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A New Approach to Capabilities Markets: Seeding Solutions for the Future

The 'Staircase Capabilities Market' is a novel mechanism for building markets to support sustained investment in solutions that address long-term issues identified in current grid planning processes. A Staircase Capabilities Market is an iterated sequence of long-term, small-volume requests for proposals for new capabilities to match anticipated system needs.

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I. Introduction: A Changing Grid

The large interconnections that make up today's electric grid are a marvel of engineering, almost always in plain sight but hidden from our consciousness. These are the largest and most expensive machines of our modern era and they mediate a simple brutal equation: generators connected to the grid provide an electric energy supply which must match—on a second-by-second basis—the aggregate demand of all the loads

connected to the same grid. Ideally, a real-time pricing mechanism connecting elastic supply and demand in an electricity market could automatically balance this equation. Physics, however, has a nasty way of intruding on economics: if for whatever reason supply cannot match demand quickly enough or for long enough, blackouts will result. Long investment time scales can be an obstacle to establishing a proper price equilibrium: of what use are high

marginal prices at times of peak demand if system operators did not invest sufficiently long ago to have a power plant or demand modifier at hand today? A solution employed by some markets, although controversial, is a forward capacity procurement mechanism: generators guarantee capacity availability at certain times, and they are paid whether they run or not. Depending on the market structure, these payments can be set by auction or at the discretion of utilities responding to voluntary targets or regulatory mandates.

The challenge of integrating large amounts of variable renewable energy into the grid brings these grid balancing questions to the forefront. Because variable generation is often driven by zero-cost fuel or is governed by must-take mandates, it creates an interesting twist in the basic supply-demand equation, challenging the old way of managing the grid. Instead of meeting demand, system planners must now meet “net demand,” defined as end-use demand minus any variable energy supply.

Matching dispatchable supply with net demand creates several new challenges. System operators need access to resources that can vary their output by larger amounts and more frequently. Moreover, they don’t always know when they will need to use dispatchable resources: operational reserve needs may become greater and meeting peak

demand may no longer be the most binding long-term problem. Second, large increases in renewable generation on the system could lead to an oversupply of generation. A portion of this capacity is desirable, as it allows system operators to retire the units with the greatest costs and the worst environmental effects. But at the same time, it is not prudent to retire too much dispatchable

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generation until cheaper and cleaner solutions appear to keep the new system of resources in balance.

Given these two new challenges, system operators are increasingly considering new “capabilities markets” to value the flexibility, capacity, and energy that can ensure that the right mix of resources is available during each step of the grid’s transformation. The following sections lay out a proposal for a new capabilities market designed to ensure an adaptive policy environment that still delivers financial certainty for investors.

II. System Goals for the Modern Era

Modern grids must deliver on multiple goals. On one hand, system operators must minimize the risk of reliability breakdowns by running the grid responsibly in real time and ensuring access to the right mix of resources in the future. On the other hand, they must drive efficiency and minimize pollution, as many environmental and health advocates are quick to point out. Both of these goals must be met while minimizing costs.

Grid planners and operators will be blamed for any problems, so they are naturally risk-averse when making forecasts or considering solutions. But grid operators represent a broad spectrum of appetite for risk, with some working very hard to implement public mandates and deliver innovation. When considering mechanisms for forward procurement, they must consider several questions:

- How can we ensure that the traditional fossil resources that we have depended on do not retire too early and leave us in a lurch with no time to fill the gaps? How can we manage variable generation resources without leaning too heavily on dispatchable fossil fuel plants?
- What kind of new problems, especially operational issues like large ramps in net demand, will arise when lots of variable renewables are added to the system or when fossil plants are retired?

- Can we count on new technologies and solutions to solve our problems? How do we ensure we are fully taking advantage of distributed resources? Will demand response deliver quickly, responsively and often enough? Will storage ever be commercially viable? Will energy efficiency deliver predictable reductions in demand we can count on for planning purposes? Is distributed generation going to create headaches for us by adding more randomness to our load forecast given its current lack visibility to our operation centers?

- How do we keep integration costs low?

At the same time, in an environment where large amounts of new renewable energy are coming onto the system, it is possible that incumbent natural gas generators will provide some flexibility on the grid, even after they are no longer selling very much of their output on the open market. With most of their startup capital long ago amortized, these generators could saturate a fledgling capabilities market, crowding out new innovative solutions that system operators may want to test before the old fossil units retire and they are left with a much bigger capacity and flexibility gap to fill.

