. Available at: http://www.eu-ecogrid.net/images/Frontpage/WP-4_final-english-summary.pdf.
[49] COMPILE. No Date. *Compile: Integrating Community Power in Energy Islands*. COMPILE. Available at: https://www.compile-project.eu/wp-content/uploads/COMPILE_brochure_EN.pdf.
[50] SMILE. 2020. "About the Project". SMILE. Available at: https://www.h2020smile.eu/about-the-project/.

equipment, and control units for automated trading.[51] A 2018 study from the University of Cyprus and the Cyprus Electric Authority found that the implementation of GOFLEX has strong potential for increased flexibility, reliability, and cost-effectiveness for consumers.[52]

- In Germany, the Czech Republic, the Netherlands, Sweden, and France, the InterFlex project is implementing six industry-scale grid flexibility and energy balancing initiatives using flexibility resources like demand response, energy storage and electric vehicles. Based on the project's results (as of December 2019), local flexibility markets, demand response flexibilities, grid automation, and energy storage islanding were successfully implemented and have the potential to be implemented, currently, on a large-scale.[53]
- In the UK, Italy, Romania, Greece, and Spain, the eDREAM project is exploring Virtual Power Plants, closed-loop demand response, and new solutions for Demand System Operators (DSO) to enhance grid flexibility, reliability, and efficiency.[54] A 2018 report produced by eDREAM and the Institute of Electrical and Electronics Engineers found that a closed-loop demand response framework can accomplish near real-time verification, and can facilitate virtual power plants where aggregated loads are traded via smart contracts, making the grid more flexible and cost-effective.[55]
- In the Netherlands and Spain, the FLEXCoop project is equipping two energy cooperatives with the tools to introduce an automated demand response framework for residential electric customers. The project's virtual power plants will promote grid flexibility and stability.[56]
- In Portugal, Spain and Germany, the DREAM-GO project developed a smart grid based on demand response and automated operations in smart metering.[57] Based on a report from the European Commission in 2019, DREAM-GO benefitted consumers, reduced costs, and increased flexibility.[58]

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[51] GOFLEX. 2020. "The Project & Our Ideas". GOFLEX. Available at: https://goflex-project.eu/Project.html.

[52] Oureilidis, K.O., Machamint, V., Efthymiou, V., Georghiou, G. E., and Papageorgiou, I. 2018. *Demonstration Tools for Trading Flexibility in Distribution Grids in Cyprus - The Cases of a Microgrid and Dispersed Prosumers*. University of Cyprus. Available at: https://goflex-project.eu/Down.asp?Name={DWSISWSYQK-592018105621-QRCYJTHKBN}.

[53] The InterFlex consortium. December 2019. *INTERFLEX: PROJECT SUMMARY*. The InterFlex consortium. p.17. Available at: https://interflex-h2020.com/wp-content/uploads/2019/11/Interflex-Summary-report-2017-2019.pdf.

[54] eDREAM. 2020. "Project Overview". eDREAM. Available at: https://edream-h2020.eu/demand-response-tools/.

[55] eDREAM. 2018. *Enabling New Tehnologies for Demand Response Descentralized Validation using Blockchain*. IEEE. Available at: https://www.researchgate.net/publication/328970344_Enabling_New_Technologies_for_Demand_Response_Decentralized_Validation_Using_Blockchain.

[56] FlexCOOP. 2020. "About FLEXCoop". FlexCOOP. Available at: http://www.flexcoop.eu/about-flexcoop.

[57] DREAM-GO. 2019. *DREAM-GO built scenarios and conclusions about the undertaken experimental tests*. DREAM-GO. Available at: http://dream-go.ipp.pt/PDF/DREAM-GO_Deliverable6-1_v3.0.pdf.

[58] Cordis. 2019. *Enabling Demand Response for short and real-time Efficient and Market Based smart Grid Operation - An intelligent and real-time simulation approach*. European Commission. Available at:

How do load flexibility resources provide ancillary services?

Keeping the grid running requires not only electric generation (kilowatt-hours as you need them) and electric capacity (megawatts standing ready to supply), but also several less visible "ancillary services", such as voltage and frequency support, without which the grid cannot operate. Ancillary services refer to grid functions, separate from generation and transmission, that help to maintain the grid's overall stability. Traditionally, these services have been provided by energy generators, though virtual power plants and other dispatchable load flexibility resources can—when paired with appropriate meters that allow utility control of the devices or services—provide these valuable ancillary services. For example, the Hawaiian Electric Utilities 2016 IRP includes an assessment of utility-scale, centralized energy storage as well as behind-the-meter, distributed demand response measures in order to determine the most cost-effective resource mix to provide ancillary service needs.[59]

2. 100 Percent Renewable Electric is Resilient

ENO's claim: ENO claims that the enhanced resilience that EFNO asserts is a benefit of battery storage and microgrids is "unsubstantiated".[60]

Reality: Resilience benefits are well known, well understood, and taken into consideration in the planning processes of many other jurisdictions. Resilience ensures that critical loads like hospitals, military bases, and telecommunications—that are essential for meeting basic human needs and ensuring safety—will always be provided, even in the event of a natural disaster or severe weather event, such as Hurricane Katrina.

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https://cordis.europa.eu/article/id/379503-demand-response-helps-fulfil-the-smart-grid-potential?WT_mc_id=exp.

[59] The Hawaiian Electric Companies. 2016. *The Hawaiian Electric Companies' 2016 Power Supply Improvement Plan (PSIP) Update*. Book 1. p.2-22. Available at: https://www.hawaiianelectric.com/clean-energyhawaii/integrated-grid-planning/power-supply-improvement-plan.

[60] Council for the City of New Orleans Docket No. UD-19-01. October 2019. *Entergy New Orleans, LLC's comments in response to the Advisors' report and proposed alternative frameworks concerning renewable portfolio standards*. p.14.

What is "Resilient" Electric Service?

Whereas "reliable" grid supply keeps the electric system working to successfully serve customers in all but the most extreme circumstances, "resilient" electric service provides critical needs during extreme events like hurricanes, wildfires or earthquakes that disrupt the grid.

Resilience allows sections of the grid to "island"—isolating themselves and continuing to operate when the system as whole is unable to deliver electricity. These islands (or minigrids) could be as large as a university campus (Wesleyan University in Connecticut and the University of California at San Diego, for example) or as small as a "microgrid" for your own household.

ENO claims that:

> *The EFNO [R-RPS] proposal…introduces an unsubstantiated notion that intermittent renewable resources tied to small residential battery storage systems somehow provide added "resilience" to the distribution grid during storms or other events that can cause outages.*[61]

ENO's claims rest on the assertion that any extreme weather event of "sufficient strength" to damage the grid would also "pose wind risks to rooftops, and flooding risks to garages or other low-lying residential areas that may house battery backup systems"[62] and that any grid-tied rooftop solar without battery storage would power down the same way as other utility resources.

The reality is that roofs are assessed for structural quality before solar companies will install panels. Solar panels are given wind load ratings that indicate the wind speeds that panels can tolerate. Most panels can withstand winds up to 160 miles per hour. In addition, a 2018 study by the Rocky Mountain Institute found that the most common cause of rooftop solar damage in the wake of Hurricanes Irma and Maria was easy and cheap to remedy: simply bolt the solar panels down more tightly.[63] It is true that battery storage systems may be located in basements and garages, and that these areas may flood in the event of extreme weather. However, not only can relevant authorities set standards for battery locations, many residential batteries are installed on a wall, out of reach of all but the most severe floods that would require residents to flee their homes (see Figure 9).

