The Potential Impacts of ELCC Reform on Chile's Electricity Market, and Recommendations to Achieve the Climate Goals

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Introduction to PA Consulting Group

Introduction to PA Consulting

ACERA engaged PA Consulting Group to examine the potential impacts of ELCC reform on Chile's energy market.

This presentation will cover three areas:

- Compare the Chilean energy market and the proposed ELCC approach to two U.S. power markets - CAISO and PJM.
- Provide our key takeaways on Chile's energy, capacity and REC market design within the context of its ELCC reform and climate goals.
- Offer three recommendations to achieve new battery storage entry, maintain private investment in the Chilean market, and ensure Chile meets its climate goals.

Today's Speakers

Ethan Paterno

Partner

- 20 years of clean energy infrastructure and power markets experience.
- M.S. Economics from the Colorado School of Mines.

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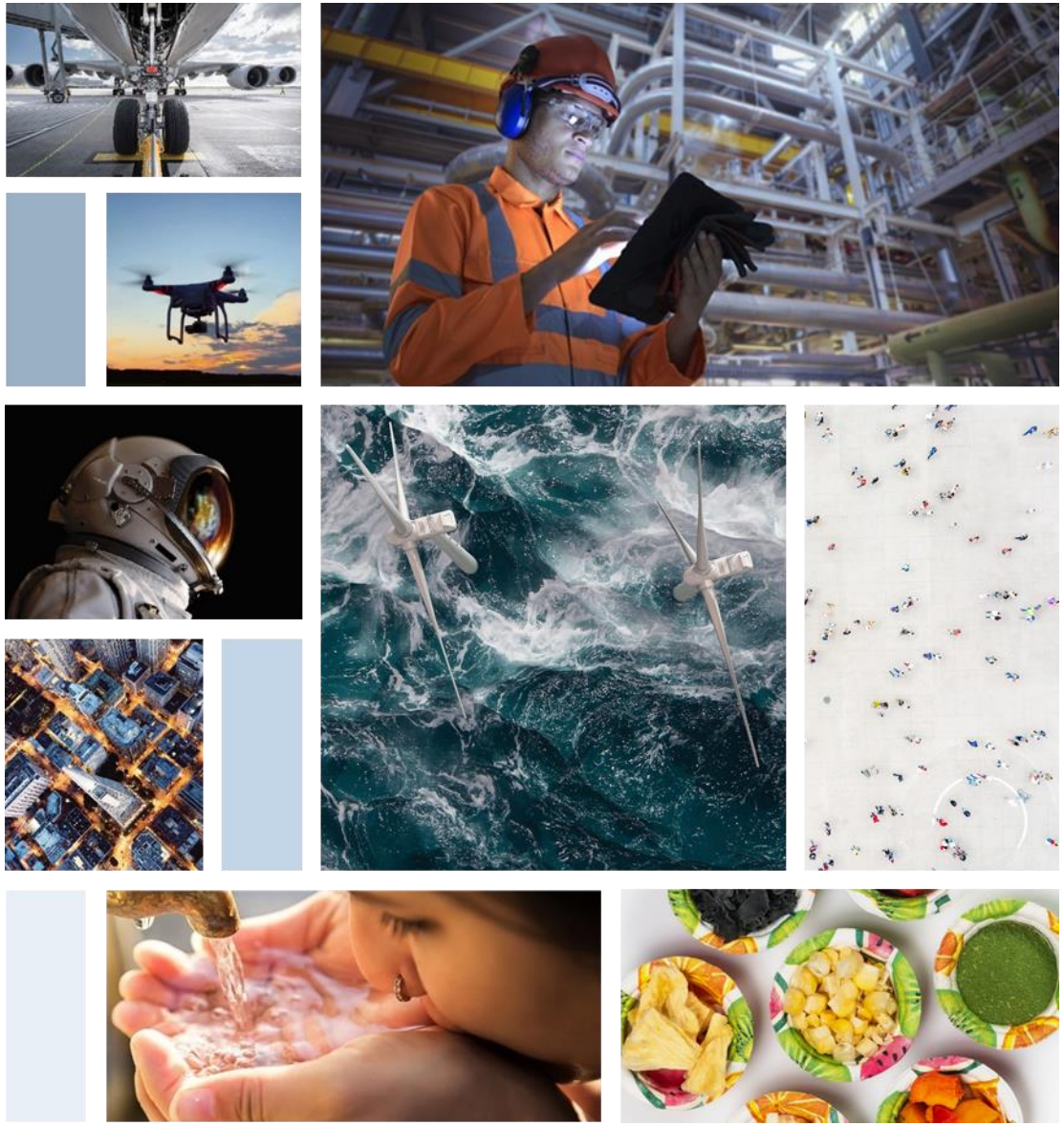
Managing Consultant