Taking all of this together, policymakers need a mechanism to deliver a stable market with attractive on-ramps for the power system capabilities to address the questions above. That mechanism would ideally:

- Address the concerns of system operators, planners and regulators about both near-term and long-term needs for a reliable grid,

- Take advantage of market competition to find the lowest price for the power systems capabilities we need,

- Minimize capital wasted on capabilities we would have gotten anyway while ensuring the necessary ones remain,

- Not unduly advantage incumbent generators or keep old polluting generators alive longer than necessary, and

- Open space for innovative new market entrants to provide carbon-free and low-pollution solutions to system flexibility and capacity issues on a sustainable commercial basis.

III. The Basic Idea: A 'Staircase Capabilities Market'

A Staircase Capabilities Market is an iterated sequence of long-term, small-volume requests for proposals (RFPs) for new capabilities to match anticipated system needs. Long time horizons (say, 10 to 20 years) would give investors required certainty;

small volumes would allow regulators to experiment with specifying the capabilities they need, and reverse auctions would allow the market to find the right price. An iterative process could drive toward an optimal solution, with each new tranche of contracted capabilities stacking over time to fill some or all of total system needs (**Figure 1**).

It is best to start small when reforming complex systems like the electricity grid and market, using an empirical approach with regular feedback on how each new intervention is affecting the necessary change. The Staircase Capabilities Market is structured to do just that. Another way to start small is to open this market to *new* capabilities only. This smaller (yet vital) scope for the Staircase Capabilities Market would sidestep most issues with incumbent markets, while providing an on-ramp for innovative new solutions to present and future grid challenges. This article therefore describes how a Staircase Capabilities Market can work alongside existing procurement mechanisms, not as a substitute but as an enhancement. If the Staircase Capabilities Market is successful, it could grow to play

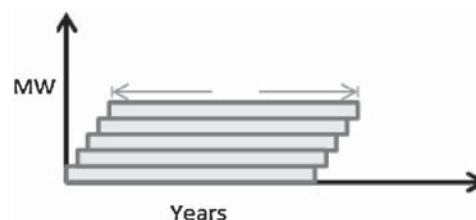


Figure 1: Staircase Capabilities Market illustration

an important role alongside current methods for valuing capacity and flexibility in existing generation. Key features of a Staircase Capabilities Market include:

(1) Market operators would open a regular open bidding process—such as an annual reverse auction—for capabilities to be delivered at some set time in the future for some set duration of years.

(2) A technical group with public stakeholder input would set: (a) the target capabilities, (b) the minimum increments for bids, and (c) the technical characteristics for bids. These technical characteristics should strive to remain as broad as possible, but could factor in technologies that are close to commercialization, making their participation more probable. This technical group would not pick winners and losers, but it might

be asked to set the bar for what is considered an innovative yet viable participant. Note that only a set fraction of the need for each capability is up for bid in each iteration – making it easier to experiment.

(3) Regulators would set a start year for contract delivery, length of contracts (maybe 10 to 20 years for investor certainty) and penalties for non-compliance. Special attention would be given to incentivize bids from innovative new technologies and business models. These rules need not change much from one tranche to the next, but the feedback should be incorporated via the iterative, small-volume RFPs. The review committee would also work with the technical group to vet bids, although the threat of penalties for non-compliance should also act as a strong incentive for market participants.

(4) A review committee would examine the performance of the Staircase Capabilities Market, measured as the degree to which it successfully recruits innovative market entrants while making marked progress toward addressing future needs. The review committee would also provide feedback to regulators and the technical group for incorporation into future iterations.

