PRIMER

RESOURCE ADEQUACY APPROACHES AND IMPORTANCE TO ENERGY CUSTOMERS

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CEBI
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ABOUT THE CLEAN ENERGY BUYERS INSTITUTE

The Clean Energy Buyers Institute (CEBI) solves the toughest market and policy barriers to achieve a carbon-free energy system. CEBI's aspiration is to achieve a 90% carbon-free U.S. electricity system by 2030 and a global community of customers driving clean energy.

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OVERVIEW

The Resource Adequacy General Approaches and Importance to Energy Customers Primer is the first edition of a series on resource adequacy. This Primer aims to educate energy customers on what resource adequacy is and how it impacts:

- Electric reliability
- Clean energy integration
- Cost efficiency

THE PURPOSE The Resource Adequacy Primer is intended to explain resource adequacy, general approaches for how it is planned, and why it is important to energy customers. The primer also explores the relationship between resource adequacy and electric reliability and uncovers the broader implications resource adequacy has on costs and the transition to a zero-carbon electric grid.

INTENDED AUDIENCE: This primer is targeted towards energy customers interested in electricity market fundamentals, market design, or grid reliability.

TABLE OF CONTENTS

I. INTRODUCTION

America's Resource adequacy is the ability of the power system to balance electric supply and demand now and into the forecasted future. To ensure adequate resources, grid operators[1] determine the amount of generation necessary for predicted future demand. Resource adequacy is one component of maintaining electric reliability, working in concert with other standards, practices, and rules to ensure outages do not occur. Resource adequacy is necessary to ensure electric reliability and to prevent under procurement. It is also related to over procurement, which results in significant and excessive costs to energy customers. Determining the right amount of resources needed to be adequate is crucial, and, depending on regulatory structure, is accomplished primarily through utility planning, wholesale capacity markets, and wholesale energy and reserve markets.

The design and implementation of each can have profound impacts upon a range of considerations important to energy customers, including reliability, cost, and the level of clean energy adoption that can be achieved.

The Resource Adequacy Approaches and Importance to Energy Customers Primer explores the basics of resource adequacy, including:

- *What resource adequacy is and its relationship to electric reliability*
- *The importance of resource adequacy to energy customers*
- *General approaches used across the U.S. to determine and ensure resource adequacy*
- *How resource adequacy affects cost and clean energy integration*

[1] Grid operators balance energy supply and demand, ensure that the power system is stabilized around a set voltage and frequency, and maintain adequate resources to ensure electricity needs are met in the future. Generally, a grid operator could be a vertically integrated utility (or group of affiliates) that balances its own generation supply against its customers' demand or a Regional Transmission Organization/Independent System Operator (RTO/ISO) that optimizes energy resources across several utilities' customers. There is no distinction between RTOs and ISOs for the purposes of this primer, and we will simply refer to them collectively as "RTOs."

II. WHAT IS RESOURCE ADEQUACY AND HOW IS IT RELATED TO RELIABILITY?

The electric grid in the U.S. is designed to deliver safe, reliable electrical service to energy customers, with a goal of doing so at least cost. **Reliability** is the foundational ability of the system to deliver power to end-use customers and power outages can occur when it is not properly maintained. Grid operators have traditionally approached the challenge of matching electricity supply and demand by adjusting power generation in real time as customer demand changes. The inverse approach is also increasingly available as newer technologies make it easier to consume energy more efficiently and in sync with power generation. In this inverse scenario, demand can adjust to balance supply at any instant. A wider range of options for balancing the grid is important as power supply becomes more variable with higher levels of intermittent generation resources like wind and solar.

The ability of a system to balance forecasted supply and demand with sufficient resources is called resource adequacy. Resource adequacy is important because under procurement – not procuring enough resources to meet energy demand at a given time – can undermine reliability; and over procurement - procuring too many resources - can become excessively costly for ratepayers. **Resource adequacy** is designed to ensure that electrical supply can meet demand under all scenarios, except the rarest. Grid planners consider a variety of factors to manage resource adequacy, including, economic forecasts, customer habits, and weather patterns given that electricity usage increases in times of more extreme heat or cold. Historically, this effort focused particularly on determining annual peak load, when demand for electricity is at its highest. However, traditional approaches to ensure resource adequacy are evolving given the increasing unpredictably of extreme weather events as a result of climate change.

RESOURCE ADEQUACY IS ONLY ONE COMPONENT OF ELECTRIC RELIABILITY

Resource adequacy is the ability of a system to balance forecasted supply and demand with sufficient resources and is important to maintaining electric reliability, which is the ability the system to deliver power to end-use customers. **However, resource adequacy does not equate to reliability**—it is only one link in a chain of standards, practices, and rules needed to ensure reliability. Adding additional resources to the power system and stockpiling fuel on-site is costly for energy customers, and it does not guarantee that a power plant or distribution line will mechanically perform under extreme conditions. Instead, most grid operators accept that the power system will not be impervious to all reliability events. The primary goals are to avoid reasonably preventable outages, manage scarce resources during emergencies to deliver electricity to the most critical functions, and ensure that imbalances do not destabilize the system.