- 16 years clean energy infrastructure and power markets experience.
- Former employee of the MISO market monitor.
- B.S. Economics, Davidson College

About PA Consulting Group

PA Consulting was founded over 75 years ago and has over **3,500 employees in more than 25 offices across the globe**. We believe in the power of ingenuity to build a positive human future in a technology-driven world. As strategies, technologies and innovation collide, we create opportunity from complexity. Our diverse teams of experts combine innovative thinking and breakthrough use of technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

Our energy practice is one of the largest energy and utility advisory practices in the world, with more than 200 subject matter experts globally. For more than 25 years, we've worked across the investor and utility value chain to **help our clients thrive in complex energy markets**. We work with a diverse array of clients, including public and private investors, independent system operators, and government regulatory agencies. Today, we are committed to helping our clients that are on the forefront of efforts to decarbonization the energy sector and the broader economy.



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Background on ELCC Reform

The Proposed ELCC Reform

Chile is considering an Effective Load Carrying Capability methodology for capacity accreditation.

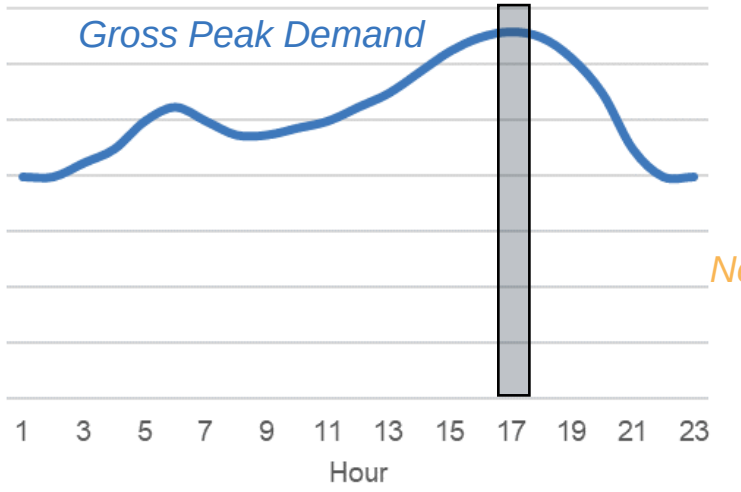
- Chile's Ministry of Energy has recently revised the country's clean energy targets:

- Achieving these policies will require phasing out of fossil-fired power generators (e.g., coal and natural gas), and replacing them with wind, solar and battery storage. In turn, this dramatic change to Chile's power fleet could result in electric grid reliability challenges, which many other power markets and regulators are currently grappling with.
- In response to these potential challenges, the Ministry of Energy is proposing to adopt an Effective Load Carrying Capability ("ELCC") methodology for the capacity accreditation of capacity resources, including solar, in an attempt to better reflect the relative reliability contribution of all resources, and to improve the market price signals for new battery storage.

What is ELCC, and Why Does It Matter?

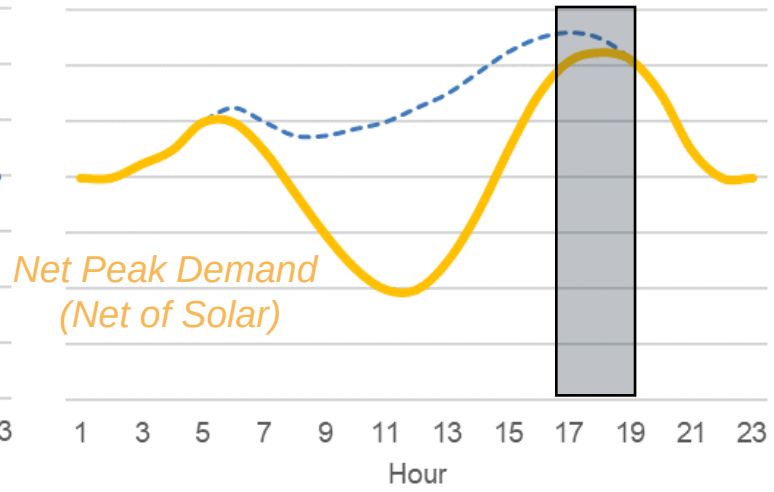
ELCC is an approach to evaluate the capacity contribution of a particular resource class to the reliability of the electric grid. ELCC becomes more important as more variable resources enter the electric system.