IV. Illustrative Example

As a thought experiment, one can imagine a staircase capabilities market for emerging solutions integrated into California's long-term planning process. California's system has 44 GW of winter afternoon peak demand, and is anticipating large amounts of wind and solar installations (15–20 GW) in the

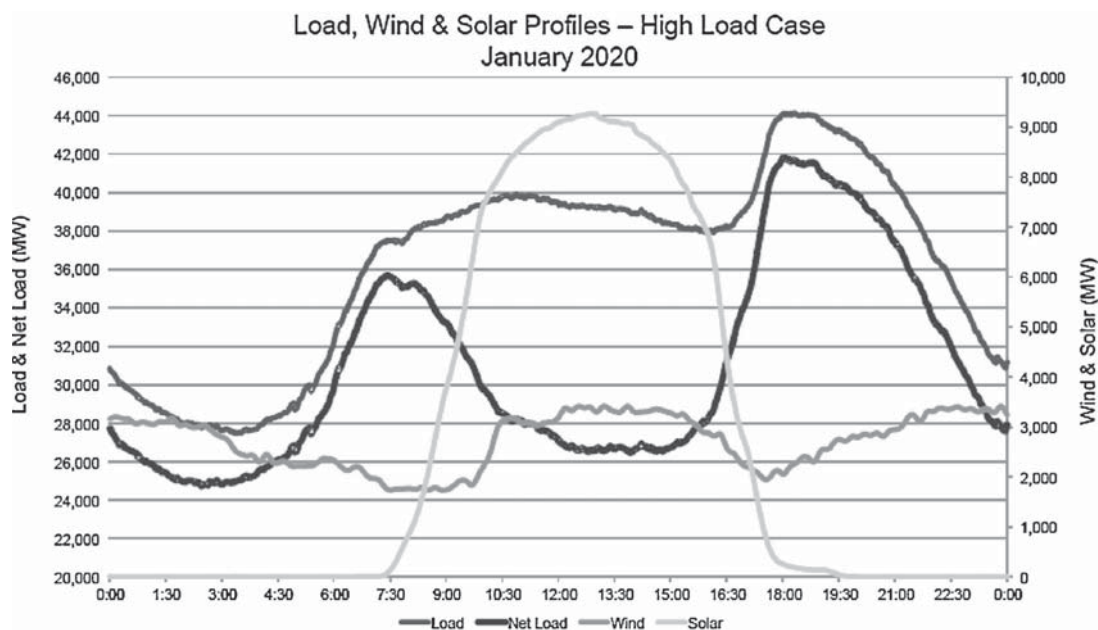


Figure 2: Load, Wind and Solar Profiles – High Load Case, January 2020¹

next 10 years. Frequent needs for large ramps in net demand fuel the independent system operator's concern about reliable renewable energy integration. These ramps must be managed either through flexible generation that can rapidly adjust its output up or down, or through load-shifting measures such as storage or demand response.

An important feature of the ramping problem illustrated in **Figure 2** is that a large component of the problem is predictable well in advance. Of the 12 GW ramp seen in the figure, some 9 GW is predictable based on when the sun is shining. Another important thing to keep in mind is that this double dip ramping problem in the net-demand curve doesn't develop overnight; the initial problem starts in the noise of day-to-day planning and gradually becomes more acute.

Imagine allocating 4 GW of daily scheduled ramp management for post 2020 to be delivered via new solutions purchased in a staircase capabilities market. This represents one-third of the projected ramping requirements. Market operators could start the staircase capabilities market with a tranche of 400 MW of new scheduled ramp capability to be delivered starting in three years. An additional option could segment this market to carve out, e.g., niches of 100 MW for distribution scale solutions or for solutions that specifically avoid transmission congestion.

The technical group would identify how much of the future ramp these new capabilities would need to meet in 10 years' time (4 GW), decide on the tranche sizes (400 MW in 20-year contracts), delivery times (start in three years), and decide on any sub-divisions of the 400 MW market tranche along further technical criteria. This would not be generic ramping capability, already provided by

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the current generation fleet, but *additional* ramping capability tied to specific anticipated system dynamics like the super-peak in **Figure 2**. Specific requirements can help address this; for example, the ramping capacity might also be required to start from a zero or very low generation profile to mitigate the risk of over-generation before the ramp.

Regulators would set up the corresponding market, run the auction, and examine and approve contracts. The review committee would examine how successful the auction was at serving the needs identified by

the technical committee and at ensuring participation from a broad range of potential bidders while maintaining reasonable costs. Based on feedback from the first iteration, it would provide a report to the technical committee and regulators for setting up the next 400 MW tranche market. After a few cycles, the review committee could provide information on bid winners' performance against their contract terms. After a few more cycles, the review committee could begin to zero in on the range of costs and benefits of meeting capabilities requirements through a Staircase Capabilities Market.

