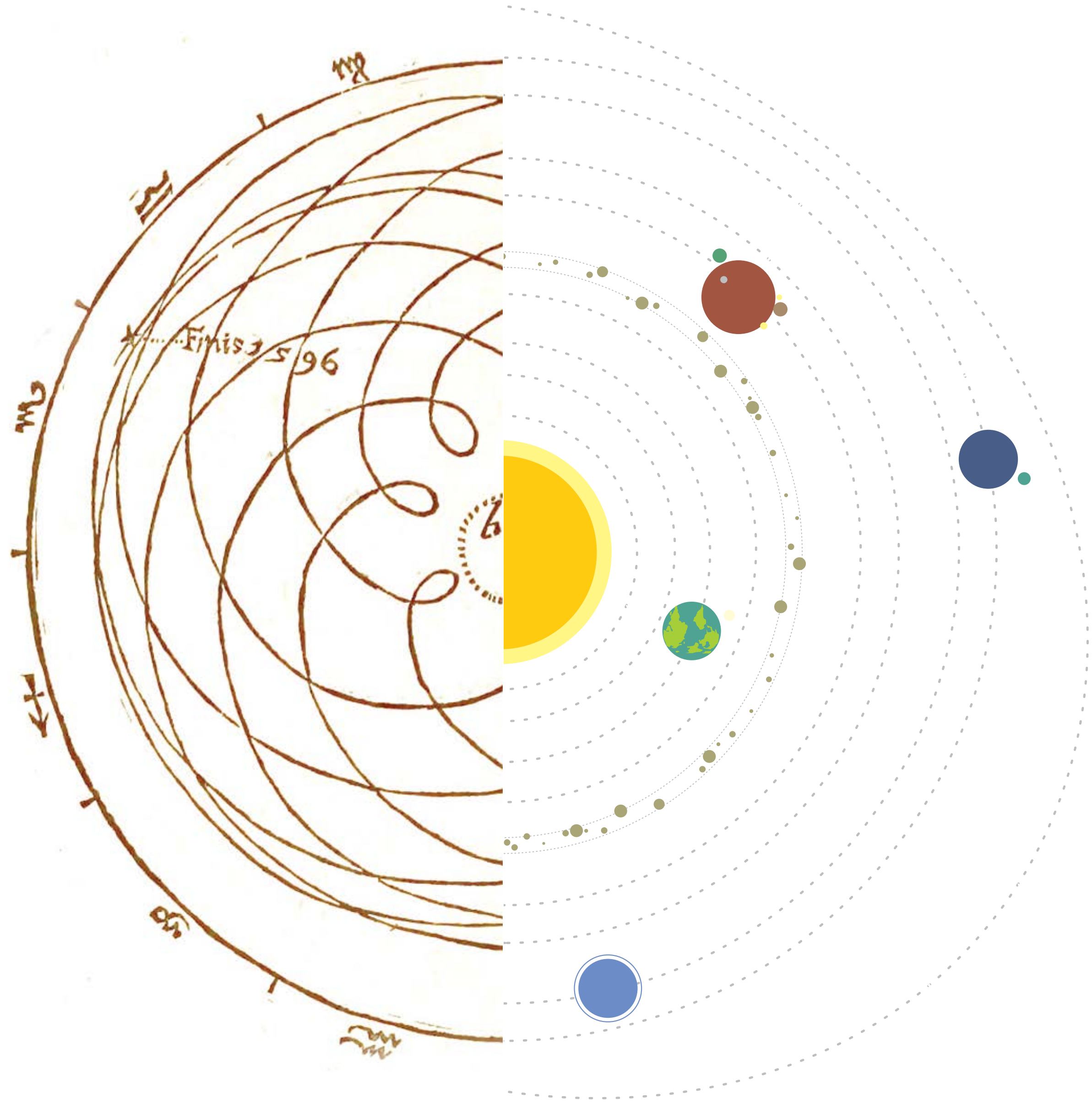


# RESOURCE ADEQUACY

## Reliability Through the Clean Energy Transition

MARCH 2021

GRIDWORKS

# INTRODUCTION

California's Resource Adequacy program, like many other facets of its current electricity system, emerged from the crucible of the 2001 energy crisis. Its current structure and function reflect the prevalent conditions and concerns of that time, including planning, procurement and operational issues. Today, California's situation has changed, for both better and worse. Nearly two decades of investment in greening California's energy system are beginning to bear fruit. Energy generation and consumption patterns and practices are substantially different, and the lines between supplier and customer are increasingly giving way to dynamic interaction. Far greater change is soon to come, especially as the impacts of climate change on the system begin to mount.

The existing Resource Adequacy program structure is clearly straining to adjust to current energy system circumstances, and the need for reform is increasingly apparent. August 2020's extreme regional heat wave resulted in rolling blackouts in California and west-wide reliability challenges, bringing these issues into urgent focus. While the blackouts were initially viewed as a breakdown in the Resource Adequacy program, a closer analysis suggests that the program may have functioned as expected: the fault was largely one of design, not function. It's clear some immediate concerns need urgent attention, but it is equally clear that it's time for a deeper reconsideration of the program's fundamental structure.

In September 2020, Gridworks initiated a series of conversations with a cohort of Resource Adequacy experts to frame aims and approaches for program reform. We asked the cohort to share their perspectives on the current program, articulate objectives for an ongoing program, establish principles for Resource Adequacy, and discuss considerations for aligning a future program with those principles.

This report integrates the wide range of thoughtful responses Gridworks received through those discussions, as well as perspectives from our own experience and research. It is not intended as a survey of all of the proposals that are currently under consideration before the California Public Utilities Commission (CPUC or the "Commission"), nor does it provide detailed analyses of any particular proposals or a proposal of its own. Rather, this paper focuses on key concepts and themes relevant to the history of the program and its future, using aspects of some of the proposals as illustrations.

The outcome of this report is a set of recommended evaluation criteria that can be used by stakeholders refining proposals to reform the Resource Adequacy program, and by decision-makers evaluating those proposals. These recommended criteria could be used to assess the extent to which each proposal:

1. Minimizes the program's complexity, making it easier to understand;
2. Eases both transactions and compliance;
3. Increases access to an array of resources that can meet demand under reasonably foreseeable stress conditions;
4. Increases the program's cost-effectiveness, and the cost-effectiveness of the overall energy system;
5. Encourages innovation and competition to enhance performance and reduce cost;
6. Advances California's clean energy, greenhouse gas reduction and air pollutant reduction goals to the extent possible, as required by statute, and complement its ambitions for a more equitable energy system; and
7. Embraces bold, comprehensive change where needed for long-term regulatory and market certainty.