TEXAS DEEP FREEZE AND CALIFORNIA HEAT STORM: RELIABILITY VS. RESOURCE ADEQUACY

As seen during the February 2021 deep freeze in Texas, mechanical failures at power plants, the inability of pipelines to deliver gas, and the fact that natural gas wellheads were not designated[2] as critical facilities meant that despite sufficiently planned resources, there was no way to extract, deliver, or combust enough gas to generate electricity.[3] Adding more resources would not have helped ensure reliability without appropriately designating and weatherizing critical facilities to ensure performance.[4]

Alternatively, during the western heat storm of 2020, energy market practices in the California day-ahead and real-time markets, such as under-scheduling of demand by load-serving entities, contributed to the inability of the grid operator to acquire sufficient additional resources to avoid controlled power outages. California also did not have a system of locating and compensating demand reduction resources that could have avoided curtailment. Improved communications, forecasting, prioritization of scarce resources, weatherization, and distribution wires upgrades often can better serve reliability than increasing the number of available generating resources by building more power plants.[5]

[2] Cramton, P. Lessons from the 2021 Texas electricity crisis. March 23, 2021. Utility Dive. https://www.utilitydive.com/news/lessons-from-the-2021-texas-electricity-crisis/596998/

[3] Bushnell, J. To Fix the Power Market, First Fix the Natural Gas Market. March 22, 2021. Energy Institute Blog. https://energyathaas.wordpress.com/2021/03/01/to-fix-the-power-market-first-fix-the-natural-gas-market/

[4] Garza, B. Hearing on Lessons learned from the Texas blackouts: Research needs for a secure and resilient grid. March 16, 2021. R Street. https://www.rstreet.org/2021/03/18/hearing-on-lessons-learned-from-the-texas-blackouts-research-needs-for-a-secure-and-resilient-grid/

[5] California Energy Commission. CAISO, CPUC, CEC Issue Final Report on Causes of August 2020 Rotating Outages. January 13, 2021. https://www.energy.ca.gov/news/2021-01/caiso-cpuc-cec-issue-final-report-causes-august-2020-rotating-outages.

III. WHY IS RESOURCE ADEQUACY IMPORTANT TO CUSTOMERS WITH CLEAN ENERGY GOALS?

Resource adequacy is critical to ensuring reliable electric service, which is a top priority for many energy customers. Electricity is also considered a public good provided by utilities and loss of reliability or grid outages are often broadly expensive and harmful. Multiple actors work in parallel and coordination have the responsibility of ensuring reliability, including the Federal Energy Regulatory Commission (FERC) and its regionally regulated grid operators, the Independent System Operators (ISO)/Regional Transmission Organizations (RTOs), the North American Electric Reliability Corporation (NERC) and its regional counterparts, state Public Utility Commissions (PUC), and electric utilities. Electric reliability is important to energy customers because outages can result in significant economic loss with studies estimating that the total U.S. cost of sustained power interruptions can be in the tens of billions every year.[6] Electric outages can also pose danger to public safety and disproportionately impact vulnerable and low-income communities.[7]

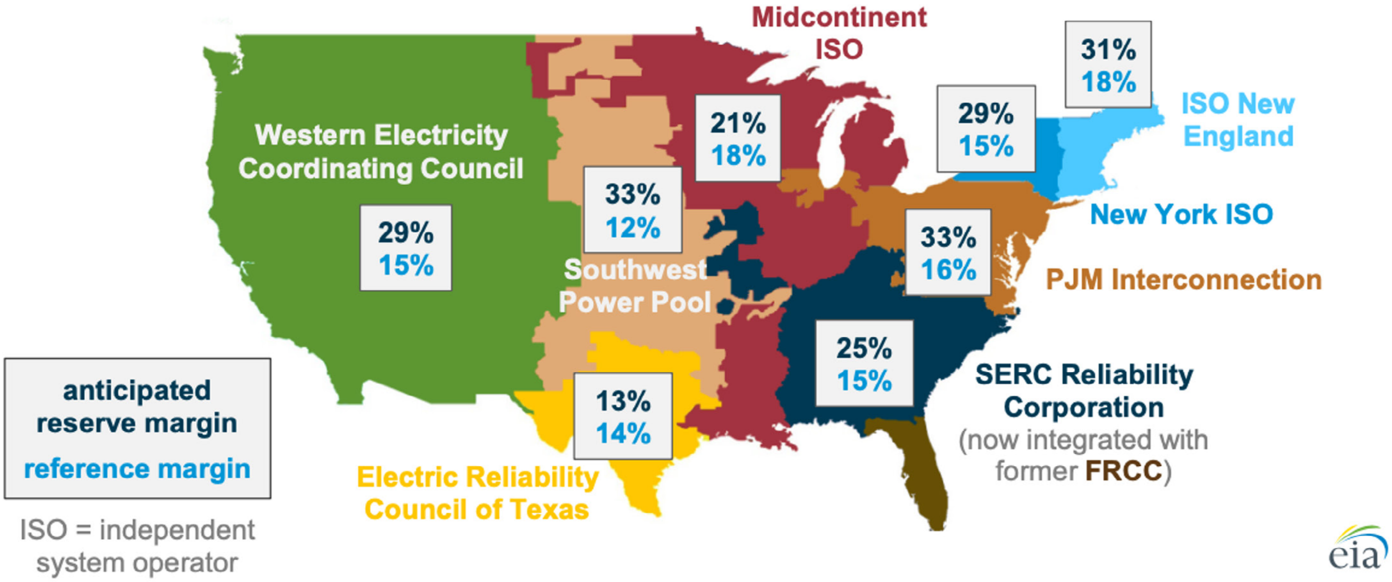
Resource adequacy is one component of reliability and a key driver of cost. Over procurement of resources can result in unnecessary building of power generation and unnecessary expense, which is often passed on to the end-use customer. Experience suggests that in practice resources are overbuilt at significant excess cost to customers. Almost every region in the U.S. has overbuilt generation resources beyond targets that are referred to as reserve or reference margins. In some instances reserve margins are significantly exceeded, sometimes doubled.[8]

[6] LaCommare et al., found that total U.S. cost of sustained power interruptions increased to $44 billion per year. LaCommare, K., Eto, J., Dunn, L., and Sohn, M. Improving the estimated cost of sustained power interruptions to electricity customers. 2018. https://eecoordinator.info/wp-content/uploads/2018/10/Improving-the-estimated-cost-of-sustained-power-interruptions-to-electricity-customers.pdf

[7] U.S. Government Accountability Office. Electricity Grid Resilience: Climate Change is expected to have far-reaching effects and DOE and FERC should take actions. March 10, 2021. U.S. GAO. https://www.gao.gov/products/gao-21-423t

[8] See a comparison of different regions reference reserve margins (target reserve margin): North American Electric Reliability Corporation. M-1 Reserve Margin. Accessed August 12, 2021. https://www.nerc.com/pa/RAPA/ri/Pages/PlanningReserveMargin.aspx

Summer 2020 reference margins and anticipated reserve margins in select NERC regions



Source: U.S. Energy Information Administration, based on North American Electric Reliability Corporation (NERC) 2020 Summer Reliability Assessment.