Status Quo / Historical Approach



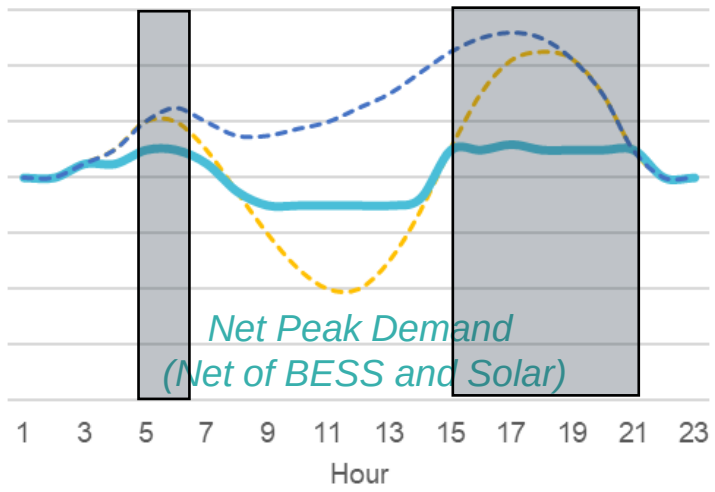
Historically with few variable resources on the system, the tightest system conditions typically occur as a function of overall electricity demand (e.g., summer afternoons). Capacity contribution reflects historical generation of variable resources during these gross peak hours.

Increased Solar Penetration



With greater solar (and wind) penetration, the tightest system conditions can occur in a wider number of hours, depending on how much solar (or wind) generates in a given hour. Capacity contribution using an ELCC approach captures this uncertainty.

Increased Solar + BESS Penetration



With greater storage penetration, the net load curve flattens significantly (since BESS are discharging in highest-value hours) and tight system conditions can now occur in a much wider number of hours.

Potential for critical system conditions

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Power Market Comparisons

ELCC Comparison – Chile vs. CAISO and PJM

Chile's proposed ELCC approach is generally in-line with the CAISO and PJM markets

	Chile	CAISO	PJM
ELCC Introduction (Year)	2026 (target)	2018	2023
ELCC Methodology	To be determined	Average for resource adequacy	Average
ELCC Evaluation Period	Annual	Monthly for resource adequacy	Annual (June to May Delivery Year)
Key ELCC Considerations	To be determined	1 day in 10 years LOLE, determined on a monthly basis (LOLE target of 0.2-0.3/month)	1 day in 10 years LOLE; 200 coincident net peak hours + 200 coincident peak putative hours
Solar Capacity Accreditation – 2022	17%* (current methodology)	11%	38-54%, depending on technology
Solar Capacity Accreditation – 2026	0%*	5%	31-47%, depending on technology
Solar + Storage Capacity Accreditation – 2022	47%* (current methodology)	100%	38%
Solar + Storage Capacity Accreditation – 2026	16-90%*	95%	80%

* Source: ACERA. 90% reflects stand-alone contribution of 4-hour BESS and is comparable to CAISO and PJM values. 16% reflects cumulative solar + storage contribution. Values are ELCC Preliminar (not Definitivo) and does not consider potential transition period adjustments. Actual value depends on facility configuration. https://energia.gob.cl/sites/default/files/informe_final_-_flexibilidad_en_el_mecanismo_de_potencia.pdf

Power Market Comparison – Chile vs. CAISO and PJM

While Chile is a much smaller market than CAISO and PJM, Chile has similar climate goals. However, Chile's current REC requirement is behind its clean energy policy commitment (e.g., Net Zero by 2050).

	Chile	CAISO	PJM
Net Zero Commitment	Net Zero by 2050	Net Zero by 2045	5 of 13 states (IL, NJ, VA, MD, DC) are targeting by 2045-50
REC Requirement	20% by 2025	60% by 2030	Varies by state
Peak Demand – 2021	11 GW	51 GW	149 GW
Total Nameplate Capacity – 2021	31 GW	110 GW	190 GW
Total Nameplate Solar Capacity – 2021	6 GW	26 GW	3 GW
Solar as % of Total Nameplate Capacity – 2021	20%	24%	2%
Renewables % of Total Nameplate Capacity – 2021	55%	37%	9%
Net Peak Demand Hour – 2021	Winter Evening	Summer Evening	Summer Afternoon

Power Market Comparison – Chile vs. CAISO and PJM…continued

Chile's wholesale market design is also similar to CAISO and PJM; however, Chile's capacity clearing prices are pre-determined – whereas CAISO and PJM are fundamentally based on an outlook of supply and demand.