One criterion that is not included, resilience, deserves particular attention. Several representatives of customer interests in our conversations, particularly those representing disadvantaged communities, noted the relationship between resilience and energy service reliability as a primary concern. As discussed in the paper, we ultimately conclude that the evaluation criteria should be focused on the limited scope of the Resource Adequacy program, which has been narrowly focused on the bulk power system. We recognize this limited scope omits extremely important reliability criteria from the Resource Adequacy program, leaving them for other, to-be-identified discussions. We urge the Commission, and all stakeholders, to think about reliability more broadly, and more inclusively, as we all work to achieve a clean and equitable energy transition.

The Resource Adequacy proposals currently being advanced by parties at the California Public Utilities Commission offer benefits and varying challenges with respect to these criteria. We hope the criteria help stakeholders and decision-makers assess the proposals, improve upon them and develop a final approach for long-lasting reform.

Ultimately, a cost-effective and reliable energy system is a fundamental prerequisite to achieving the rich promise inherent in the transformation of the energy sector, including benefits for a more equitable and prosperous society as well as for the environment and human health. A renewed and reformed Resource Adequacy program can offer a stronger, more suitable foundation for California's energy future.

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# THE CURRENT RA PARADIGM IS AT BEST "BARELY WORKING" – AND AT WORST "ISN'T DOING ITS PRIMARY JOB." WHY?

Throughout Gridworks' convening on Resource Adequacy (RA), we approached near consensus on only a few points. One was that the program is "barely working." Extreme complexity, shifting reliability stresses, and lack of reflection of the changing nature of supply, demand and energy imports all shine a less than flattering light on the current structure. Professor Shaun McRae, invited by the Energy Division to reflect on its proposal came to a harsher conclusion: today's program just "isn't doing its primary job." This, of course, begs a critical threshold question: What is Resource Adequacy's primary job?

### RESOURCE ADEQUACY ADDRESSES RELIABILITY, BUT NOT IN EVERY SENSE OF THE WORD

Resource Adequacy is often referred to as California's reliability program—but reliability means many things to many people. When the lights go out- or electronic devices (or worse yet, your electric vehicle) can't charge, is RA to blame? Possibly, but certainly not always.

The most common cause of electric service disruption is a failure in the distribution system. Recently, the most common headlines associated with power outages have been associated with Public Safety Power Shutoffs resulting from wildfire risks. Neither distribution system failures nor Public Safety Power Shutoffs fall within the scope of the existing RA program, despite their impacts on electric system reliability. The RA program does not consider ancillary or other intra-hour services either, despite their importance to reliability.

Energy service disruptions clearly have disproportionate impacts on disadvantaged and underrepresented community members, in terms of severity of impact and the ability to mitigate and recover from those impacts.[1] A focus on resiliency[2] could help prioritize resource investments on reducing these harms, whether they result from network ("bull power system") problems, Public Safety Power Shutoffs, extreme weather or distribution system failures. The Resource Adequacy program has focused on balancing supply and demand in the bulk power system, rather than overall reliability as experienced by customers. However, the majority of the thought leaders in Gridworks' convening agree that the program should not be expanded to cover these broader concerns. Rather, they conclude that RA should continue to focus on one thing: assuring the balance of supply and demand on the bulk power system on a forward basis. We note that equity demands that Resource Adequacy is considered in the larger context of how California prioritizes its attention on and in its energy system, taking into consideration the needs and perspectives of all customers.

### PROGRAM GOALS: REQUIRING MORE THAN BALANCING BULK POWER SYSTEM SUPPLY & DEMAND

Most participants in our discussions felt the RA program should complement, rather than be seen as a driver, of California's climate, environmental and social justice policy objectives. The interest in narrowly focusing on the significant task of balancing supply and demand on the bulk power system, so long as the effort is consistent with California's broader goals, was clearly well-inten-

1 *See, e.g.,* Jessel, Sawyer & Hernández, "Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature," Frontiers in Public Health (Dec. 12, 2019); Botts, "California Divide: "We Need the Food That We Lost,' Low-income Families Still Reeling From Blackouts" CalMatters (Updated Feb. 27, 2020).

2 *See* CPUC Energy Division, "Microgrids and Resiliency Staff Concept Paper," R. 19-09-009, at 11-15. (July 20, 2020), noting that "Resiliency is a concept that … lacks a clear, specific, and widely shared meaning" and suggesting the following definition: "Resiliency refers to the ability to mitigate the impact of a large, disruptive event by any one or more of the following mechanisms: 1. Reducing the magnitude of disruption; 2. Extendingthe duration of resistance; 3. Reducing the duration of disruption; 4. Reducing the duration of recovery."

tioned. The legislation underpinning the Resource Adequacy program unequivocally requires more, however, stating that the Commission must:

> "[E]nsure the reliability of electrical service in California **while advancing**, to the extent possible, the state's goals for clean energy, reducing air pollution, and reducing emissions of greenhouse gases." *Pub. Util. Code § 380(b) (emphasis added).*

We suggest that the Commission and stakeholders explicitly consider this requirement in evaluating proposals, in light of this clear statutory mandate.

At a minimum, Resource Adequacy procurement and showings should enable full carbon accounting of emissions associated with the underlying resources. The language of the statute indicates more is intended: i.e., that procurement under the program is designed to help California achieve its climate and clean air goals "to the extent possible." In keeping with California's and the Commission's values, the extent to which reform proposals address equity concerns should also be explicitly evaluated and considered.

## DOES RESOURCE ADEQUACY HAVE A SINGLE FOCUS, OR THREE (AND POTENTIALLY FOUR)?

During our exploration with convening participants, it became clear that even though RA's overarching single goal is ensuring a balance of supply and demand on the network grid, RA does not operate as a single program. RA essentially comprises three very distinct elements: Planning, Procurement and Performance.

On one level, RA is a planning enterprise, determining whether forecasts of demand can be met by the "capacity" of supply resources. The capacity metric itself incorporates forecasting elements, anticipating whether the supply resource will be effective and can deliver power to the grid when needed to meet the most challenging demand conditions.

On another level, RA is a procurement program. It requires load-serving entities to acquire the "availability" of sufficient resources on at least a year-ahead and month-ahead basis to meet the prescribed targets, intended to ensure those resources will be in operation and able to produce energy to meet demand when needed. Importantly, RA does not currently require load-serving entities to buy any actual energy from those resources, and the statute underlying the program refers to capacity, not energy.[3]

On a third level, RA requires a particular type of performance from the resources that load-serving entities procure. In a holdover from the energy crisis' "Must Offer Obligation," those resources must generally bid into the California Independent System Operator ("CAISO") market.[4] The program itself does not provide any restrictions on the price of those bids, which brings us to the new element currently under consideration.