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[61] Ibid.

[62] Ibid.

[63] Burgess, C. and Goodman, J. 2018. *Solar Under Storm: Select best practices for resilient ground-mount PV systems with hurricane exposure*. Rocky Mountain Institute. Available at: https://rmi.org/wp-content/uploads/2018/06/Islands_SolarUnderStorm_Report_digitalJune122018.pdf.

Figure 9. Behind-the-meter battery storage system

Source: Reproduced from International Renewable Energy Agency. 2019. Behind-the-meter batteries: Innovation landscape brief. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_BTM_Batteries_2019.pdf?la=en&hash=86DF5CFBEDB71EB9A00A5E3680D72D6E346BD23A.

How do load flexibility resources provide resiliency?

Behind-the-meter solar plus battery storage is not only useful as one of several important load flexibility resources, it also provides deep resilience benefits by assuring backup power in the event of a power outage. New Orleans residents know the frightening, disruptive, health-threatening impacts of power outages well, given the city's experience with hurricanes—including Hurricane Andrew in 1992, Hurricanes Isidore and Lili in 2002, Hurricanes Cindy, Katrina and Rita in 2005, Hurricanes Gustav and Ike in 2008, and Hurricane Isaac in 2012.[64] During and after the most infamous of these hurricanes—Katrina—made landfall, it caused more than 1,800 deaths and destroyed over 800,000 housing units, making it the third deadliest hurricane in U.S. history.[65] Katrina exposed serious shortcomings regarding New Orleans' storm preparedness and resiliency, as the city's Superdome storm shelter deteriorated into chaos with limited power, no plumbing and an acute shortage of supplies.[66] Outbreaks of West Nile, mold, and endotoxin

[64] Rand, S. June 1, 2017. "As hurricane season starts, a look back at 10 recent Louisiana storms". The Times-Picayune. Available at: https://www.nola.com/news/weather/article_d4097522-0891-56bd-9df1-50424748d6f6.html.
[65] Hurricane Science. No Date. "Katrina Impacts". Available at: http://www.hurricanescience.org/history/studies/katrinacase/impacts/.
[66] Scott, N. August 24, 2015. "Refuge of last resort: Five days inside the Superdome for Hurricane Katrina". For the Win. Available at: https://ftw.usatoday.com/2015/08/refuge-of-last-resort-five-days-inside-the-superdome-for-

levels rose as bacteria-infested water flooded the city.[67]

The legacy of Katrina is still felt today: many neighborhoods remained significantly altered even a decade after the storm, and the city's population remains at just 80 percent of what it was before the hurricane hit.[68] In addition to the broader health and safety impacts of hurricanes, the consequences of short and long power outages include: disrupted communications and transportation; closure of businesses, grocery stores, gas stations, ATMs, banks and other important services; food/medicine spoilage; water contamination; loss of power to medical devices; increased levels of carbon monoxide indoors; and heat/cold stress and mortality.[69]

For essential facilities like hospitals, for households with high-stakes critical needs (like insulin or power-dependent medical devices), for every home and business that places a high value on keeping minimal lighting, phone charging, internet connectivity and minimal refrigeration during natural disasters/power outages: solar with battery storage has a value that exceeds the cost of net metering or incentive payments for capacity from batteries. Families and small businesses are choosing to add battery storage resources without the assurance that they will receive payments for these services: they are doing so for their own peace of mind.

For example, in November 2019, over one thousand homes in Vermont with battery storage installed were able to keep the lights on during a storm that knocked out power to more than 115,000 customers.[70] The largest utility in the state—Green Mountain Power—is currently seeking to take advantage of the energy stored in residential batteries, and the opportunity to reduce system-wide costs that they present by drawing on their power at times of peak, via a proposed "Bring Your Own Device (BYOD)" program. If approved by the state utility commission, the program would allow customers to lease batteries from the utility in a one-time payment or monthly installments. For customers located in areas where local capacity needs are greatest, the utility is offering a "bonus incentive payment" of $150 per kW.[71] In 2018, the utility saved about $600,000 in peak capacity fees by relying on battery storage already connected to the grid. In

hurricane-katrina.

[67] Frank, B. 2012. "The Health Effects of Hurricane Katrina". Carleton: Geology and Human Health. Available at: https://serc.carleton.edu/NAGTWorkshops/health/case_studies/hurricane_Katrina.html.

[68] Gibbens, S. 2019. Hurricane Katrina, explained. National Geographic. Available at: https://www.nationalgeographic.com/environment/natural-disasters/reference/hurricane-katrina/.

[69] U.S. Department of Homeland Security. No Date. "Power Outages". Available at: https://www.ready.gov/power-outages.

[70] Spector, J. November 7, 2019. "Batteries vs. Blackouts: 1,100 Homes Powered Through Vermont Outage with Storage". Green Tech Media. Available at: https://www.greentechmedia.com/articles/read/green-mountain-power-kept-1100-homes-lit-up-during-storm-outage.

[71] Mingle, J. October 22, 2019. "In Vermont, Green Mountain Power seeks to expand home battery storage pilot". Energy News Network. Available at: https://energynews.us/2019/10/22/northeast/in-vermont-green-mountain-power-seeks-to-expand-home-battery-storage-pilot/.

2019, this figure rose to $900,000 in savings from drawing on batteries for one single hour during peak.

Vermont's Green Mountain Power is not alone: Massachusetts (National Grid) and Rhode Island (Liberty Utilities) also offer "bring your own battery" programs in which families and businesses are paid incentives for the utility to use their privately purchased battery.[72] Several other states and utilities are exploring and launching battery storage grid-integration programs. San Francisco's "Solar+Storage for Resiliency" project plans to deploy solar and storage to 67 emergency shelters within the city to help the city be better prepared for large-scale power outages.[73] A recent cost-benefit analysis of the program found that for every dollar invested in solar plus storage, $1.60 is generated in benefits, primarily due to reductions in morbidity and mortality and revenue from excess power generation.[74] California's "Self-Generation Incentive Program" has resulted in 450 MW of privately purchased battery capacity installations by providing residential customers a 30 to 50 cent per watt-hour incentive.[75] In addition, even when local incentives are unavailable, all U.S. customers are eligible for the federal investment tax credit, which lowers the cost of a battery system by as much as 30 percent.[76]

In Europe, cutting-edge projects in countries including Denmark, the UK and Portugal have demonstrated that decentralized, flexible and optimized grids are more resilient due to their ability to automatically respond to varying conditions—providing a level of stability and security by way of better grid management. Moreover, since these systems are "smart," they produce large quantities of detailed data that enable their continual improvement in response to unexpected conditions and changing circumstances.[77]

What is the value of resiliency?

Although resilience is not typically assigned a value when utilities estimate the cost-effectiveness of a potential solar and storage project, the benefits of resilient electric supply commonly acknowledged in the

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[72] Finkelstein, J., Kane, S. & Rogers, M. March 2019. *How residential energy storage could help support the power grid*. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.

[73] SF Environment. 2019. "Solar and Energy Storage for Resiliency (Solar Resilient)". Available at: https://sfenvironment.org/solar-energy-storage-for-resiliency.