In this example, after 10 iterations, 4 GW of new ramping capabilities would be in contract, with 2.8 GW already in operation. At this point, policymakers could start looking at expanding the role of the Staircase Capabilities Market to larger portions of system needs or use lessons learned to reform their broader resource adequacy framework. Alternatively, once the Staircase Capabilities Market proved the performance of bid winners' technologies, those capabilities technologies could enter the existing resource adequacy framework. ***The Staircase Capabilities Market could be used to supplement existing mechanisms for assuring resource adequacy; it is not designed to replace them.***

An important variation in this example might be to start with smaller tranches, perhaps 130 MW, and then steadily increase the size of tranches

(say 60 MW per year) in pace with learning from the process. For example, 4 GW of contracts could be achieved through tranches of the following size: 130 MW, 190 MW, 250 MW, . . . , 620 MW, 680 MW. This quadratic rise in ramp capacity could be matched by an advanced refinement process, wherein the initial iterations examine how ramping solutions play alongside a broader basket of system needs. In this case, further iterations of the market could hone in on additional requirements that meet the more acute ramping needs as they occur. This takes advantage of the flexibility of the Staircase Capabilities Market. Regardless of how quickly the tranches grow, the key will be *to provide long-term transparency about how the Staircase Capabilities Market will evolve: giving bidders and investors the certainty they need to participate.*

A strong candidate for meeting ramping capabilities would be a new kind of fast-start, fast-ramping combined cycle gas turbine (CCGT), which could be used to manage large ramps while avoiding over-generation. To push this example further, it is interesting to consider the conditions under which this generator's services might fail clearing the Staircase Capabilities Market. First, they might not meet a technical standard like a maximum GHG emissions profile. Second, in a market designed to deliver

ramping capability at a pre-set time every day, such a generator might not be the lowest-cost bidder compared to other possible solutions that cannot provide 24-hour dispatchability, but are very good at mitigating ramps on a predictable schedule. Finally, the technical group might decide that a fast-start, fast-ramping CCGT is only



incrementally different from existing technology and should seek to have its value captured in an existing procurement mechanism or market instead (in California's case the CA Independent System Operator's forthcoming Flexi-ramp product could fill this role, along with proposed three- to five-year forward procurement mechanisms at the California Public Utilities Commission).

The Staircase Capabilities Market is a competitive mechanism that provides an on-ramp for new and innovative solutions that currently face significant barriers to entry. The risk to ratepayers involved with

the long-term, 10–20 year commitments in each tranche is meant to match the risk to innovators involved in providing desirable *new* solutions that might never otherwise become available.

V. Defining the Specifications

The Staircase Capabilities Market described here is meant as a new type of market mechanism for long term planning, a flexible mechanism to encourage experimentation while providing market participants with dependable long-term revenue streams to incent their bids. As such, this article will not designate specific market specifications for tranches, but leave that open to the region's specific power needs.

Still, it may be useful to list some examples of the kinds of solutions and system needs that might be good targets for a new Staircase Capabilities Market. Examples of new solutions that could be encouraged to participate:

- Grid-scale and distribution-scale storage,
- Smart grid solutions integrated with behind-the-meter storage and demand response,
- Automatic demand response and actively managed building loads, and
- Compensated variable energy resource curtailment: e.g., a wind producer could be

compensated for intentionally curtailing some of their output in order to produce a smoother overall product or provide dispatchable generation reserves.

Examples of system needs that could be targeted:

- Peak shifting and net-load shaping,
- Ramp mitigation (as in illustrative example above),
- Greenhouse gas emissions reductions,
- Local criteria pollutant reduction,
- Local reliability issues,
- Increasing the efficiency of transmission and other infrastructure assets, and
- Resiliency in emergencies, critical systems support, controlled islanding.

Of course, the Staircase Capabilities Market mechanism itself is not likely to be the right structure for every region. It may be useful to list some examples of alternative structures that could build on the idea:

- Instead of setting technical criteria for a given tranche, a point system could be introduced. Resources with more points could compete with higher bids (perhaps using a bid multiplier for a given threshold number of points).
- Mechanisms could be introduced to include aggregate resources or third-party ownership. Utilities or third parties could bid into contracts, build their own set of resources, and be held liable for meeting contract terms.