In addition to these three facets, the potential of addressing the energy price RA resources bid into the CAISO markets is at issue in the current RA proceeding. During the August reliability challenges, some resources paid to be available for reliability under the RA program at least arguably did not actually contribute to balancing California's supply and demand. Some resources submitted high bid prices that were not selected in the market, and thus avoided having to perform. Still others bid high prices and were selected, contributing to August's price spikes.[5] The power generated by some RA resources was sold to other markets willing to pay higher prices, an issue that is generally addressed through CAISO market rules and operations rather than by Resource Adequacy requirements. Adding a price component to RA, or potentially a requirement to limit exports from RA resources under stress conditions,[6] could represent additional layers of complexity in an already exceptionally complicated program.

3 *See* Pub. Util. Code § 380 (b)(1) & (c).
4 Recently proposed changes to demand response requirements to participate in the CAISO markets have been controversial.
5 Notably, market manipulation does not appear to have occurred.
6 While export restrictions under stress conditions would ensure that California gets the primary benefit of resources that are located within the state- they could result in "exporting" reliability problems to neighboring systems, and undermine the regional cooperation California depends upon for a cost-effective, reliable system throughout the year.

## WHAT THE AUGUST 2020 EVENTS TELL US ABOUT RESOURCE ADEQUACY'S INADEQUACIES

At the simplest level, the rolling blackouts in August 2020 resulted from an imbalance of supply and demand: for a few hours on August 14 and 15th, there simply wasn't enough energy on California's system to meet overall needs. The grid operator rotated power cuts throughout California, causing outages affecting nearly 500,000 customers,[7] to avoid a catastrophic grid failure and much broader and longer-lasting impacts.[8]

If the cause of the rolling blackouts was an imbalance of supply and demand, and if maintaining that balance is the core function of Resource Adequacy, isn't it an open-and-shut case that the program failed? Not quite, for a few reasons.

No reliability program is designed to keep the lights on under any circumstances; the cost of 100% reliability would be prohibitive. There's far more to the story, however. The Final Root Cause Analysis issued by the CAISO, the CPUC and the California Energy Commission (CEC)[9] spells out a series of factors that contributed to the blackouts. We'll focus here on a few enigmatic questions that offer clues into the underlying fundamental policy issues.

> "NOVELTY ORDINARILY EMERGES ONLY FOR THE [PERSON] WHO, KNOWING WITH PRECISION WHAT [TO] EXPECT, IS ABLE TO RECOGNIZE THAT SOMETHING HAS GONE WRONG."
>
> — THOMAS S. KUHN
> *The Structure of Scientific Revolutions*

## CALIFORNIA'S BULK POWER SYSTEM WITHSTOOD HIGHER LEVELS OF DEMAND WITHOUT TRIGGERING BLACKOUTS. WHY DID THE POWER GO OUT THIS TIME?

The blackouts occurred when California's system demand was approximately 42,240 megawatts on August 14, and when it was approximately 41,140 megawatts on August 15. California had not had rolling blackouts for nineteen years at that point, despite having much higher peak demand levels many times during that period.[10] Why did this happen, if California's energy supply was able to satisfy greater demand in the past?

One simple explanation is that California had more generating resources available in the past, including domestic and imported resources that were not counted against RA requirements. Many generating units have retired in the interim and were not fully replaced. In fact, almost exactly a year before, the CAISO had warned of a potential 4,700 MW shortfall.[11]

Another serious supply issue relates to California's interdependence with its neighbors. For at least the last fifty years, California has been able to import a significant amount of energy from neighboring states when needed, and the state's long-term planning has essentially presumed that would continue. August's heat storm was west-wide, putting energy systems of California's neighbors to the east and the north to a knife-edge test, and leaving little or no excess to export to California. The issue was not just that our neighbors were facing their own high demand as a result of the extreme heat; just as the nature of California's energy supply and demand patterns are changing, so are those of our neighbors, limiting the resources that could be dispatched to help support California's needs.[12] The diversification of in-state resources, combined with increasing interdependencies among western states, creates more challenging coordination needs than ever before — and can clearly exacerbate system stress points.

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7 CAISO, CPUC & CEC, "Final Root Cause Analysis: Mid-August 2020 Extreme Heat Wave," at 35 (Jan. 13, 2021)("Final Root Cause Analysis").
8 Id.
9 Id.
10 *See, e.g.*, https://www.caiso.com/documents/californiaisopeakloadhistory.pdf
11 Stanfield, "Calif. Power Shortages Stem From Lack of Firm Generation Capacity, Experts Say" (SPC Global, Aug. 20, 2020), *available at*
12 *See* n. 4 and associated text.

> “THERE IS A CRACK... IN EVERYTHING
> THAT’S HOW THE LIGHT GETS IN”
>
> — LEONARD COHEN, “ANTHEM”

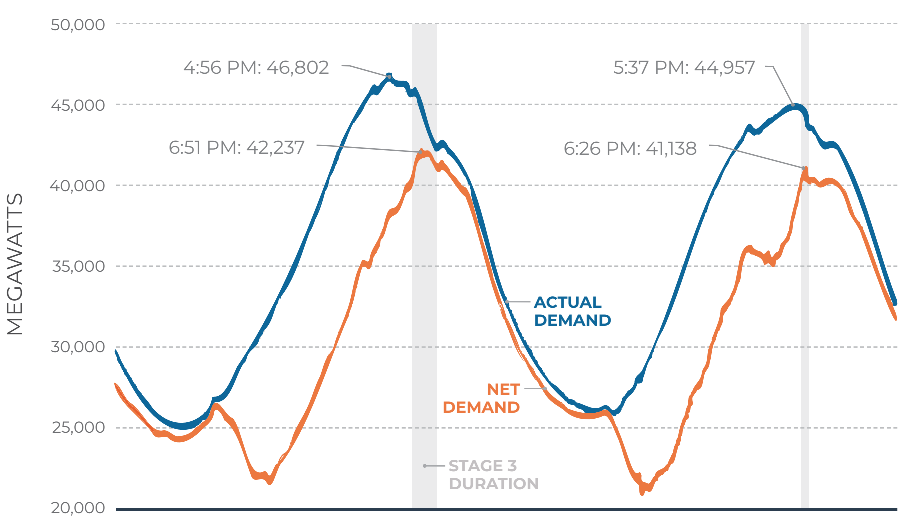
California had not just weathered higher peaks in the past, however. It weathered higher peaks *on the very same days* that the rolling blackouts occurred. The rolling blackouts occurred after demand had fallen from the August 14 and August 15 daily peaks, by approximately 4,565 MW and 3,819 MW, respectively. In other words, demand had fallen nearly as much as the total shortfall in supply resources CAISO had projected. The following graph illustrates the peak demand levels and when the Stage 3 rolling blackouts occurred on those two days.