[74] City and County of San Francisco, Department of the Environment. December 2018. "Solar and Energy Storage for Resiliency". SF Environment. p.2. Available at: https://sfenvironment.org/sites/default/files/fliers/files/sfe_en_solar_resilient_cost_benefit_analysis.pdf.

[75] California Public Utilities Commission. 2020. "About the Self-Generation Incentive Program". Available at: https://www.cpuc.ca.gov/General.aspx?id=11430.

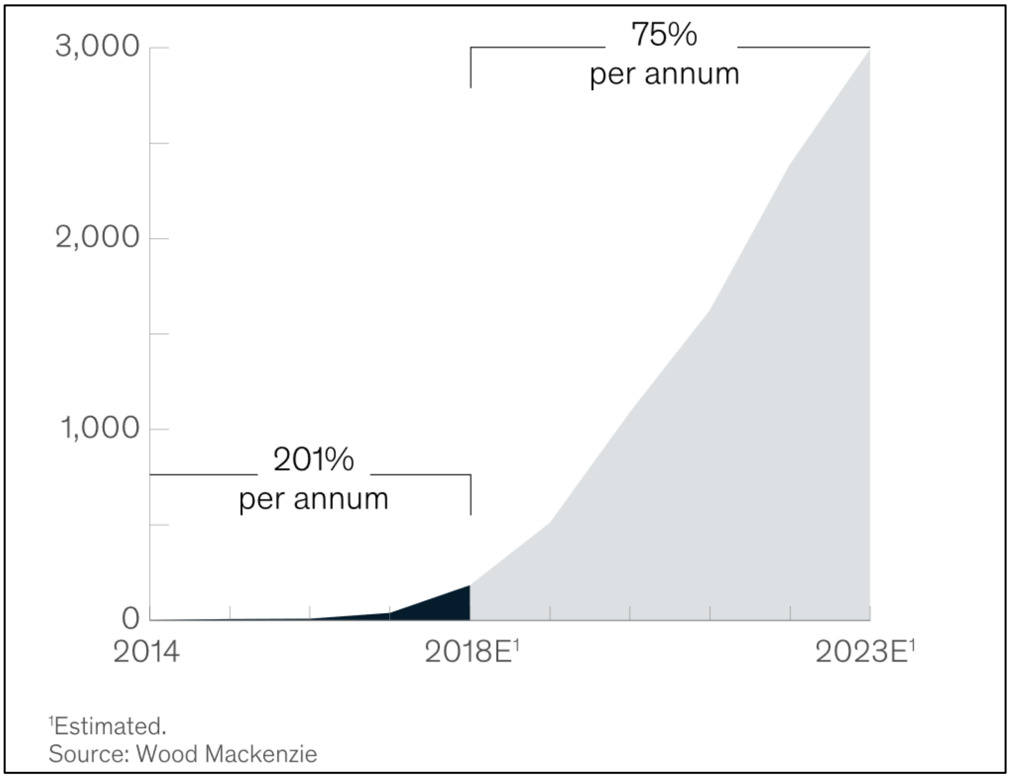
[76] Finkelstein, J., Kane, S. & Rogers, M. March 2019. *How residential energy storage could help support the power grid*. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.

[77] SMILE. 2020. "About the Project." SMILE. Available at: https://www.h2020smile.eu/about-the-project/.

event of a power outage. Utilities measure this benefit as the "value of lost load".[78] Recent research by the National Renewable Energy Laboratory valued the resiliency benefits of batteries at $2,000 to $14,000 per hour in large buildings like schools and hospitals, noting the importance of current electricity costs, load profiles, the average timing, cost and duration of power outages in determining the most cost-effective storage systems for resiliency.[79]

Given the significant benefits of storage for resiliency, utilities are accelerating efforts to encourage the adoption of battery storage systems. According to a 2019 McKinsey & Company analysis, residential battery storage installations have increased dramatically, from 2.3 MWh in 2014 to 185 MWh in 2018, and are expected to reach nearly 3,000 MWh per year by 2024 (see Figure 10).

Figure 10. Annual U.S. residential energy storage installations (MWh)



Source: Reproduced from Finkelstein, J., Kane, S. & Rogers, M. March 2019. How residential energy storage could help support the power grid. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.

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[78] Woods, B. and Stanton, E.A. March 2019. *Massachusetts Non-Energy Benefits of Battery Storage*. Applied Economics Clinic. Prepared on behalf of Clean Energy Group. Available at: https://aeclinic.org/publicationpages/2019/3/15/massachusetts-non-energy-benefits-of-battery-storage.

[79] National Renewable Energy Laboratory. 2018. *Valuing the Resilience Provided by Solar and Battery Energy Storage Systems*. Available at: https://www.nrel.gov/docs/fy18osti/70679.pdf.

3. 100 Percent Renewable Electricity is Affordable

ENO's claim: ENO claims that the R-RPS proposal would greatly increase customer costs.

Reality: Renewable energy does not require firm capacity in order to be cost-effective, in fact, the most reliable, resilient and affordable option would be to pair renewable energy with load flexibility resources.

ENO claims that:

> *The costs [of EFNO's R-RPS proposal] would be astronomical and represent a remarkably inefficient use of the City's finite resources.*[80]

ENO's assertion that EFNO's R-RPS proposal would be prohibitively expensive rests primarily on research conducted by the Clean Air Task Force (CATF), which found that a clean energy standard would be less costly than a renewable-only standard, largely due to the omission of firm capacity resources in the R-RPS proposal and the "enormous quantities of storage capacity" that would be required by a renewables-only plan.[81] The CATF study conducted a very detailed accounting of the costs of renewable energy and storage while failing to fully account for their many benefits, such as the reliability and resiliency benefits discussed in previous sections.