However, generation overbuild is not the only driver of cost in the context of resource adequacy. To meet resource adequacy requirements, utility planners and grid operators propose eligibility parameters that may be outdated and affect the cost of electricity. Eligibility rules for what counts toward resource adequacy can create artificial barriers to newer resources, like clean energy resources. This is in part historical because resource adequacy requirements were originally designed in an era of fossil-burning resources.

For example, requiring that a resource be capable of generating for 10 continuous hours or available year-round might be easy for certain power sources, like coal or gas, but harder for others, like battery storage or solar energy. While certain requirements may remain necessary, some existing resource adequacy requirements are outdated and may no longer be required given advances in technology. These vestiges serve as implicit policy choices rather than engineering demands.

To compound concerns, outdated resource adequacy requirements can impede lower-cost outcomes by preventing lower-cost resources from meeting resource adequacy requirements in the first place. As a result the resource adequacy requirement preserves the higher-cost resources. This concern is not theoretical. For example, FERC's former chief economist has concluded that at least some existing resource adequacy requirement constructs arbitrarily favor certain resources like natural gas and may thus be unnecessarily increasing costs for end-use customers.[9]

[9] Driscoll, W. Biased capacity markets accelerating gas over solar, storage. November 26, 2019. PV Magazine USA. https://pv-magazine-usa.com/2019/11/26/biased-capacity-markets-accelerating-gas-over-solar-storage/

Clean energy development likewise interacts with both resource adequacy decisions and cost impacts.[10] Some examples include:

01

Wholesale energy market prices are based on marginal costs, which are low to zero for renewable resources.[11] As renewables ramp up, energy market prices will likely dip unless the wind is not blowing and the sun not shining. These prices will incentivize flexible technologies to come online as needed, but lower prices overall make it harder for these markets to incentivize efficient investment.

02

Clean energy resources offer services that are often not adequately valued in markets across RTOs but can improve resource adequacy (e.g., fast frequency response, demand-side participation).

03

Variability of renewable resources requires resource adequacy approaches that better consider hourly production, balancing across planning areas, and optimization of resource portfolios.

Stakeholders are increasingly exploring updated resource adequacy requirements to better reflect the new and evolving resource mix on the grid.[12] These considerations are relevant to energy customers for at least two reasons. First, clean energy resources are increasingly the lowest-cost options available. Electricity should be affordable, and clean energy resources support this long-standing goal. Second, energy customers and the U.S. populace increasingly seek zero-emissions resources to meet their electricity needs, which has become a key priority across customer categories, big and small.[13]

[10] Gimon, E. Why the Clean Energy Industry Should Be Interested in Resource Adequacy. July 2020. Energy Innovation Policy and Technology LLC. https://energyinnovation.org/wp-content/uploads/2020/07/Why-The-Clean-Energy-Industry-Should-Be-Interested-In-Resource-Adequacy-FINAL.pdf

[11] Plummeting natural gas prices also have a similar effect.

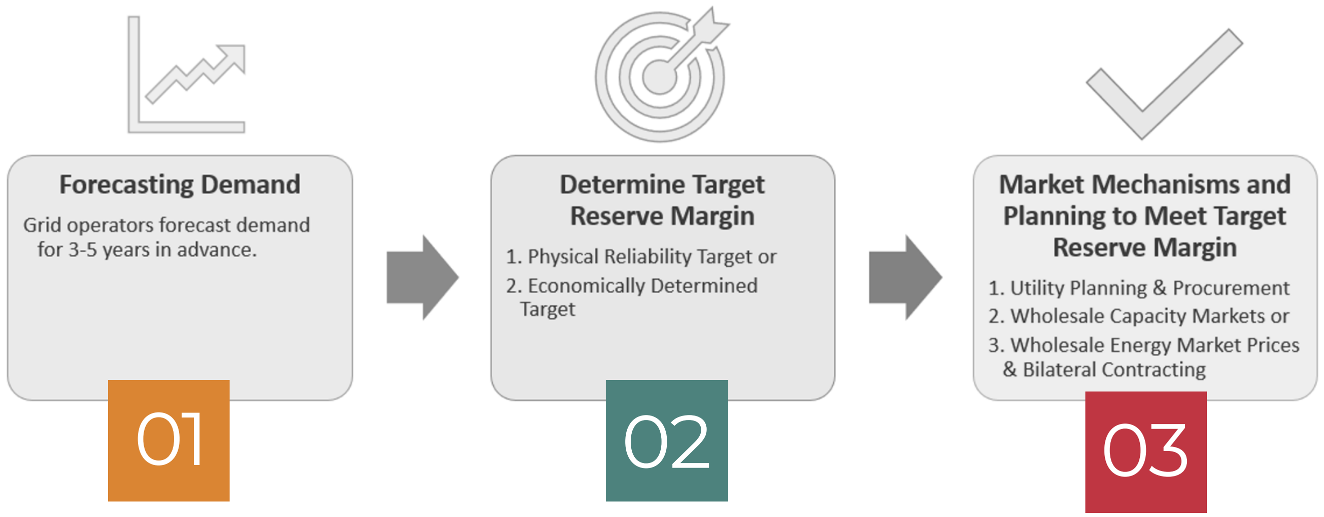
[12] Bialeck, S., Gundlach, J., & Pries, C. Resource Adequacy in a Decarbonized Future. March 2021. Institute for Policy Integrity. https://policyintegrity.org/files/publications/Resource_Adequacy_in_a_Decarbonized_Future.pdf