The absolute peak, which is used as the target for the Resource Adequacy, no longer appears to present the most significant challenge; instead, the “net peak” — the greatest demand on the system that cannot be met with intermittent wind and solar resources — seems to be the more challenging problem, at least for now.[13]

## WHY DOES RESOURCE ADEQUACY FOCUS ON THE ABSOLUTE PEAK, AND WOULDN’T SUBSTITUTING THE NET PEAK SOLVE THE PROBLEM?

As we explained in the first article in this series, “California’s 2020 Energy Blackouts: Resource Adequacy May Not Have Failed, But Is It Working?”[14] our current Resource Adequacy regime is built on a simplifying assumption: if we have sufficient resources to meet peak demand, those resources would be sufficient to meet demand at any other time. This simple paradigm made sense in the early 2000s, when much of the fleet of generation resources were fully “dispatchable”— i.e., they could be directed to produce power at virtually any time, so long as they were online. Soon after its adoption, however, this model began to show signs of a less than perfect fit to the realities of balancing supply and demand on the bulk power system.

### Demand and Net Demand for August 14 and 15




13 To be sure, increased and as yet unexplained high forced outage rates, exports, and other operational issues also contributed to the conditions that led to the rolling blackouts. This discussion is not intended to provide a comprehensive analysis of the cause of the blackouts, which is addressed by the Joint Agency Final Root Cause Analysis.

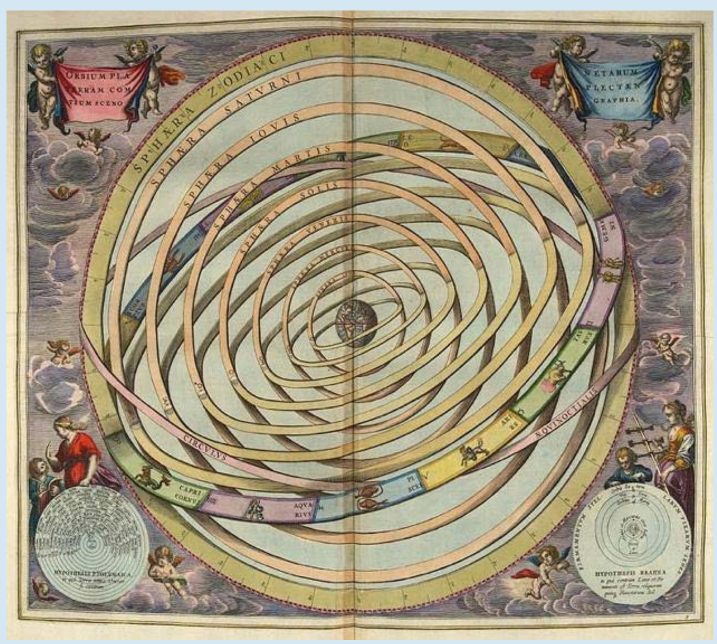
14 https://gridworks.org/2020/09/californias-2020-energy-blackouts-resource-adequacy-may-not-have-failed-but-is-it-working/

It might be tempting to simply replace the system peak with the "net peak," addressing the immediately apparent issue from August's reliability challenges and avoiding more significant disruption to the existing program and to market expectations. Doing so would certainly help address the need to keep the lights on during net peak stress conditions. Unfortunately, it would also add complexity to an already extremely complicated system, and not do very much, if anything, for other stresses. Why? Because the underlying presumption, that sufficient capacity to meet the most challenging point in the demand curve is a reasonable proxy for sufficiency at all other times, was never quite right — and is increasingly wrong.[15]

## RESOURCE ADEQUACY'S "EPICYCLES" AND "DEFERENTS"

Even when the energy system was much simpler than it is today, in several cases the basic model RA was built upon fell short of assuring a balance of supply and demand. Providing sufficient resources to meet the system peak did not necessarily assure a balance of supply and demand in transmission-constrained "local areas," where energy delivered through network transmission alone can't meet the full need. A local resource adequacy target was adopted, overlapping with the system resource adequacy requirement.

Transmission constraints between the northern and southern portions of California's grid meant that resources in one might not be able to meet all of the needs in the other, and so a regional requirement was also considered. Ultimately, to avoid introducing another "product" in addition to system and local RA, a counting regimen was imposed, requiring load serving entities to meet a portion of their obligations with resources within their own region. Similarly, to reflect restricted capabilities of various resource types, "Maximum Cumulative Capacity" limits were set, capping the quantity of several categories of those resources that could be used to meet RA obligations. As solar and wind's collective proportion of the generating fleet grew, new system stresses developed, including the ability to maintain supply and demand balances when the sun set and solar generation rapidly decreased, but while demand levels remained high. "Flexible" resource adequacy requirements were adopted to address these steep system ramps. The accumulation of local and flexible RA requirements, new counting rules and limits, and other patches to the basic RA program model has led to a supposedly



15 We intend this discussion to illustrate the problems associated with using peak points, whether net peak or absolute peak, as a proxy, and are not suggesting that any reform proposals currently before the Commission intend to simply substitute a net peak focus for the current absolute peak focus.

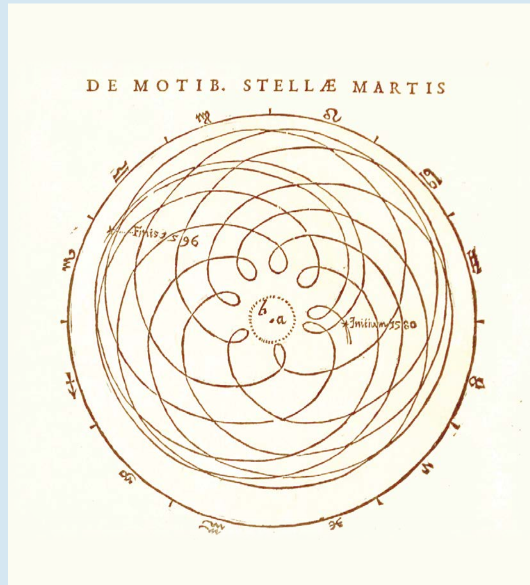
market-based program of almost unparalleled complexity, often referred to as "Rube Goldberg" mechanism — or worse.