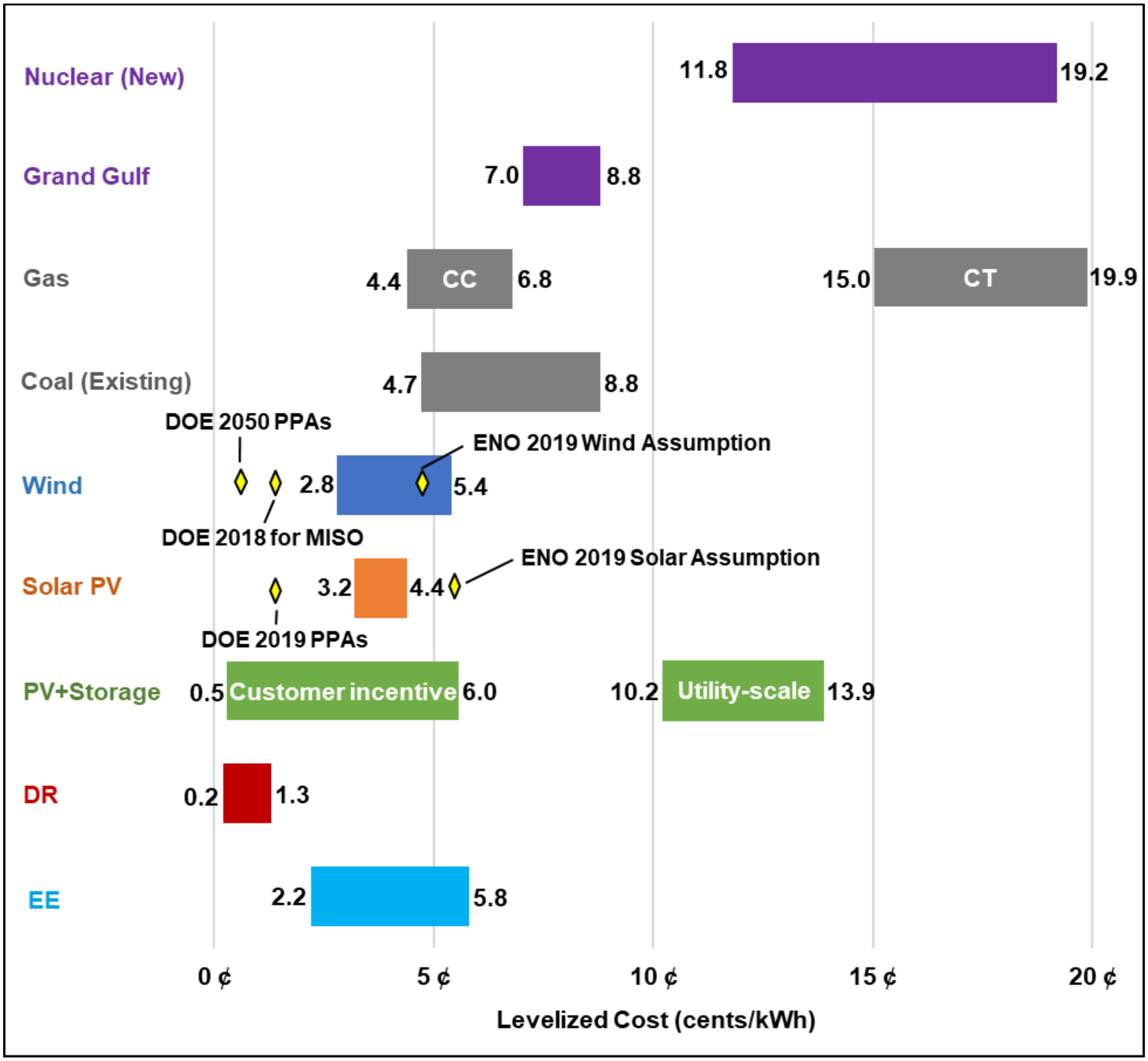
The reality is that ENO, CATF and ENFO agree that renewable energy is already cost-effective and is projected to become more cost-effective in the future. However, ENO and CATF come to the incorrect conclusion that firm capacity is a requirement to balance a grid with 100 percent renewable resources. In fact, a more reliable, resilient and cost-effective grid would pair renewable energy with load flexibility resources of all kinds.

Renewable energy is the best deal for electric customers

Renewable energy, demand response and energy efficiency are currently available and cost-competitive (see Figure 11 below).

[80] Council for the City of New Orleans Docket No. UD-19-01. July 2019. *Entergy New Orleans, LLC's reply comments in response to Council resolution R-19-109 concerning the establishment of renewable portfolio standards*. p.3.
[81] Ibid. p.8.

Figure 11. Levelized cost of energy (cents per kWh)



Sources: 1) Lazard. 2019. Lazard's levelized cost of energy analysis. Version 13.0. p. 2. Available at: https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf; 2) Lazard. 2019. Lazard's levelized cost of storage analysis. Version 5.0. p. 14. Available at: https://www.lazard.com/media/451087/lazards-levelized-cost-of-storage-version-50-vf.pdf; 3) Entergy New Orleans, LLC. July 2019. 2018 Integrated Resource Plan. p.38. Available at: https://www.entergy-neworleans.com/irp/2018_irp/; 4) Entergy New Orleans, LLC. 2017. Fuel Adjustment Data - Period 1: Electric cost of service; High: Todd, O. 2018. Revised Direct Testimony of Orlando Todd. On behalf of Entergy New Orleans, LLC. Docket No. UD-1; 5) U.S. Department of Energy. August 2019. 2018 Wind Technologies Market Report. Figures 57, 58, 62. p. 62, 63, 65. Available at: https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Wind%20Technologies%20Market%20Report%20

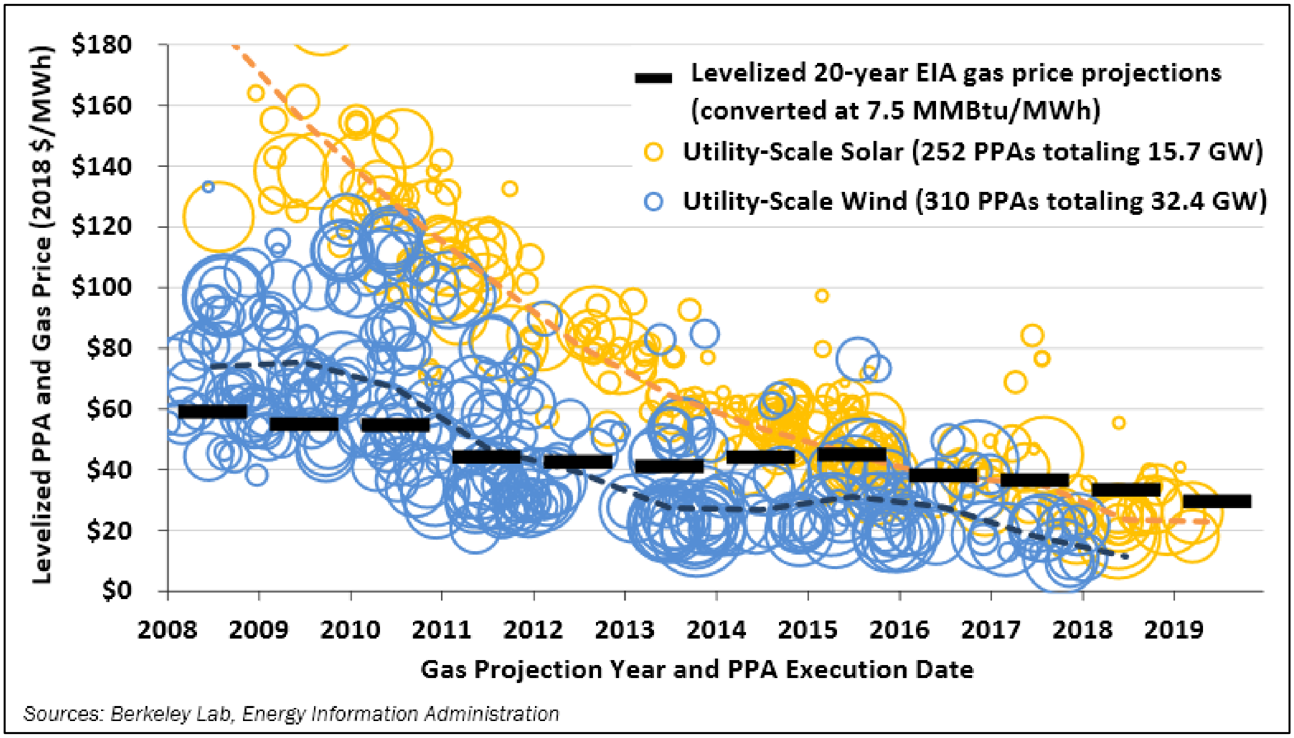
FINAL.pdf; 6) Molina, M. December 2018. "Renewables are getting cheaper but energy efficiency, on average, still costs utilities less". ACEEE. Available at: https://www.aceee.org/blog/2018/12/renewables-are-getting-cheaper-energy; 7) Hummon, M. April 2014. "Value of Demand Response: Quantities from Production Cost Modeling". NREL. p.13. Available at: https://www.nrel.gov/docs/fy14osti/61815.pdf.