	Chile	CAISO	PJM
Energy market	Nodal	Nodal	Nodal
Capacity market	Yes	Yes	Yes
• Bid vs. cost-based	Cost-based	Bid-based	Bid-based
• Market clearing mechanism	Yes, but conducted on ex-post basis	No, bilaterally arranged but liquid trading	Yes
• Time period	1 calendar year	1 month to 10+ years	1 Delivery Year (June to May)
• Are capacity clearing prices predetermined?	Yes	No	No

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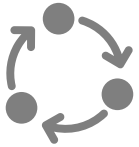
Key Observations and Recommendations

Our Key Observations of Chile's Market Design and ELCC Reform

Chile's ELCC reform is the right approach to capacity accreditation, but other changes are needed to the overall market design to support continued investment in the Chilean market.

An ELCC approach to capacity accreditation is a reasonable and internationally-recognized means to evaluate the reliability contribution of renewables, and all forms of capacity.

- Chile's proposed changes align with recent and forthcoming changes in other established international markets, such as CAISO and PJM



However, ELCC and its impact on capacity revenues for existing generators must be considered within the context of a holistic market design of the entire electricity market and its capacity, energy, and REC markets.

- Chile's ELCC reforms in isolation will directly harm existing generators by reducing their future expected capacity revenues. Investor confidence in market rules is essential to achieve Chile's climate goals.

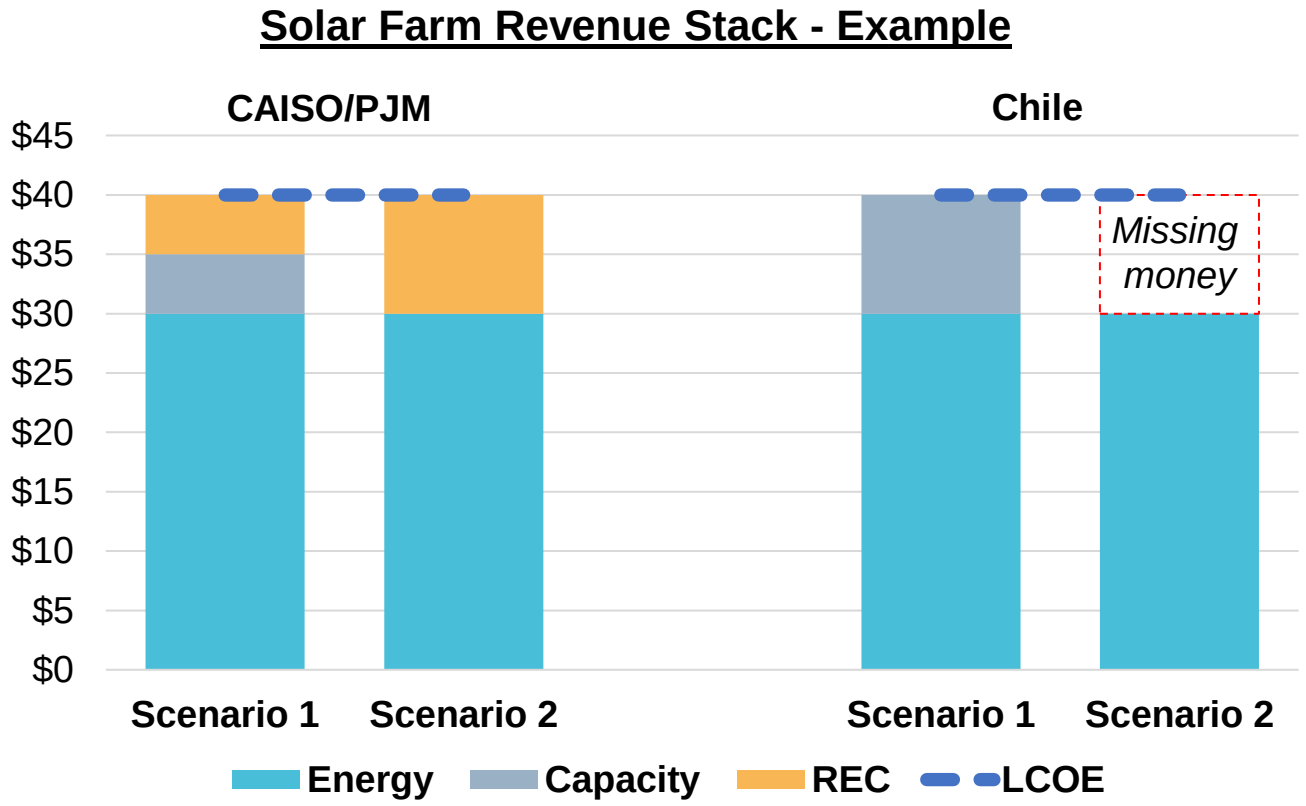
Battery storage resources are unlikely to enter a market based on the proposed ELCC changes alone; targeted programs such as a Clean Peak Standard are better to attract storage.