Students of science will recognize this phenomenon, in which the prevalent model of understanding how a system works begins to break down as real-world data inconsistent with that model accumulates. The temptation is to create exceptions for the data to find a way to preserve the basic functioning of the model; exceptions grow in number and complexity, weighing the model down, until a new model that better fits all of the data replaces it.

The classic examples are in astronomy: before Copernicus, the "heavenly bodies" were believed to revolve in perfect circular orbits around the Earth *(see page 5)*.

Except, of course, they didn't. The data observed by astronomers didn't match the paradigm, leading them to invent patches — called "epicycles" and "deferents" — to align the data with the prevailing theory. The results included this model below of how they believed the planet Mars revolved around the earth.

A graphical depiction of Resource Adequacy's complexities might bear an uncomfortable resemblance.




## CAPTURING THE CURVE: MOVING BEYOND A SINGLE PROXY POINT TO BETTER ATTAIN RELIABILITY

Fundamentally, the ability of resources to contribute toward the balance of supply and demand is context-dependent. The effective ability to address certain circumstances changes with the nature of the energy supply, and with the nature of demand as well. Simply put, just as a single point cannot adequately describe a curve, a single stress point can't stand in for the varying conditions at issue along the demand curve, or the ability of the fleet's varying capabilities to address those varying conditions.

The inability of a single stress point to serve as a reliable proxy in our modern grid explains why some, including the CAISO, suggest we need to take an "all hours" approach- ensuring we have enough capacity for every hour of the day, every day of the year.[16] Some of the participants in our conversation observed, however, that this approach offers diminishing returns, and may not merit additional contracting costs and administrative burdens. Pacific Gas & Electric ("PG&E") suggests a middle ground that would still capture more of the anticipated range of stress conditions.[17] Its concept is to segment the daily demand curve in each season into blocks, or "slices," in which conditions are sufficiently similar that the varying capabilities of supply resources can be better matched to the prevailing demand needs. This approach illuminates multiple aspects of the problem we are trying to solve, including the fact that differing challenges to balancing supply and demand are

16 CAISO, "Initial Track 3.B Proposal and Comments on Additional Process of The California Independent System Operator Corporation" (Aug. 7, 2020).
17 PG&E, "Revised Track 3b.2 Proposals of Pacific Gas and Electric Company (U 39 E)" (Dec. 18, 2020). Note also that San Diego Gas & Electric Company has offered a proposal building on this concept: "San Diego Gas & Electric Company (U 902 E) Second Revised Track 3B.2 Proposal," (Feb. 26, 2021).

posed at differing times of the day, and that these change as well across different seasons.

Whether in an all-hours, "slice of day," "peak plus shoulders" or just a peak-based approach, a reliability target is established that balances three factors: risk to reliability, complexity, and cost. Within that balance lies an implicit assumption: counting capacity on varying levels of granularity along the curve is a reasonable measure of confirming a reliable balance of supply and demand. This begs the question: is capacity working as a suitable reliability metric for our changing energy system?

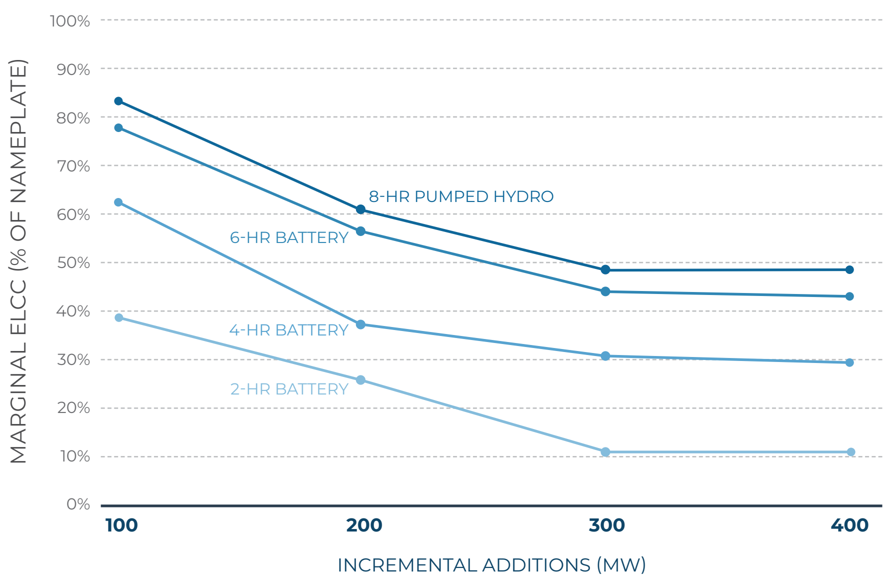
## CAPACITY IS ALSO A PROXY. IS IT THE RIGHT ONE?

Resource Adequacy seeks to assure sufficient supply to meet anticipated demand on the bulk power system by tallying the total "net qualifying capacity" of contracted or owned supply, including demand response, against a reliability target.[18] At a high level, this metric is generally a function of the "nameplate" maximum production of the supply resource, reduced by the "deliverability" of the power produced to the overall bulk power system and by the resource's performance. Capacity is often referred to as a "regulatory product" — one required, bought and sold due to regulatory requirements, not because it is actually consumed by customers (the product actually consumed, of course, is electricity). As the Energy Systems Integration Group (ESIG), which has been working with national experts to develop fundamental principles for resource adequacy and reliability in modern grids, observes: no resource offers "perfect" capacity to address all resource adequacy needs.

The use of a de-rating mechanism, referred to as Effective Load Carrying Capacity, or "ELCC," was introduced to better reflect the ability of intermittent resources to meet demand. ELCC is intended to capture the value of the contribution to meet demand of one type of resource, such as intermittent wind or solar, relative to a "perfect" resource. In light of the imperfect nature of all supply resources, including the adverse effects weather can have on all resources to varying degrees, some have suggested applying ELCC to supply resources across the board.