Demand response is cheaper than any other load balancing resource on a levelized basis. Wind, solar and energy efficiency prices are 17 to 70 percent lower than ENO's existing Grand Gulf nuclear plant (a key component of ENO's Clean Energy Standard proposal, which the utility falsely claims is necessary to keep customer rates low[82]) and existing coal elsewhere in MISO. The U.S. Department of Energy's (DOE) 2018 levelized wind PPA price for MISO (2.1 cents/kWh) is 53 percent lower than ENO's 2019 wind assumption (4.5 cents/kWh), and demonstrates how much cheaper wind energy is in MISO than the U.S. average. DOE's 2050 wind PPA projection (1.1 cents/kWh) indicates that these prices are expected to drop even further. DOE's 2018 and 2050 wind prices are both lower than Lazard's (2.8 to 5.4 cents/kWh)(see Figure 11 above). The DOE's 2019 solar PPA price (2.2 cents/kWh) is lower than the prices estimated by Lazard (3.2 to 4.4 cents/kWh) and 59 percent lower than the price being assumed by ENO (5.4 cents/kWh). In addition, utility solar plus storage is cheaper than new coal or new nuclear. When we levelized various Massachusetts' utility customer incentives for flexible peaker resources (including demand response and battery storage),[83] we found that their costs are lower than utility-owned solar plus storage and competitive with demand response programs.[84]

The U.S. Department of Energy's 2018 Wind Market report shows wind prices in the southeast (which includes Louisiana) have fallen dramatically since 1996; from approximately $80/MWh in 1996 to approximately $40/MWh in 2015.[85] The same report shows wind prices have been competitive with gas price projections since approximately 2010, while solar prices have been competitive since approximately 2016 (see Figure 12 below). In recent years, the prices of solar has fallen even faster than the price of wind.

[82] Council for the City of New Orleans Docket No. UD-19-01. July 2019. *Entergy New Orleans, LLC's reply comments in response to Council resolution R-19-109 concerning the establishment of renewable portfolio standards*. p.2.
[83] Based on the assumption that these resources have the same 10 percent capacity factor used by Lazard for gas peaker plants.
[84] This is based on forthcoming AEC work: Castigliego, J., Stanton, E.A., Alisalad, S. and Tavares, E. 2020 (Expected). *The Value of Winter Electric Reliability in New England*. Applied Economics Clinic. Prepared on behalf of Clean Energy Group. Publication will be available at: https://aeclinic.org/publicationpages/2019/6/13/the-value-of-winter-electric-reliability-in-new-england.
[85] U.S. Department of Energy. August 2019. *2018 Wind Technologies Market Report*. Figure 53, p. 59. Available at: https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Wind%20Technologies%20Market%20Report%20FINAL.pdf. (Data in 2018 dollars).

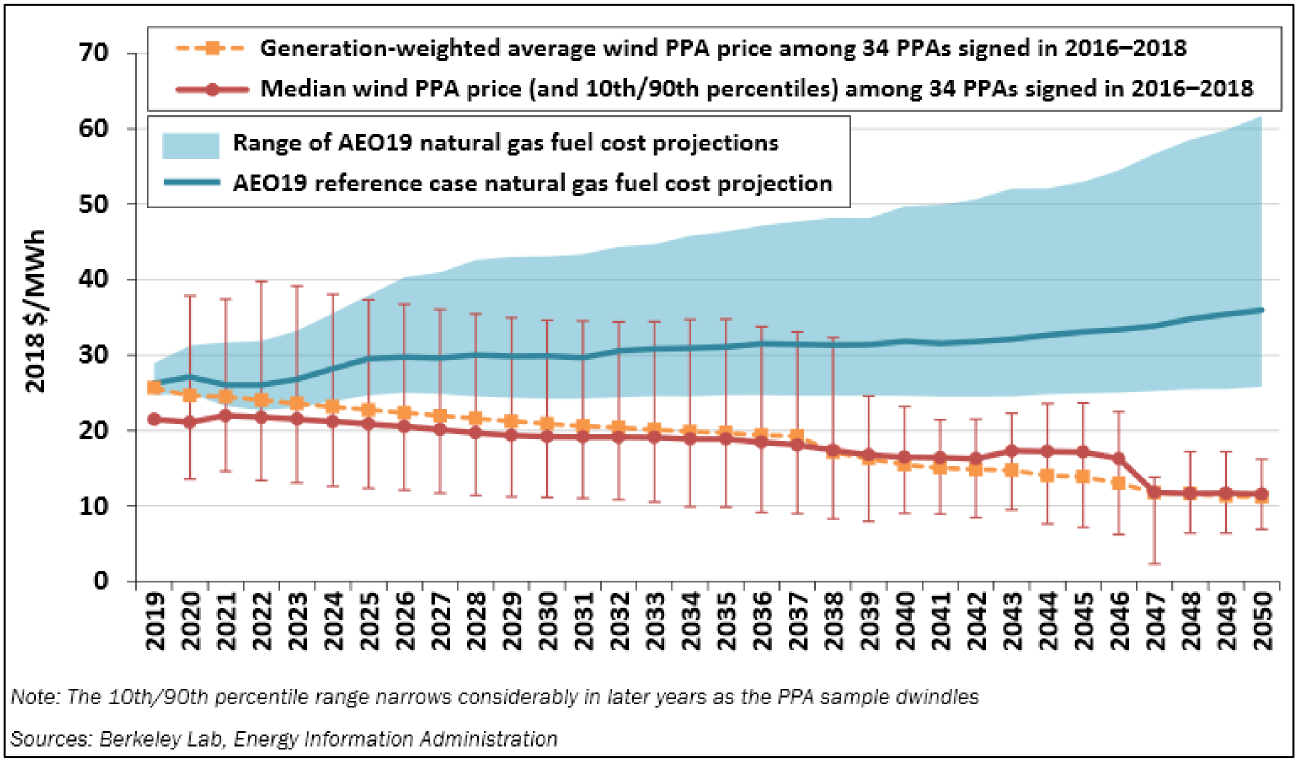
Figure 12. Levelized wind and solar PPA prices and levelized gas price projections



Source: Reproduced from U.S. Department of Energy. August 2019. 2018 Wind Technologies Market Report. Figure 56, p. 62. Available at: *https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Wind%20Technologies%20Market%20Report%20FINAL.pdf.*

Renewable energy is forecasted to become even less costly over time. The U.S. Department of Energy's 2018 Wind Market report projects that wind price will fall below any gas price projection by 2025, and will fall to approximately $10 per MWh (1 cent/kWh) by 2050 (see Figure 13 below).

Figure 13. Wind PPA prices and natural gas fuel cost projections over time



Source: Reproduced from U.S. Department of Energy. August 2019. 2018 Wind Technologies Market Report. Figure 57, p. 63. Available at: *https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Wind%20Technologies%20Market%20Report%20FINAL.pdf*.