[13] Kennedy, B., and Spencer, A. Most Americans support expanding solar and wind energy, but Republican support has dropped. June 8, 2021. Pew Research Center. https://www.pewresearch.org/fact-tank/2021/06/08/most-americans-support-expanding-solar-and-wind-energy-but-republican-support-has-dropped/

IV. DETERMINING RESOURCE ADEQUACY

Any approach to ensuring resource adequacy involves three key steps. First, grid operators forecast future demand. Second, because reliability is considered central to the electric sector, grid operators add overhead to that determined need, known as the reserve margin. Third, grid operators employ a variety of processes to fulfill the total calculated resource adequacy demand and reserve.

Figure 1. Steps to Managing Resource Adequacy



01

FORECASTING DEMAND.

Grid operators forecast demand often three to five years in the future. Although the goal is to conduct this exercise accurately, over-forecasting demand, where grid planners predict more demand for electricity than materializes, has been common across regional transmission organizations and vertically integrated utilities.[14] Over-forecasting feeds into over-procurement and can significantly drive-up customer costs.[15]

02

DETERMINING A TARGET RESERVE MARGIN.

The reserve margin – or the set amount of resources procured above and beyond the needs forecast - is an additional layer of protection against outages.

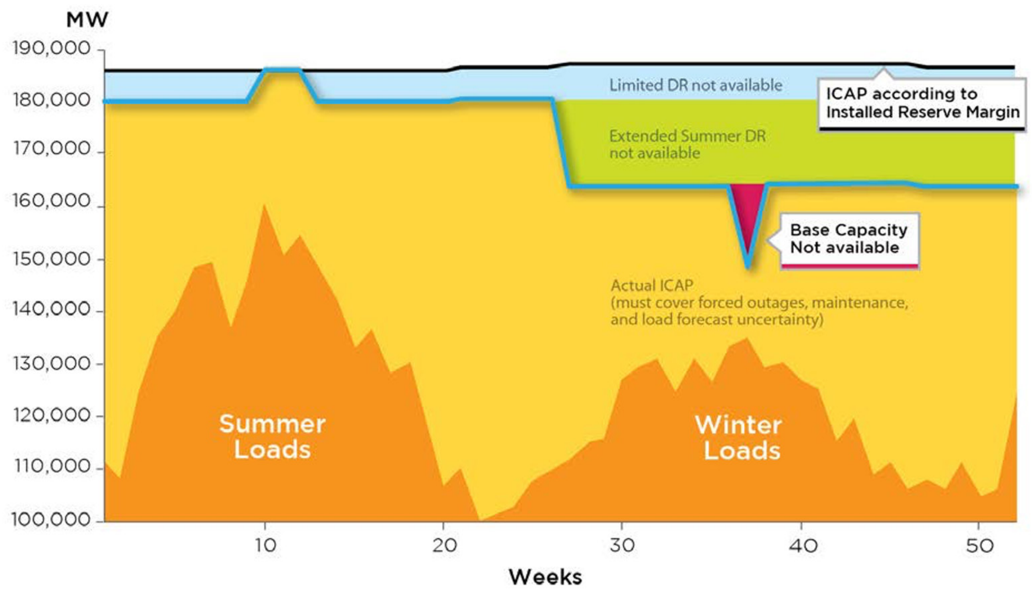
[14]See comments on the Sustainable FERC project about the issue of overforecasting. Chen, J. U.S. Department of Energy Quadrennial Energy Review 1.2, Comments of the Sustainable FERC Project, Natural Resources Defense Council. July 1, 2016. Natural Resources Defense Council. https://drive.google.com/file/d/1lJfsK0YM4AI8YKWWhg9UEy49Rw0OP_fv/view
[15]Chen, J. What's the (Demand) Forecast? More Energy Efficiency on the Radar. October 2015. Natural Resources Defense Council. https://www.nrdc.org/experts/jennifer-chen/whats-demand-forecast-more-energy-efficiency-radar

Setting a target reserve margin is generally accomplished in one of two ways. Regulators, utilities, or grid operators responsible for resource adequacy (whether legally or effectively) can administratively set a target based on a physical reliability criterion, or determine the optimal level of resources through economic means.

PHYSICAL RELIABILITY TARGET.

Reserve margins can be set using a target for how often it may be acceptable to experience outages. One commonly employed target is the once-in-ten-years Loss of Load Expectation (1-in-10 LOLE), which is an industry guidepost that is designed to avoid outages due to all but rare events that occur less frequently than once in 10 years. The reliability target translates to a reserve margin expressed as a percentage of extra generating capacity available above the forecasted system annual peak electricity demand. The target reserve margin typically ranges around 13% to 17%, but in practice utilities and grid operators often procure more than the recommended range. [16] Experts are beginning to look for more nuanced reliability metrics and resource adequacy targets that go beyond LOLE and reserve margins. [17]

Figure 2. Methodology for Establishing Maximum Product Quantities



Source: PJM Capacity Performance Proposal, August 2014, page 17. Fig. 2 is an older example of determining resource adequacy needs relative to peak demand. Currently, PJM procures the same amount of capacity throughout the year and has eliminated summer-only demand response. Installed Capacity (ICAP) is the summer rated capability of a unit. Demand resources (DR) are demand-side resources like demand response, distributed generation, and storage that can help balance load in response to market signals.