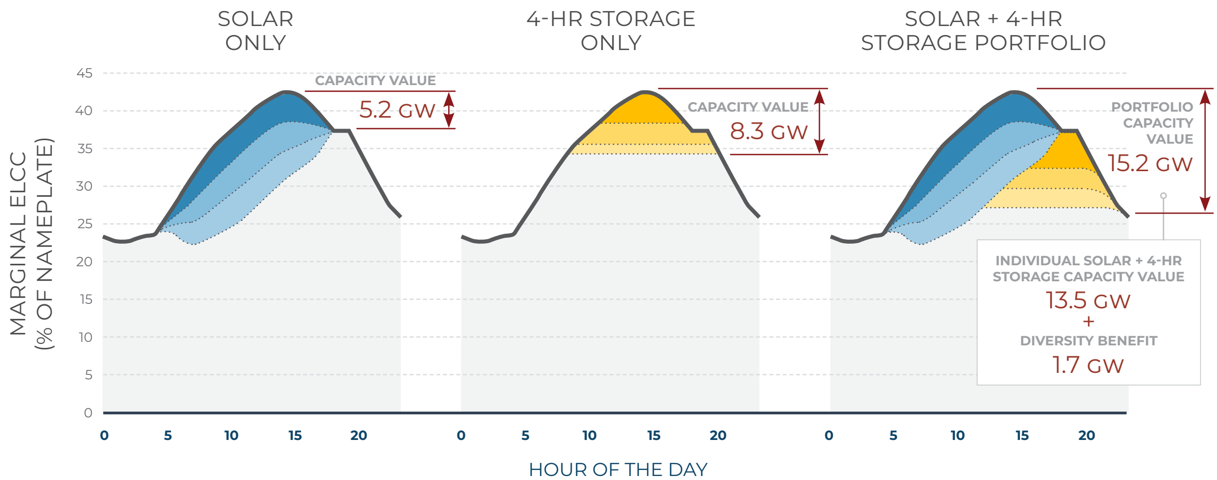
ELCC is an extremely valuable tool for determining whether the overall supply fleet can meet varying grid stresses. As more of any one resource is added to the system, the next unit with the same characteristics that is added to the fleet offers diminishing returns.

This incremental value is also dependent on the nature and quantity of other resources in the system; the more alike they are, the more those additions could have diminishing returns, although the converse may also be true. In some instances, adding diverse types of units to the fleet may actually have a synergistic effect—i.e., they may offer more value in combination, as they may make




**SOURCE** Portland General Electric, "Integrated Resource Plan" (July 2019) (note that capacity values are system-dependent; graphic is shown solely for illustrative purposes)

18 Currently, that reliability target is comprised of a demand forecast for a 1-in-2 weather year plus a 15% planning reserve (for the system overall) or a 1-in-10 year forecast with assumed outages (for local transmission-constrained areas).




**SOURCE** Schlag & Ming, "Practical Considerations for Application of Effective Load Carrying Capability: PJM Capacity Capability Senior Task Force Meeting" (E3, Aug. 7, 2020)

up for each other's limitations (for example, when both solar and storage are added to a system, they can provide more value to the system than the sum of their individual capacity values).

As a result of these two dynamics, the reliability value of any individual unit cannot be determined on an absolute basis. Its value is relative, and depends not only on how many units like it are part of the supply fleet, but also on the nature and quantity of other units of different types in the supply fleet. In other words, the value assigned to an individual unit could be higher or lower depending on whether its value is determined before or after other contributions are considered, or are added to or removed from the supply fleet.

Of course, as demand changes due to climate change, electrification, and other factors, the relevant stresses also change. Climate and other future demand pattern changes could result in different ELCCs relative to a resource's ability to solve the new stresses. In other words, notwithstanding a unit's actual performance, the overall context of the energy supply and the specific problems that need to be solved would also change its ELCC rating over time. These issues led the consulting firm Energy and Environmental Economics (E3), in its recent paper on using capacity for reliability planning, to conclude that "ELCC is a property of a portfolio of resources, not of individual resources themselves," and that "it is not a straightforward exercise to calculate the ELCC of an individual resource within the context of a much larger portfolio of intermittent and energy-limited resources."[19]

The issues associated with using capacity ratings are not limited to ELCC. As we noted in our first article in this series,[20] the current approach to assigning a single rating number, however derived, provides insufficient credit in some circumstances (e.g., discounting solar contributions to meeting absolute peak demand) and too much credit in others (e.g., providing credit for resources during the "net peak" when they can't reasonably supply power). Stanford Professor Frank Wolak, who contributed to developing the CPUC Energy Division's reform proposal and played an instrumental role in helping California recover from the energy crisis, provided a particularly stark example in the CPUC's January 8 RA workshop: simply put, a solar resource without storage can't help address an imbalance of supply and demand that occurs at night, whatever its capacity rating. PG&E's "slice of day" proposal would address those intra-day and cross-seasonal variations by requiring different capacity ratings for each "slice," depending on the resource's specific ability to contribute to the needs in that "slice."

19 Schlag et al, "Capacity and Reliability Planning in the Era of Decarbonization: Practical Application of Effective Load Carrying Capability in Resource Adequacy" at 7, 5 (E3, Aug. 2020)(Schlag), available at https://www.ethree.com/wp-content/uploads/2020/08/E3-Practical-Application-of-ELCC.pdf
20 https://gridworks.org/2020/09/californias-2020-energy-blackouts-resource-adequacy-may-not-have-failed-but-is-it-working/

A recent study suggests maintaining a balance of supply and demand under reasonably foreseeable stress conditions may require even more complex, probabilistic analyses incorporating additional factors. The EPRI study concluded that the failure to adequately consider multiple simultaneous stresses could result in materially overcounting resource value and underestimating reliability risks.[21] In light of the multiple factors that contributed to recent reliability events, such as those seen in February 2021 in Texas, this analysis seems particularly prescient.

Last, but far from least, capacity ratings are challenging when it comes to new technologies and new combinations of technologies. Renewables and storage are undergoing particularly rapid technology changes and are increasingly developed as "hybrid" resources. In part, these changes have been driven to meet the "net peak" needs apparent in last August's reliability crises. As noted above, however, incremental capacity value decreases as more of any imperfect resource is added to the system, and many have recognized that the four-hour storage most commonly added to renewable generation will soon start to show decreasing additional value.[22] With little operational data, assigning capacity ratings to hybrids has proven challenging even in the first instance.

While shifting, complex and assumption-ridden capacity values for individual resources may truly represent the best advanced prediction of their changing reliability value, in light of the chimerical nature of the energy system, valuations of this nature form a very challenging basis for investment and transactions, and are particularly troublesome for long-term contracts. This does not undermine the usefulness of capacity as a metric, particularly when applied on a fleet-wide basis. It does mean, however, that applying capacity value to individual resources will necessarily involve judgment calls by government agencies based on complex assumptions, and that the financial interests implicated in those decisions will make those calls very difficult.