Renewable energy resources are most cost-effective paired with load flexibility

As ENO discusses in its critique of EFNO's R-RPS, solar and wind generation are intermittent: they cannot be dispatched at will by grid operators. Intermittent resources pair poorly with firm resources like nuclear and coal-fired generation, which cannot be "ramped" up and down to flexibly adjust to provide energy when needed, save up energy produced at renewables peak generation times, and shape the system's load curve to eliminate peaks and save money for all customers.

The best pairing with renewables is load flexibility resources, like demand response, energy efficiency, battery and other forms of energy storage, virtual power plants and peak shifting measures. These flexible resources provide energy when needed to meet customer demand, save up excess energy produced by renewables to use when its needed, and shape and flatten load to lower costs. Load flexibility resources are a cost-effective balancing solution for our modern, clean, and inexpensive renewable generation resources.

Load flexibility is a lot more than just lithium batteries

As states, cities and utilities commit themselves to a clean energy future, the typical resource planning that relies on firm capacity and centralized generation resources is no longer the most cost-effective or reasonable approach. Alternatives to firm capacity for grid balancing involve more than a single technology—clean energy portfolios will include utility-scale renewables, distributed renewable energy and a myriad of load flexibility resources.

While battery storage is the most "famous" of the bunch, load flexibility resources are not limited to battery storage: energy efficiency, demand response, virtual power plants, load shaping measures and hydro pumped storage all have equally important roles to play in an optimized, cost-effective renewable future (see Table 3 in Section 1 above).

Resource portfolios that use load flexibility resources save customers money

Recent detailed resource expansion and dispatch modeling for jurisdictions around the United States shows reliable and cost-effective system balancing using load flexibility portfolios that include demand response, energy efficiency, and battery storage. ENO incorrectly claims: (1) that firm resources like nuclear are essential to system reliability, and (2) that firm zero-carbon resources (i.e. nuclear) can be had at low cost. New electric modeling studies have explored less and less reliance on firm resources in favor of low-cost load flexibility resources, demonstrating that neither firm resources nor expensive capacity oversupply are needed to balance high renewable penetration system.

In March 2019, New Mexico passed the Energy Transition Act mandating 50 percent renewable energy by 2030 and 100 percent carbon-free electricity by 2045.[86] A 2019 modeling analysis of New Mexico's retiring San Juan Generating Station—for which 924 MW were retired in 2017 and the remaining 924 MW will be retired in 2022—examined its replacement with a Clean Energy Resource Portfolio (CERP) consisting of renewables and load flexibility resources (primarily battery storage and demand response).[87] The study explains that: "After 2032, the CERP builds additional wind resources (following the 2031 Four Corners retirement) and additional solar PV, battery, and demand response resources (to maintain reliability and meet energy requirements). These renewable resources can more efficiently meet changing system conditions than the larger-scale gas-fired generating units in PNM's MCEP."[88] Modeling results find that the CERP replacement is 1.5 percent less expensive that replacement using gas-fired units.

In 2015, Hawaii became the first U.S. state to set a 100 percent renewable target, aiming to do so by

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[86] Long, N. March 13, 2019. *New Mexico Passes 100% Clean Energy Bill*. Natural Resources Defense Council. Available at: https://www.nrdc.org/experts/noah-long/new-mexicos-energy-transition-heads-governor.
[87] Glick, D., Peluso, N. and Fagan, B. February 2019. *San Juan Replacement Study*. Synapse Energy Economics. Prepared on behalf of Sierra Club. Available at: https://www.synapse-energy.com/sites/default/files/San-Juan-Replacement-Study-18-128.pdf.
[88] Ibid. p.2.

2045.[89] Based on their utility commissions' critiques and requirements, Hawaii's most recent integrated assessment plan—called "Power Supply Improvement Plan" (PSIP)—rejects the previous PSIP's large buildout of gas resources,[90] claimed necessary as a transition fuel to balance high expected solar penetration levels.[91] Instead, the 2016 PSIP offers a 100 percent renewable generation by 2045 plan that includes 115 MW of demand response and 3.4 GW of battery storage. The Hawaiian utilities' modeling balances their high renewable levels with a combination of overbuild and load flexibility resources, resulting in 6 percent higher costs that in the 2014 plan to invest in gas resources under low gas risk circumstances. The commission chose this path based on careful consideration of the financial and reliability risks associated with gas and LNG delivery in a hurricane prone region. Hawaii plans to implement a "demand response management system…that will be used to deliver the [demand response] services through the intelligent management and optimization of groups of [demand-side energy resources]".[92]

Hawaii's PSIP sets the state on the path to 100 percent renewable energy by planning to: achieve 52 percent renewable energy by 2021 and aggressively pursue grid-scale renewable resources; achieve 100 percent renewable energy on the island of Molokaʻi by 2020; maximize distributed energy resources; pursue ambitious demand response programs; achieve grid modernization; and preserve grid flexibility to be able to use emerging technologies.[93] In order to ensure this action plan is followed, Hawaii outlines planning principles that include committing to renewable energy as a first choice, achieving an inclusive energy transformation, maintaining flexibility to account for changing circumstances, prioritization of grid reliability and resiliency, and pursuing a diverse mix of resources.[94]

Puerto Rico's 2019 integrated assessment plan provides system modeling to 2038 in the context of a recently enacted 100 percent renewables by 2050 law.[95] The scenarios modeled include one that avoids new gas investment (using base or most likely renewable generation prices) and is less expensive than the

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[89] State of Hawaii. 2015. State of Representatives Twenty-Eighth Legislature. House Bill No. 623. *A Bill for an Act Relating to Renewable Standards*. Available at: https://www.capitol.hawaii.gov/session2015/bills/HB623_CD1_.HTM.

[90] Woods, B., Tavares, E., Alisalad, S. and Stanton, E.A. October 2019. *Puerto Rico Integrated Resource Plan: Lessons from Hawaii's Electric Sector*. Applied Economics Clinic. Available at: https://aeclinic.org/publicationpages/2019/10/22/xjr7mhm3mdk3hgl3tb1jqe0trljj9v.

[91] The Hawaiian Electric Companies. 2016. *The Hawaiian Electric Companies' 2016 Power Supply Improvement Plan (PSIP) Update*. Book 1. Available at: https://www.hawaiianelectric.com/clean-energyhawaii/integrated-grid-planning/power-supply-improvement-plan.

[92] Ibid. p. 2-19.

[93] Ibid. p. ES-2.

[94] Ibid. p. ES-4.