[16] NERC recommended reserve margins typically range from 13%-17%. Reimers, A., Cole, W., and Frew, B. The impact of planning reserve margins in long-term planning models of the electricity sector. 2019. Energy Policy. https://doi.org/10.1016/j.enpol.2018.10.025

[17] Energy Systems Integration Group. Redefining Resource Adequacy for Modern Power Systems [Video]. December 3, 2020. https://www.esig.energy/download/redefining-resource-adequacy-for-modern-power-systems/

REDUCING RESOURCE ADEQUACY COSTS THROUGH POOLING

Resource sharing is one way to reduce cost and the amount of resources procured and is a key feature of Regional Transmission Organizations (RTOs), which share resources across utilities. This results in a lower required reserve margin for a given resource adequacy target, thereby lowering costs compared to utilities acting on their own. In fact, reducing build of long-lived assets is estimated to result in an order of magnitude savings greater than the savings potential from more efficiently using existing assets. [18]

ECONOMICALLY DETERMINED TARGET.

Although resource adequacy is most often determined through administratively-driven planning processes, this is not the only option. An alternative to settings by reference to a desired level of reliability is for regulators to look to economic forces or economic studies to determine what level of resource adequacy is justified by its costs.[19] As an example of this model, the Electric Reliability Council of Texas (ERCOT) market in Texas primarily relies on its energy and operating reserves market, as well as bilateral contracting, to incentivize sufficient investment in resources.[20] When the system experiences events where there is less electricity available to meet demand, prices in the ERCOT energy market rise to higher levels than allowed in other energy markets. This is referred to as **scarcity pricing**, which serves as an incentive for generators to have resources available during scarcity to earn additional revenue, and is intended to reflect the actual market value of energy served during those times.

The scarcity pricing market mechanism aligns procurement to what customers need and for which they are willing to pay and has therefore historically resulted in cost savings to customers.[21] The value of this approach remains despite the recent electricity crisis associated with Winter Storm Uri, that resulted in millions of people without power for days and hundreds of deaths throughout Texas, and to a lesser extent the surrounding region. The outages were not the fault of one technology or market construct, but a system-wide failure. At the height of power outages, over 48% of ERCOT's generation was forced offline, and even if wind and solar resources were operating at maximum capacity they would have only provided 31% of ERCOT generation mix. Further evidence uncovers that Texas building codes are not designed for exposure to prolonged cold temperatures, resulting in increased stress on electricity demand.[22] Analysis is still underway; however, preliminary evidence highlights the impacts of extreme weather on electricity grid planning and the need to modernize

[18] See the value propositions of MISO and PJM for a representation of how pooling resources can save costs. Midcontinent Independent System Operator (MISO). Value Delivered: MISO Value Proposition 2020. 2020. https://cdn.misoenergy.org/2020%20MISO%20Value%20Proposition%20Flyer%20One%20Pager521883.pdf; PJM Interconnection. PJM Value Proposition. 2019. https://www.pjm.com/about-pjm/~/media/about-pjm/pjm-value-proposition.ashx#:~:text=decrease%20congestion%20costs.-,Transmission%20enhancements%20in%20PJM%20are%20expected%20to%20reduce%20costs%20by,a%20year%20by%20alleviating%20congestion.&text=This%20results%20in%20savings%20of,than%20otherwise%20would%20be%20necessary.

[19] This can result in reserve margins lower than that from 1-in-10 LOLE. Indeed, studies translating 1-in-10 LOLE into costs result in higher numbers than typical estimates for the value of lost load (VOLL), which is the cost to consumers from an outage. 1-in-10 LOLE therefore likely results in a level of reliability that exceeds typical customers' willingness to pay.

[20] The Texas Public Utility Commission has a nominal reserve margin; however it is not enforced, and therefore the actual reserve margin is determined primarily through market forces.

[21] ERCOT wholesale electricity prices have benefited from an energy only market. Gimon, E. Texas Regulators Saved Customers Billions by Avoiding a Traditional Capacity Market. October 19, 2016. https://www.greentechmedia.com/articles/read/texas-regulators-save-customers-billions

[22] Vibrant Clean Energy, LLC. ERCOT Winter Storm Uri Blackout Analysis. March 2021. https://www.vibrantcleanenergy.com/wp-content/uploads/2021/03/VCE-ERCOT-StormUri.pdf; Gimon, E. Lessons from the Texas Big Freeze. May 2021. Energy Innovation.

approaches by prioritizing reliability and resiliency through weatherization, prioritization of critical functions, forecasting and communications. While resource adequacy is an important consideration in extreme weather discussions, holistic investment in the modernization of the U.S. electricity infrastructure is necessary to protect customers and vulnerable communities.

IDEA TO CONSIDER: DIFFERENTIATED RESOURCE ADEQUACY OR RELIABILITY?
Historically, the cost of both reliability and resource adequacy has been socialized across ratepayers with all electric customers contributing to achieve the same target. In reality, the value of electrical service varies across customer, purpose, and time. Ensuring a steady electricity supply to critical facilities, such as a hospital or community center, are often deemed more essential than running residential pool pumps during extreme heat. With transparent prices, demand response programs, on-site generation, or technology that enables electricity customers to more effortlessly respond to prices, resource adequacy could become more tailored so that customers could determine how to best use power from the grid. For example, a demand response program could allow a customer to be compensated for reducing demand during capacity shortages and be compensated for doing so, reducing costs. Other customers might invest in on-site generation and storage enabling self-supply power during outages.

03

MARKET AND/OR PLANNING MECHANISMS TO MEET TARGET RESERVE MARGIN.