Perhaps the clearest tip of the iceberg of capacity's limitations as the sole metric for Resource Adequacy is energy storage. In response to the CAISO's 2019 warnings of incipient capacity shortages, the CPUC took action, and ordered procurement of additional capacity. Regulatory programs reliant on regulatory products can easily be analogized to computer programs: they will do exactly what they are requested to do, but do not necessarily address issues outside of the precise scope of the request. In this case, the CAISO has expressed concerns that the energy storage procured in response to the CPUC orders may provide capacity- the target metric for the existing Resource Adequacy program- but may not address deficiencies in the amount of actual energy that is generated. While storage would be extremely useful in shifting excess electricity from one time of day to another, for example, its ability to provide relief is limited by its initial state of charge when there is an extended shortage of electricity.

To capture the usefulness of storage while acknowledging that its usefulness depends on its ability to charge, CalCCA and Southern California Edison's Resource Adequacy proposal[23] introduced another interesting solution. In their proposal, an energy requirement would be added to the existing capacity requirement, to ensure that storage demonstrates its energy source in order to be counted on for capacity. PG&E's proposal takes a similar approach in its "slices" proposal, and would require storage counted on for capacity in one "slice" to show where the energy had come from in another "slice." These solutions would help ensure that storage is available to provide power when expected, but would again add complexity to an already labyrinthine program.

We conclude that the use of capacity ratings for any specific unit, and their use as a basis for transactions and for determining performance, is increasingly fraught- and that capacity alone cannot measure the prospective balance of supply and demand, even on a fleet-wide basis. Are these complexities simply a fact of life, given the growing diversity of our energy supply and the changing conditions it faces, or are there other ways to break down the reliability problems we are trying to solve that might be simpler?

21 EPRI, "Exploring the Impacts of Extreme Events, Natural Gas Fuel and Other Contingencies on Resource Adequacy" (Jan. 2021).
22 *See, e.g.,* Schlag at 5-6.
23 CalCCA & SCE, "Southern California Edison Company (U 338-E) and California Community Choice Association's Track 3 Proposal," (Aug. 7, 2020).

## CAN RESOURCE ADEQUACY'S OBJECTIVES BE MET THROUGH ENERGY ALONE?

Given that capacity as a construct is challenging, California could go straight to the product customers actually use — energy — as the primary metric for Resource Adequacy. Texas' energy system, and others around the world, have used an "energy only" approach, without requiring procurement or demonstration of capacity. Just as the capacity construct should not be viewed as the root of all of the issues with California's existing Resource Adequacy program, the recent failures of the Texas market should not necessarily be viewed as an indictment of the "energy only" approach. Among other issues, Texas did not impose any forward-looking reliability program on load-serving entities (not even one using energy as the basis, rather than capacity).[24] Each market construct has its benefits and its limits.

The CPUC's Energy Division, and its consultant, Prof. Wolak, have suggested that it may be time to move the focus of Resource Adequacy to energy. In this approach, rather than obligating load-serving entities to meet capacity targets by procuring an equivalent amount of derated capacities of specific physical units, either a central procurement entity or individual load-serving entities[25] would enter into contracts with marketers to supply sufficient energy at a fixed price, through a "Standard Fixed Price Forward Contract (SFPFC)." The proposal is complex, and would involve far more than we can address in this report. The proposal, and aspects of the SCE-CalCCA and PG&E proposals, suggests a question that we approach on a generic, rather than proposal-specific basis: would an energy-based approach offer benefits over a capacity-based approach.

In essence, energy-based approaches to assure reliability on a forward basis adopt various aspects of well-known commercial hedging concepts as a regulatory program. Energy "options contracts" offer buyers the right, but not the obligation, to buy the energy they need to meet load at specified prices; similarly, "contracts for differences" buffer buyers from spot-market prices on a purely financial basis. These types of contracts are widely used by companies and load-serving entities; for example, those buyers that chose to use them in Texas were apparently insulated from the extremely high market prices that occurred in February, and at least to some extent from the supply shortages.[26] In an energy-based regulatory program, load-serving entities would be required to procure some form of these energy-based instruments (or they would be procured for them, through a central entity), rather than leaving their use solely to the load-serving entities' discretion.

An energy-based approach could untangle multiple agencies from fixing the specific procurement value of individual resources. This prescriptive task is an inevitable, and increasingly frustrating, process that can't hope to keep up with changing technologies and challenges. The inherent risk of arranging for sufficient supply from a diverse range of resources well in advance of the operating moment, based on a forecast of reasonably foreseeable conditions, cannot be avoided. The question this type of approach raises is: which entities are best at addressing that risk on an ongoing, dynamic basis? Governmental or quasi-governmental organizations, like the CPUC or the CAISO? Load-serving entities? Energy marketers and generation owners? Or, perhaps, is it better to allocate risk management to each in accordance with their relative expertise, information and abilities?

Perhaps the most difficult challenges for an energy-only approach are whether:

1. It could provide a sufficient safeguard to ensure that the supply fleet actually procured incorporates the right mix of characteristics to meet a reasonable range of anticipated conditions;
2. The system operators have sufficient visibility and control to assure reliability; and

24 Texas' ERCOT did require reserves, just as CAISO does in California.

25 This paper does not address the complex jurisdictional and policy issues associated with central versus individual procurement, which merit deeper analyses than we can provide here.

26 The very high cap on energy prices in Texas, intended to minimize the "moral hazard" that market participants would lean on the regulatory cap rather than commercially arrange to hedge their exposure to market prices, clearly worked for some but did not meet overall societal objectives (and resulted in reactive governmental market intervention, with governmental entities pressing to protect energy customers from energy bills that did not benefit from hedging).

3. The resources procured are properly assessed in greenhouse gas accounting and considered with respect to advancing California's climate and clean air objectives.

An energy-based approach would also face a legal hurdle. AB 380, which authorizes the Resource Adequacy program, focuses on sufficient capacity, not sufficient energy. Even if an energy basis was determined to provide the best foundation for the Resource Adequacy program, the existing statute does not appear to empower the CPUC to require energy hedging or other energy-focused requirements for load-serving entities other than investor-owned utilities.

Recent energy system reliability events make clear that attention to the physical capabilities of the fleet of resources is essential to maintaining reliability. Financial penalties for failure to provide sufficient energy at a specific price may not be sufficient to ensure reliability, as it may well be more economic for retailers to breach contracts or even go bankrupt rather than meet contractual price and quantity constraints. These events also make clear that more attention is needed to the range of reasonably foreseeable circumstances we can expect the energy system to face, including the potential for multiple challenges to occur at the same time — and for extended periods of time.