[95] Puerto Rico Electric Power Authority. June 2019. *Report No. RPT-015-19. Puerto Rico Integrated Resource Plan 2018-2019*. Submitted by Siemens Industry. Available at: http://energia.pr.gov/wp-content/uploads/2019/02/PREPAEx.-1.0-IRP-2019-PREPA-IRP-Report.pdf.

utility's preferred scenario.[96] The February 2020 IRP hearing focused on the need for load flexibility resources for resilience and reliability, including extensive discussion of the use of virtual power plants for reliability and the likelihood of families and small businesses purchasing solar plus battery systems for resilience. Virtual power plants are not a theoretical concept; they are being utilized by Hawaii Electric (4.3 MW with 1,000 homes for peak load reduction), ISO New England (20 MW with 5,000 solar plus storage homes), and East Bay Community Energy in California (solar plus storage on multifamily housing for peak load reduction).[97]

A 2018 modeling study by the Rocky Mountain Institute found that clean energy resources provide a variety of valuable and cost-effective grid services, including reductions to energy consumption and peak load, frequency regulation and voltage support (see Table 4 below).[98]

Table 4. RMI's list of grid services from load flexibility resources

Resource	Service			
	Energy	Peak Capacity	Flexibility	Additional Network Stability*
Energy Efficiency	Reduces consumption	Reduces Peak Load	Flattens Ramps	N/A
Demand Response	N/A	Reduces Peak Load	Can actively respond to ramp events, in both directions	Current-generation active load-management technologies can provide reserves and frequency regulation
Distributed** and Utility-Scale Battery Energy Storage	N/A	Provides active power injection		Can provide reserves, frequency support (including synthetic inertia), voltage support, and black start
Distributed** Renewable Energy	Energy generator	Can reliably produce at "capacity credit" during peak hours	Balanced portfolios can reduce ramp rates	When renewable resource is available, can provide reserves, frequency regulation, and voltage support
Utility Scale Renewable Energy				

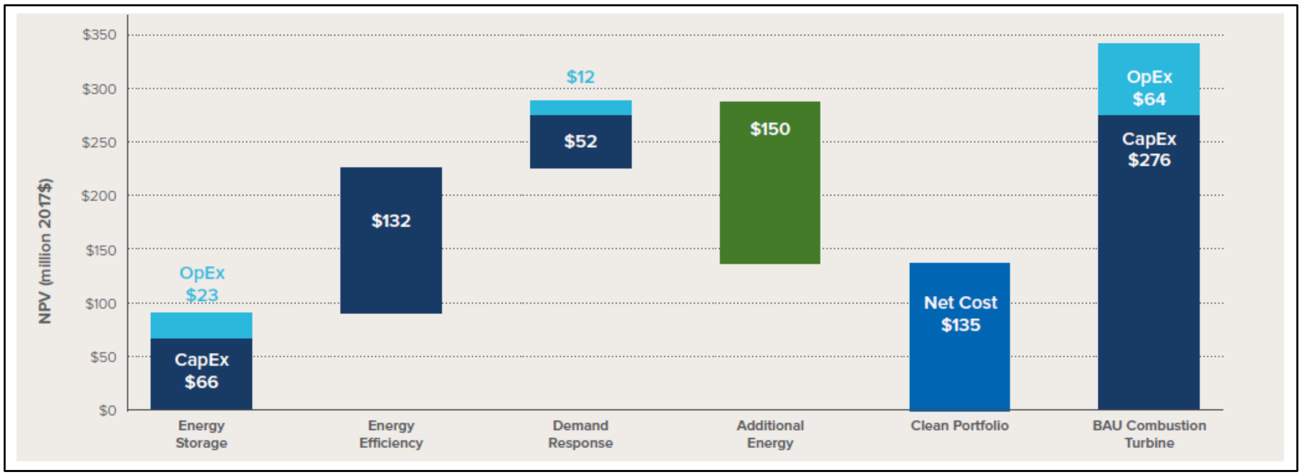
*Note: *includes distribution-level voltage support and other ancillary services **includes behind-the-meter and front-of-the-meter deployments*
Source: Recreated from Dyson, M., Engel, A., and Farbes, J. 2018. The Economics of Clean Energy Portfolios. Rocky

[96] Stanton, E.A. 2019. Docket No. 2018-0001. *Testimony on Puerto Rico Electric Power Authority (PREPA) Least Cost Integrated Resource Plan*. Testimony to Puerto Rico Energy Bureau on behalf of Sunrun. Available at: https://aeclinic.org/publicationpages/2019/10/25/testimony-on-puerto-rico-electric-power-authority-prepa-least-cost-integrated-resource-plan.
[97] Rascher, C.J. 2019. Docket No. 2018-0001. *Testimony on Puerto Rico Electric Power Authority (PREPA) Least Cost Integrated Resource Plan*. Testimony to Puerto Rico Energy Bureau on behalf of Environmental Defense Fund.
[98] Dyson, M., Engel, A., and Farbes, J. 2018. *The Economics of Clean Energy Portfolios*. Rocky Mountain Institute. Available at: https://rmi.org/insight/the-economics-of-clean-energy-portfolios/.

Mountain Institute. Table 1, p. 23. Available at: https://rmi.org/insight/the-economics-of-clean-energy-portfolios/.

The study found that renewable plus load flexibility portfolios are 2 to 5 percent less costly than actual proposed natural gas plants around the country. Among the proposed gas plants analyzed, was a gas combustion turbine from the MISO region which is outperformed in modeling by a combination of demand response and battery storage (see Figure 14 below).[99]

Figure 14. Cost breakdown of clean energy portfolio versus gas-fired power plant in Mid-Atlantic region



Source: Reproduced from Dyson, M., Engel, A., and Farbes, J. 2018. The Economics of Clean Energy Portfolios. Rocky Mountain Institute. Figure 21, p. 44. Available at: https://rmi.org/insight/the-economics-of-clean-energy-portfolios/.

How do load flexibility resources reduce capacity costs?

Load flexibility resources can reduce, shave and/or shift peak demand. Lower peak load means less capacity and reserve resources need be purchased or kept online. If New Orleans could perfectly flatten its 6,063 GWh annual electric demand, its new peak would be 0.7 GW compared to the current peak of 1.2 GW. New Orleans' current peak requires a reserve margin (extra capacity that ENO must purchase over and above the peak) of 0.10 GW; the flattened peak would only require 0.06 GW.

Flexibility resources' ability to flatten load and save money on capacity purchases is magnified for behind-the-meter resources like rooftop solar, in-home or in-business batteries, demand resource and energy efficiency. In electric system planning, these behind-the-meter resources are counted as reductions to demand and not as increases to energy supply. If 30 percent of New Orleans current supply were replaced with behind-the-meter flexibility resources (as called for in EFNO's R-RPS), ENO's flattened capacity and reserve would shrink by 0.38 GW.

Adjusting for the saved line losses from behind-the-meter resources would increase these savings still

[99] Ibid. p.43-44.

further. Both ENO[100] and MISO[101] line losses are 3.5 percent. That's 3.5 percent of electricity that never makes it to the customer. Behind-the-meter generation and other close-to-load resources shrink or eliminate the distance electricity needs to travel from generator to consumer, and thereby shrink these losses, saving customers money.

How do load flexibility resources shrink generation costs?

In the longer run, when MISO renewables exceed 40 percent of supply or ENO exceeds a more specific local threshold, adding load flexibility resources will enable more low-cost renewable energy to be added to the system by balancing supply to efficiency-adjusted demand minute-by-minute. Load flexibility resources like demand response, virtual power plants, utility-scale batteries, distributed batteries, electric vehicle batteries, and pumped hydro storage can all shape load to fit around renewable solar and wind generation, by: saving energy from one time period to use in another, shifting flexible demand to occur times of higher renewable generation, and responding dynamically to constantly changing electric demands. When load is shaped around renewable generation, a greater share of low-cost renewables can be effectively utilized, bringing costs down for consumers.