In the U.S., resource adequacy is generally implemented through (a) utility planning and procurement, (b) capacity markets, and (c) energy market prices and associated bilateral contracting.

A) VERTICALLY INTEGRATED UTILITY PLANNING AND PROCUREMENT.

In some markets utilities are the primary entity planning for their own customers' generation needs, subject to oversight from their state public utility commissions. This planning mechanism exists in much of the West, Midwest, and Southeast. The benefit to planning is the potential to coordinate a portfolio of resources that would work well together to provide least-cost capacity to meet state energy policy goals. Utilities can competitively procure[23] these resources to reduce costs . [24] Vertically integrated utilities can also conduct their own planning as a member of an RTO. Being a part of an RTO or otherwise sharing capacity means that each utility does not have to procure as much. For example, target reserve margins in the RTO Southwest Power Pool, where all utilities[25] are vertically integrated, are 12%. This is a lower target reserve margin compared to utilities that do not share capacity whose targets

[23]See this report on best practices for procurement. Wilson, J., O'Boyle, M., and Detsky, M. Making The Most Of The Power Plant Market: Best Practices For All-Source Electric Generation Procurement. April 2020. https://energyinnovation.org/wp-content/uploads/2020/04/All-Source-Utility-Electricity-Generation-Procurement-Best-Practices.pdf
[24]Kahrl, F. All-Source Competitive Solicitations: State and Electric Utility Practices. March 2021. Electricity Markets and Policy Group. Berkeley Lab. https://emp.lbl.gov/publications/all-source-competitive-solicitations
[25] For an example of planning in SPP see Alabama Power. Integrated Resource Plan Summary Report. 2019. https://www.alabamapower.com/content/dam/alabamapower/Our%20Company/How%20We%20Operate/Regulations/Integrated%20Resource%20Plan/IRP.pdf

can be around 18% and around 25% proposed winter target capacity.[26] However, these utilities earn revenues based on investments in capital and recover costs from customers, which means they have an incentive to build more than needed[27] as long as it is approved by state regulators.[28] Actual reserve margins can be quite high for vertically integrated utilities. In addition, customers bear the risk of stranded assets, failed projects,[29] or cost over-runs.[30]

B) WHOLESALE CAPACITY MARKETS.

Capacity markets are designed to provide a platform for the buying and selling of resource adequacy commitments. These markets allow for more transparency than bilateral transactions and competitiveness than vertically integrated utility planning, but the main trade-off is the lack of differentiation between resources that provide value aside from basic capacity. Capacity markets trade in basic megawatts of capacity and do not distinguish, for example, emissions-free or flexible resources.

The organized wholesale market the Midcontinent ISO (MISO), has a voluntary capacity market, but participation in capacity markets are mandatory in other organized wholesale markets including PJM, New York ISO and New England ISO, which means that utilities must procure enough from these markets to satisfy customer demand plus a reserve margin.[31] Many of the utilities in these regions are restructured, which means that the utilities have separated their generation and transmission/distribution businesses under the theory that generation can be competitively procured while the poles and wires companies remain natural monopolies. Some restructured states in the region further enable customers to choose their own electricity providers. Utilities in these **retail choice** states do not have the stability of captive customer bases. These utilities benefit from the markets because they are not locked into paying for full generation assets over their useful lives. However, mandatory markets have been controversial because they lack the ability to select the kinds of generation that customers or policies prefer or require, and customers can end up procuring duplicative capacity because they must buy from the capacity market and seek resources with attributes they want elsewhere.

As noted above, mandatory capacity markets also favor natural gas resources by design[32] because the market parameters are designed to prefer flexible and easily-dispatchable resources. Further, the capacity market demand curve, which is set by the RTO and not by

[26] See winter reliability targets in this report: North American Electric Reliability Corporation. NERC 2020–2021 Winter Reliability Assessment. October 2020. **https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_WRA_2020_2021.pdf**
[27] See this resource on utility rate of return and how it transfers risk to customers: He, Z. The Averch Johnson Effect: Introduction to Electricity Markets. Accessed August 12, 2021. **https://www.e-education.psu.edu/ebf483/node/681**
[28] E.g., Mississippi Power's reserve margin would be greater than 40% through 2028, absent retirements, compared to a target reserve margin of less than 15%. See Wilson, S., Mississippi Regulators want Mississippi Power to Reduce its Surplus Generation Capacity by 2027. January 5, 2021. The Northside Sun. **https://www.northsidesun.com/most-recent/mississippi-regulators-want-mississippi-power-reduce-its-surplus-generation-capacity#sthash.039bhmpR.6mlEATpZ.dpbs**
[29] Santee Cooper nuclear reactor project is a well-known example. Hicks, B. Who ended up with the harshest sentence in the VC Summer scam? February 25, 2021. Post and Courier. **https://www.postandcourier.com/columnists/hicks-who-ended-up-with-the-harshest-sentence-in-the-vc-summer-scam/article_c493c804-777b-11eb-a80b-cfe639e31f3d.html**
[30] Williams, D. Plant Vogtle opponents seeking faster review of cost to customers. August 16, 2020. Augusta Chronicle. **https://eu.augustachronicle.com/story/news/2020/08/16/plant-vogtle-opponents-seeking-faster-review-of-cost-to-customers/43075909/**
[31] In PJM, there is a way that utilities could opt out of their capacity market, but it was designed as a mechanism for large vertically integrated utilities that mostly self-supply. Thus, this carve out has only been used a handful of times. Chang, M., Frost, J., Lane, C., and Letendre, S. The Fixed Resource Requirement Alternative to PJM's Capacity Market. April 2020. Synapse Energy Economics. **https://www.law.nyu.edu/sites/default/files/Fixed-Resource-Requirement-Alternative-to-PJM-Capacity-Market.pdf**
[32] Mays, J., Morton, D., and O'Neill, R. Asymmetric risk and fuel neutrality in electricity capacity markets. 2019. Nature Energy. **https://doi.org/10.1038/s41560-019-0476-1 capacity.**

actual demand bids, procures more when more supply bids into the market.[33] It does so at lower prices, however, which means that suppliers bear some costs of oversupply unlike with cost-of-service utilities.