- In many markets, attracting new battery storage requires tailored approaches that are specific to the unique reliability attributes that battery storage can provide to a wholesale electricity market.

Capacity, Energy and REC Market Feedback Mechanisms

In CAISO and PJM, the capacity, energy and REC markets work together to balance changes between them, and, collectively, work to provide investors with the return needed to support investment.

- Chile's REC requirement currently does not match its stated climate goals, which prevents Chile's REC market from compensating renewables for changes to its energy and capacity markets.
- Typically, a decline in capacity revenues for renewables such as solar would result in an increase in REC prices and associated revenues, since REC revenues are designed to provide the '*missing money*' renewables need to generate a return on investment after accounting for energy and capacity revenues.
- However, Chile's REC requirement of 20% was achieved in 2020 and the REC market is currently oversupplied as a result, leading to REC prices that are very low. And as a result of this oversupply there is no way for Chile's REC market to respond and offset the decrease in capacity revenues from the ELCC-based capacity accreditation.



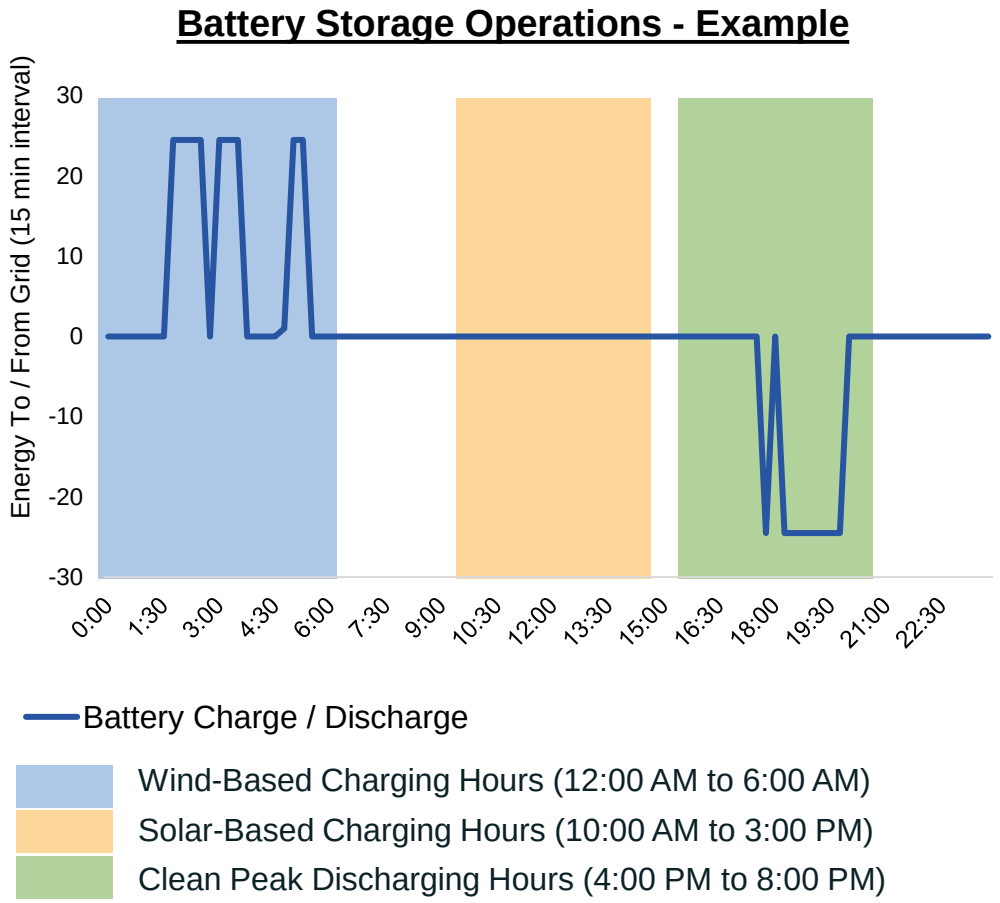
Scenario 1 = Solar capacity accreditation of 15%
Scenario 2 = Solar capacity accreditation of 0%

Specialized Programs for New Battery Storage

Massachusetts's Clean Peak Standard is an example of a new program being implemented to explicitly attract new battery storage to help support grid reliability.