Utilities also have an opportunity to leverage private ownership of battery systems through incentive programs—like Green Mountain Power's Bring Your Own Device program,[102] California's Self-Generation Incentive Program,[103] and National Grid, Eversource[104] and Liberty Utilities'[105] bring your own battery programs. By offering incentives for the utility's use of resources like solar panels, battery storage and demand response measures, utilities reduce their overall costs to access stored energy as needed. The utility only pays for the incentive and the energy it uses—reaping the reward of being able to call on that energy as needed—and the customer pays the remainder—reaping the reward of free-on-the-margin self-generation and storage. Unlike centralized, utility-scale resources where the planning, execution, operations and maintenance all fall to the utility—distributed resources incentivized by the utility are a powerful way to reduce and manage overall energy system costs.

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[100] Entergy. 2018. *Entergy Statistical Report and Investor Guide*. p.35. Available at: https://www.entergy.com/userfiles/content/investor_relations/docs/2018_Investor_Guide.pdf.

[101] MISO. 2020. "Transmission Owner Loss Data". Available at: https://www.misoenergy.org/markets-and-operations/settlements/ts-pricing/to-loss-data/.

[102] Green Mountain Power. 2020. "Bring Your Own Device". Available at: https://greenmountainpower.com/bring-your-own-device/.

[103] California Public Utilities Commission. 2020. "Self-Generation Incentive Program". Available at: https://www.cpuc.ca.gov/sgip/.

[104] MassSave. 2020. "Use your Battery Storage Device to Make the Grid More Sustainable". Available at: https://www.masssave.com/saving/residential-rebates/connectedsolutions-batteries.

[105] Liberty Utilities. 2020. "Battery Storage Pilot Program". Available at: https://new-hampshire.libertyutilities.com/grafton/residential/smart-energy-use/electric/battery-storage.html.

Why are load flexibility resources so cost-effective?

Load flexibility resources are cost-effective for four main reasons: first, they provide grid reliability and lower energy system costs by helping to reduce, shave and shift peak demand; second, they provide grid resilience by guaranteeing backup power during power outages thereby lowering their net costs; third, they are already cost-competitive with firm resources and their prices are predicted to drop further; and fourth, when customers bear the costs to purchase and install these resources, utilities need only pay an incentive to access the energy service as needed. Flexibility resources include a variety of technologies and measures including demand response, energy efficiency, load shaping measures, energy storage technologies and virtual power plants.

While many flexibility resources are well-established and known for their peak savings, a new crop is providing even more grid flexibility for a lower cost due to lower connectivity costs and cutting-edge machine learning approaches.[106] There are also emerging procurement practices for demand response, including “pay-for-performance” energy efficiency, where utilities purchase efficiency from aggregators, which reduces overall costs because the utility pays only for savings delivered without having to administer and verify its own efficiency program.[107] There are also portfolio-based procurement options, where utilities procure a locally-specific, least-cost portfolio of flexibility resources including not only energy efficiency, but also demand response, battery storage and distributed generation.[108] Finally, an increasing number of utilities—including Arizona Public Service Company, Xcel Energy Colorado[109] and Northern Indiana Public Service Company[110]—are relying on all-source resource solicitations that provide utilities with apples-to-apples cost comparisons for traditional and non-traditional capacity and generation options.

States, cities and utilities are increasingly acknowledging the important and valuable resiliency benefits of storage technologies—for example, six states (California, Oregon, New York, Massachusetts and New Jersey)[111] now have energy storage mandates in place. Analysis from McKinsey found that between 2012 and 2017, the cost of residential battery storage systems decreased by more than 15 percent every year.[112]

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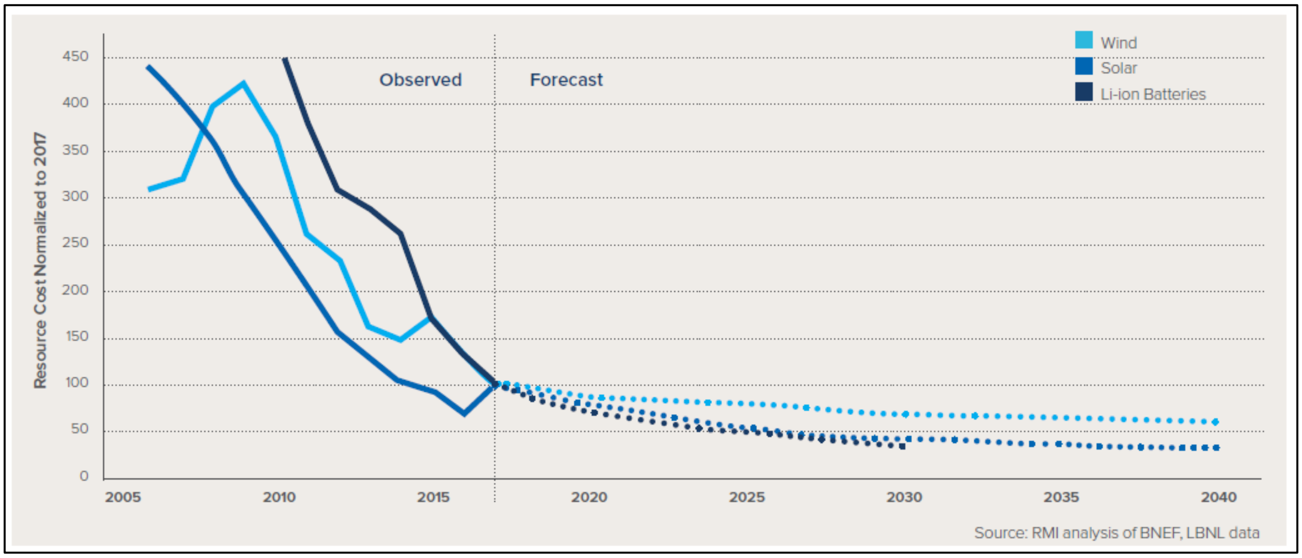
[106] Dyson, M., Engel, A., and Farbes, J. 2018. *The Economics of Clean Energy Portfolios*. Rocky Mountain Institute. p.22. Available at: https://rmi.org/insight/the-economics-of-clean-energy-portfolios/.
[107] Ibid. p.25.
[108] Ibid.
[109] Ibid.
[110] Northern Indiana Public Service Company. 2018. *2018 Integrated Resource Plan Executive Summary*. p. 2. Available at: https://www.nipsco.com/docs/librariesprovider11/rates-and-tariffs/irp/irp-executive-summary.pdf.
[111] Kramarchuk, R. September 2019. *Policy Backdrops / Drivers in PJM*. S&P Global. Prepared on behalf of Energy Foundation.
[112] Finkelstein, J., Kane, S. & Rogers, M. March 2019. *How residential energy storage could help support the power grid*. McKinsey & Company. Available at: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-residential-energy-storage-could-help-support-the-power-grid.

The Rocky Mountain Institute projects the prices of wind, solar and battery storage to drop by about 50 percent from today to 2030 (see Figure 15 below).

Figure 15. Historical and forecast cost declines for wind, solar, and batteries



Source: Reproduced from Dyson, M., Engel, A., and Farbes, J. 2018. The Economics of Clean Energy Portfolios. Rocky Mountain Institute. Figure 6. p.21. Available at: https://rmi.org/insight/the-economics-of-clean-energy-portfolios/.

Ultimately, load flexibility resources are the future of energy: they provide the same capacity and ancillary services as traditional peaker resources and serve to lower both utility and customer costs by reducing, shaving and shifting peak demand and by enabling greater renewable energy integration.