Mandatory capacity markets could be structured to procure particular types of capacity or enable utilities serving customers to partially carve out from the market, but they currently do not.[34]

C) WHOLESALE ENERGY MARKETS PRICES AND BILATERAL CONTRACTING.

All RTOs have wholesale energy markets, which feature price caps where energy offers cannot increase beyond a certain amount without justification. However, if energy market caps were raised to a high enough amount, energy market revenues could incentivize capacity investments in resources capable of following real-time market prices.

In practice, wholesale energy markets operate in tandem with contracting flexibility to maintain resource adequacy where energy customers wishing to hedge against high energy market prices, or obtain specific types of generation, can bilaterally contract for specific resources. This approach provides an economic mechanism for ensuring adequate resources.

The ERCOT market in Texas is the only energy market that allows prices to rise to what is estimated to be the value of electricity to customers during times of scarcity. ERCOT is not regulated by FERC because the Texas grid has limited transmission interties with the rest of the country and is exempt from FERC jurisdiction under the Federal Power Act. The ERCOT market also includes an administratively set demand curve for operating reserves that can respond quickly. This combination of market prices, bilateral contracting, and requirement to maintain reserves serve as ERCOT's resource adequacy mechanism. As seen with ERCOT, allowing the market to primarily determine the level of adequate resources has not resulted in over-procurement.

IDEA TO CONSIDER: COMBINING PLANNING AND MARKETS?

Each energy planning model – whether a wholesale capacity market or vertically integrated utility procurement model - has its own strengths and weaknesses. Further research and analysis is necessary to explore a combination of planning with competition on a regional level to better coordinate resources that complement each other and satisfy policy and customer preferences, while harnessing the cost discipline of competition. Utilities implementing state policies can conduct planning with competitive procurement, but miss out on the economies of scale and scope of sharing resources across broad regions. Regional state committees in theory could conduct coordinated planning on a regional basis to take advantage of regional sharing and competition, but are currently not structured to do so.

[33] PJM procured 22 percent more capacity than needed in a 2018 auction. Chen, J. PJM Auction Illustrates Importance of Demand Curve Fix. June 2018. NRDC. https://www.nrdc.org/experts/jennifer-chen/pjm-auction-illustrates-importance-demand-curve-fix

[34] This is aside from Midcontinent ISO's (MISO's) voluntary capacity market, which serves to supplement other means of procuring capacity.

V. IMPACTS OF DIFFERENT RESOURCE ADEQUACY APPROACHES ON CLEAN ENERGY ADOPTION AND COST EFFICIENCY

Each of the resource adequacy approaches discussed affect clean energy procurement and consumer costs differently. Whether these approaches are helpful to customers interested in low-cost clean energy also depends on utility practice and specific market design.

CLEAN ENERGY IMPACTS.

Resource adequacy is centered on ensuring a sufficient amount of resources, but different procurement mechanisms can influence the resource mix. These mechanisms can impact clean energy adoption and choices in at least four ways.

RULES OR PRACTICES THAT PREFERENCE CERTAIN RESOURCE CHARACTERISTICS.

First, the resource adequacy procurement mechanism may favor baseload or fuel-burning resources because 'long-standing' is falsely equated with 'reliable'. Utility planners can select specific resource types if they can justify their choices to state regulators, but voluntary utility clean energy procurement goals have been found to fall short of the actions needed to address climate change.[35] While market rules must be resource-neutral, they can specify characteristics of certain types of resources. This is apparent in capacity market rules that favor year-round performance versus more cost-effectively procuring tailored amounts and types of resources given different seasonal needs.[36] The former favors baseload resources while the latter allows for more intermittent resources like wind, solar, and demand response.

CUSTOMER CHOICE.

Second, while resource adequacy pertains to the level of resources needed, the resource adequacy construct, depending on details, can significantly impact whether customers can choose certain types of generation directly or even indirectly (aside from renewable energy credit (REC) purchases). For example, customers in traditionally regulated markets who cannot purchase from sources other than their monopoly utilities must accept whatever resource mix is available through the utility or negotiate green tariffs. In these situations, the state regulating the utility can require the utility to procure a certain energy mix, and customers may seek to influence that process. [37] In restructured areas where capacity markets are used, capacity is a commodity devoid of clean or carbon-free energy attributes

[35] Romankienwicz, J., Bottorff, C., and Stokes, L.. The Dirty Truth About Utility Climate Pledges. January 2021. Beyond Coal. Sierra Club. https://coal.sierraclub.org/the-problem/dirty-truth-greenwashing-utilities

[36] Newell, S., Spees, K., Yang, Y., Metzler, E., and Pedtke, J. Opportunities to More Efficiently Meet Seasonal Capacity Needs in PJM. April 2018. The Brattle Group. https://brattlefiles.blob.core.windows.net/files/13723_opportunities_to_more_efficiently_meet_seasonal_capacity_needs_in_pjm.pdf

[37] Bonugli, C., O'Shaughnessy, E., and Ratz, H. Enhancing Solar Energy in Utility Integrated Resource Plans: Opportunities for Customers, Utilities, and Regulators. Forthcoming release - anticipated 2021.

and buyers cannot directly choose what particular types of generation are selected through those markets. In addition, stakeholders have pursued rules changes in those markets that effectively make it harder for renewable energy to participate in these markets. In PJM for example, attempts to raise the minimum prices bid in capacity markets through the Minimum Offer Price Rule would have inflated the bids of renewable energy resources, making it harder for these resources to "clear the market" and be selected. [38] Customers and states have attempted to work within existing systems by creating separate markets to identify and pay for attributes, such as the REC markets.