## THE RIGHT TOOL FOR THE PURPOSE: SHOULD RESOURCE ADEQUACY USE DIFFERENT METRICS FOR DIFFERENT PROGRAM ELEMENTS?

Returning to our premise- that Resource Adequacy is not one program, it is really a combination of multiple functions- might help analyze which tools will best assure achieving the program's objectives. The capacity-based and energy-based approaches each has benefits and disadvantages, which differ relative to each of Resource Adequacy's discrete functions. It may be time to consider differing approaches for each of these functions, reducing complexity for market participants involved in each function and perhaps providing better results for each desired outcome. For example, it may make sense to retain a capacity and an ELCC-focused approach for reliability planning, while shifting to an energy approach for procurement, performance and even price exposure.

For the most part, asking whether a resource fleet is capable of meeting particular challenges is essentially a planning function, and one that most would agree must remain with the agencies. Even the Standard Fixed Price Forward Contract approach would require a capacity-based assessment to provide some assurance that the collection of procured resources would meet projected operational needs. In our convening, participants were nearly unanimous in observing that California policymakers were unlikely to be comfortable in backing away from assuring performance from physical units. The recent reliability events underline the importance of regulators in forecasting stress conditions and testing the resources that have been procured against anticipated needs. Capacity seems particularly well-suited to that purpose, especially given the strengths of the ELCC tool for assessing the reliability value of resource fleets. That is not necessarily the same thing as specifying the capacity value of individual resources for purposes of procurement or determining whether those resources actually performed as required, where tools such as ELCC are problematic.

For procurement and performance, energy output at specific times is a clear, well-understood and transparent measure. It offers a simple, undisputable metric for all concerned, from designers, developers, owners and operators of supply to load serving entities, regulators and the grid operator. This type of performance-based, rather than prescriptive, regulatory measure can enable greater competition and incentives for innovation than the current capacity construct. An energy focus might also be helpful with interstate coordination and cooperation. Energy metrics would likely ease utilization and reserve resource sharing across neighboring states, as it would avoid potential (and potentially significant) differences between the states' capacity assessment approaches. Lastly, an energy focus would enable a more direct means of addressing interest in having Resource Adequacy contribute to restraining energy prices.

Disaggregating the planning, procurement, performance, and price functions would introduce new complexities, however. Key challenges include questions of how much to buy, in which timeframes and under what circumstances. Perhaps the most difficult issue would be addressing whether the resources procured would meet regulators' planning targets, or would require cycles of procurement to fill gaps between modeling outcomes and energy-based contracts. Unless those potential gaps could be easily anticipated by procuring load-serving entities, additional procurement cycles could add significant cost, complexity and frustration.

## WHATEVER PATH RESOURCE ADEQUACY TAKES, WE CAN'T GO IT ALONE

As California and its neighbors make progress towards their respective clean energy goals, the value of regional coordination is significantly increasing.[27] California has always heavily depended on imports to maintain reliability, but its RA program has not been designed to monitor changes in resource fleets, supply and demand balances, nor changing policy priorities in neighboring states.

As our collective dependence on renewable resources increases, the value of geographic diversity also increases, as weather conditions depressing performance or increasing demand in one area are at least less likely to have the same effect across the region. Increased regional integration could also make the cost of major reliability infrastructure that could serve wide areas, such as larger pumped storage installations, easier to absorb, following the precedent of the investment in the major interties connecting California to its neighbors decades ago. Recent experience with weather previously considered extreme, including the west-wide heat storm in August and the extended period of intense cold in Texas and the Midwest, suggest geographical diversity benefits may require even broader exchanges of power.[28]

We note only that import and export issues are likely to increase in significance, absent extraordinary investments in storage and California-only resources that may not be cost-effective. The development of future RA constructs should consider whether and how to maximize the benefits of regional coordination, and whether measures such as export restrictions will provide an overall benefit or burden to an affordable, reliable energy supply for California that advances its equity and climate objectives.

27 The Energy Imbalance Market demonstrates the value in the operating day; increased regional coordination in the advanced frame of Resource Adequacy is also likely to be beneficial. As with questions regarding central versus individual load-serving entity procurement, this report does not address the complex questions of regulatory jurisdiction that pertain to regional approaches.
28 While the independence of Texas' ERCOT system precluded the use of resources from other areas to support reliability, the regional weather pattern limited the likelihood that neighboring states could have exported enough excess power to address concerns even if ERCOT's system allowed imports.

# CONCLUSION

## WE CAN'T KNOW THE FUTURE, BUT WE CAN KNOW WHAT WE WANT FROM IT

California's energy system has already changed substantially, and is almost unrecognizable relative to the system that existed when the Resource Adequacy program sprung from the ashes of the 2001 energy crisis. We know these changes are just the beginning, between the revolution in the nature of the energy supply, the increasing electrification of every sector of the economy, and the extreme challenges accompanying climate change. As California considers potential changes to the Resource Adequacy program, the thought leaders in our conversations were clear that compatibility with future needs is more important than compatibility with current systems and market expectations — with the notable exception of avoiding disruption to procurement needed to maintain reliability this coming summer.

Our ability to forecast technology developments, demand needs, and climate impacts are necessarily limited. However, we can identify the characteristics we want for the energy system, and particularly for the reliability program supporting it. In assessing Resource Adequacy reform proposals, the first step should be to specify those characteristics, and to use them as evaluation criteria to determine which aspects of those proposals should be further explored and potentially adopted.

Based on the conversations in our Gridworks convening, we suggest the following evaluation criteria. In order to assess whether a Resource Adequacy reform proposal will address the fundamental challenges of the program and ready it for California's energy transition, decision makers should ask whether the proposal:

1. Minimizes the program's complexity, making it easier to understand?
2. Eases both transactions and compliance?
3. Increases access to an array of resources that can meet demand under reasonably foreseeable stress conditions?
4. Increases the program's cost-effectiveness, and the cost-effectiveness of the overall energy system?
5. Encourages innovation and competition to enhance performance and reduce cost?
6. Advances California's clean energy, greenhouse gas reduction and air pollutant reduction to the extent possible, as required by statute, and complement its ambitions for a more equitable energy system?
7. Embraces bold, comprehensive change where needed for long-term regulatory and market certainty?

A perfect proposal would clearly and unambiguously meet or exceed each of the criteria. But a proposal need not clear that awesome hurdle to have merit. The challenge for decision-makers is to determine the relative weight of these criteria and make deliberate steps to improve system reliability at reasonable cost. California's prospects for achieving its important climate and equity goals for the energy system depend on it.