- Contracts could compensate bidders for offering flexible resources in modular increments. For example, a bidder could be paid to offer somewhere between 20 and 30 MW of ramping in eight years at a set price, with the final number based on a series of signals from regulators or systems planners in the intervening years. This allows



planners to plan more economically and less conservatively and creates a market for planning risk.

It is important to remember that the value of a Staircase Capabilities Market comes not only from its ability to consider new categories of technologies, systems needs, and business models, but also from its ability to combine or disaggregate old categories (like combining system need with a local need). If this market is to act as an on-ramp, though, the technical group and review committee must consider—at each iteration—how these chimeras will eventually integrate with existing procurement and market

mechanisms, or they must create whole new long-term categories for system procurement.

VI. Managing the Transition

Managing the transition from old to new protocols and markets is a substantial challenge with any major change to power market structures. As proposed here, the Staircase Capabilities Market addresses this challenge in two ways. First, because it starts with one small tranche, it does not have an immediate impact on the status quo. It does not threaten markets dominated by incumbents today but offers an on-ramp for new market entrants, giving leverage over incumbents' future rents. Second, the Staircase Capabilities Market—as defined here—creates a brand new market for new solutions, so existing players have no need to adapt their current behavior. Like adding an extra lane to a highway, the Staircase Capabilities Market is not likely to cause any major problems in the flow of traffic.

One issue to be aware of, however, is that the Staircase Capabilities Market creates a revenue stream to new solutions for incremental services, but it is conceivable that incumbent generation may already provide some or all of those services for *free*. This is not necessarily a bad outcome if the services provided by existing generation are tied to an unwanted externality, such as GHG emissions from a plant that

must run at some minimum rate, but it is important to carefully consider the ramifications of paying one service provider and not another.

During transition periods, markets are also prone to gaming as unintended consequences of new designs are revealed. There are several ways that the Staircase Capabilities Market helps avoid gaming of the system. First, by using tranches and starting with a smaller new market, there is less incentive for large market players to look for gaming opportunities; this provides time for regulators to work out the kinks in this system before it becomes mainstream. The iterative nature of the Staircase Capabilities Market makes it adaptive, so market operators will get multiple chances to get things right if the review committee reports gaming.

VII. Shifting the Energy Paradigm

The Staircase Capabilities Market is a mechanism for seeking lowest-cost innovative solutions to future grid capability requirements. Via its iterative nature, the Staircase Capabilities Market is also an important mechanism for gathering information about how best to set and define power policy goals. The iterative process allows policy makers to experiment with different types of market interventions in a non-destructive, predictable

manner. This is a very important feature for electricity markets policymaking because of transformation that the electric sector is currently undergoing.

This energy shift, similar to the Energiewende in Germany, is being driven by an increasing penetration of variable energy in electricity grids. This increasing



penetration itself is driven by the need to lower pollution, the impressive drop in price of solar and wind technology, and by the will of individuals to control their energy destiny. The initial effect of the energy shift is to create a burst of new renewable energy competing with existing dirty sources. In planning for an energy system dominated by variable energy resources in the long term, there will be an excess of electricity produced, unless very cheap storage becomes abundant quickly. The result is that will no longer make sense to manage the grid principally around payments for un-differentiated energy production with smaller payments for ancillary services.

In the future, exactly when and how energy is produced or delivered will likely become as economically relevant as its raw kilowatt-hour amount, and to some extent this is already happening. For example, the Electricity Reliability Council of Texas recently raised the price cap on its real-time market, doubling the maximum amount that can be charged at peak by June 2015 and making explicit the growing time value of electricity. One can imagine that this temporal dimension will be captured through dynamic pricing or an auxiliary options market for time shifting, all coupled to increased elasticity in supply and demand with a lot of automation to insulate consumers from constant decision-making. While eventually the glut of energy available through renewables might be captured either through storage or new business practices (similar to past industries that developed around sources of cheap hydro-power), a low-carbon trajectory for our power systems will demand new technology and innovations to better manage and shift power flows. The Staircase Capabilities Market, and its variations, is a structure to help these novel solutions arrive on time.■

Endnote:

1. Virginia Thompson, *Unlocking the Potential of Energy and Environmental Policy*, Presentation for California ISO, 2002, at http://www.wspp.org/filestorage/panel_1_thompson_casio.