OVERSUPPLY CROWDING OUT NEWER RESOURCES.

Third, where market forces help shape resource procurement, oversupply of resources overall can crowd out investments in new resources. This could happen under cost-of-service regimes as well, to the extent that regulators are less likely to approve clean energy build due to existing generation capacity oversupply.

OVERSUPPLY MUTING ENERGY MARKET PRICE SIGNALS TO DEPLOY FLEXIBLE RESOURCES.

Fourth, oversupply of resources can also mute energy market price signals that would inform flexible resources to deploy and balance variable renewable generation.[39] This can dampen responses from other resources that would otherwise cost-effectively help integrate variable generation.

COST EFFICIENCY IMPACTS.

Various resource adequacy procurement mechanisms impact cost efficiency and allocate risks between suppliers and buyers differently. Generally, the costs customers bear increases with higher target reserve margins and decreases with capacity resource sharing across utilities. Under cost-of-service models, customers pay for all costs, including that attributed to oversupply. Compared to cost-of-service utility resource procurement, cost of overcapacity, beyond meeting the target reserve margin, is borne in part by investors in markets, who earn less if too much supply drives market prices down.[40]

[37] Bonugli, C., O'Shaughnessy, E., and Ratz, H. Enhancing Solar Energy in Utility Integrated Resource Plans: Opportunities for Customers, Utilities, and Regulators. Forthcoming release - anticipated 2021.
[38] Morehouse, C. PJM proposes to end FERC MOPR policy that raised prices for state-subsidized resources. April 29, 2021. Utility Dive. https://www.utilitydive.com/news/pjm-proposes-to-end-ferc-mopr-policy-that-raised-prices-for-state-subsidize/599248/
[39] Chen, J. Is Capacity Oversupply Too Much of a Good Thing? 2017. Natural Gas & Electricity. https://doi.org/10.1002/gas.22016
[40] Martin, R. Overpowered: PJM market rules drive an era of oversupply. December 2019. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/overpowered-pjm-market-rules-drive-an-era-of-oversupply-54111666

VI. RESOURCE ADEQUACY GOING FORWARD

Resource Adequacy is a key driver of how the electric grid is built and operated. As the resource mix shifts to lower cost variable renewables and technologies facilitate smarter energy consumption choices, how resource adequacy is ensured and paid for should evolve too. It is increasingly possible to employ new technology and practices to enable energy customers to determine their own needs, and therefore greater optionality and flexibility may be relevant to resource adequacy in the future. Likewise, a changing resource mix will inform how adequacy is best ensured. This may encourage, for example, greater geographic balancing areas and state/federal complementary interaction. Future Clean Energy Buyers Institute resources will dive deeper into the different resource adequacy approaches currently in place across the U.S. to analyze current challenges and explore innovation solutions.

GLOSSARY

Unless otherwise indicated the following definitions are based on definitions found in the Federal Code, The Energy Information Administration, and the North American Electric Reliability Corporation.

Bulk-Power System
The facilities and control systems necessary for operating an interconnected electric energy transmission network (or any portion thereof), and electric energy from generating facilities needed to maintain transmission system reliability. The term does not include facilities used in the local distribution of electric energy.

Cost-of-service Utilities (or Cost-of-service regulation)
A utility under traditional electric utility regulation that is allowed to set rates based on the cost of providing service to customers and the right to earn a limited profit.

Grid Operator or Balancing Authority
The responsible entity that integrates resource plans ahead of time, maintains demand and resource balance within a Balancing Authority Area, and supports Interconnection frequency in real time.

Loss of Load Expectation or Loss of Load Probability
An analysis typically performed on a system to determine the amount of capacity that needs to be installed to meet the desired reliability target, commonly expressed as an expected value, or LOLE of one day in ten years.

Peak Load
The highest hourly integrated net energy for load within a Balancing Authority Area occurring within a given period (e.g., day, month, season, or year) or the highest instantaneous demand within the Balancing Authority Area.

Reliability Standard
A requirement approved by the Federal Energy Regulatory Commission under section 215 of the Federal Power Act, to provide for Reliable Operation of the Bulk-Power System. The term includes requirements for the operation of existing Bulk-Power System facilities, including cybersecurity protection, and the design of planned additions or modifications to such facilities to the extent necessary to provide for Reliable Operation of the Bulk-Power System, but the term does not include any requirement to enlarge such facilities or to construct new transmission capacity or generation capacity.

Reliable Operation
The operation of elements of the Bulk-Power System within equipment and electric system thermal, voltage, and stability limits so that instability, uncontrolled separation, or cascading failures of such system will not occur as a result of a sudden disturbance, including a Cybersecurity Incident, or unanticipated failure of system elements.

Resource Adequacy
The ability of the electric system to supply the aggregate electrical demand and energy requirements of the end-use customers at all times, while taking into account scheduled and reasonably expected unscheduled outages of system elements.

Reserve Margin or Reference Margin
The difference between available capacity and peak demand, normalized by peak demand shown as a percentage to maintain reliable operation while meeting unforeseen increases in demand (e.g., extreme weather) and unexpected outages of existing capacity.

Vertically Integrated Utility
A utility that owns its own generating plants, transmission system, and distribution lines to provide all aspect of electric service to customers in its service territory. Vertically integrated utilities can operate within wholesale markets while retaining monopolistic services in its territory.

Wholesale Capacity Markets
A market operated by an RTO/ISO in which resources are paid for being available to meet future peak electricity demand when needed. Capacity is the ability of a resource to meet demand when called upon by the grid operator.

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