- Load-serving entities need to procure "Clean Peak Energy Certificates" (CPEC) equal to 1.5% of total electricity sales in 2020; with the requirement increasing by 1.5% annually.
- Qualified renewable generators, storage resources and DR may earn CPECs for each MWh produced during the following Seasonal Peak Periods:
  - Spring: from 5:00 P.M. until 9:00 P.M;
  - Summer: from 3:00 P.M. until 7:00 P.M;
  - Fall: from 4:00 P.M. until 8:00 P.M;
  - Winter: from 4:00 P.M. until 8:00 P.M.
- "Multipliers" provide extra incentives for generation during periods of highest potential impact.
  - For example, the summer/winter seasonal multiplier is 4x the spring/fall baseline 1x.
  - Generators that produce during the highest single hour of demand in a month obtain a 25x multiplier.

More information on the Clean Peak Standard is available at:
https://www.mass.gov/clean-peak-energy-standard



Grandfathering Exemptions For Significant Rule Changes

Both CAISO and PJM have examples of grandfathering existing resources from rule changes that would have had significant impacts on resource revenues and investor returns.

Power Market:

CAISO

Resource Type: Demand Response (4% of CAISO market).

Existing Rule: Demand response resources must be available during top 40 hours.

New Rule: Demand response resources must be available during top **100** hours.

Rule Change: June 2021.

Exemption: Demand resources with an executed contract at the time of the rule change.

Power Market:

pjm

Resource Type: Wind and solar.

Existing Rule: Contracted wind and solar can bid as price-takers (i.e, $0/MW-day) in the Base Residual Auction capacity market.

New Rule: Contracted renewables can only bid above their unsubsidized cost (i.e., excluding REC value).

Rule Change: December 2019.

Exemption: All renewables (operating and planned) with a signed interconnection agreement at the time of the rule change.

"The exemptions that we direct here are an extension or re-adoption of the status quo ante for many types of resources that accept the premise of a competitive capacity market, have operated within the market rules as those rules have evolved over time, and made decisions based on affirmative guidance from the Commission indicating that those decisions would not be disruptive to competitive markets."

– Federal Energy Regulatory Commission regarding PJM capacity market exemptions

Our Recommendations

We recommend the following three market design changes be implemented to support the ELCC reform.

1. Update REC Requirement to Align With Chile's 2030 and 2050 Climate Goals:

- Chile's current REC requirement of 20% by 2025 was enacted in 2013 and exceeded for the first time in October 2017 (and on an annual basis in 2020). Interim targets have been significantly overachieved for years. As a result, REC prices have been at low, or "voluntary", pricing levels.
- Aligning Chile's REC requirement with its climate goals of 80% by 2030 and Net Zero by 2050 would increase the demand for RECs and thereby the price of RECs, and would provide an important feedback mechanism currently missing from Chile's market. Specifically, with a higher REC requirement, a decline in capacity revenues would be offset by an increase in REC revenues, since these units are needed satisfy Chile's clean energy requirements.

2. Create a "Clean Peak Standard" for Battery Storage:

- A reform to ELCC in isolation likely will not drive significant development of battery storage, since capacity revenues are likely to be a small portion of overall revenues for battery storage (even if they are made eligible for capacity revenues).
- The creation of a Clean Peak Standard would more explicitly support the development of battery storage and reward them for their contribution to reliability. Similar to a REC requirement, a Clean Peak Standard requires load serving entities to purchase "clean peak certificates" generated by certain preferred resources such as battery storage during a system's peak hours.

3. Grandfather Capacity Accreditation for Existing Generators:

- Grandfathering ELCC values based on the current methodology for Chile's existing generators (including those that have entered into long-term contracts or have achieved financial close) will ensure private investors generate a return on their existing investments. It will also give investors confidence that future regulatory changes will not prejudicially harm them. Both of these benefits will ensure future private investment in renewable and battery storage in the Chilean market.
- Increasing the REC requirement should not be considered as a replacement for Grandfathering. It may take time for the REC market to calibrate price formation to the higher REC requirement, and banks may be initially reluctant to lend against REC revenues.

For any questions, please contact us.

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About PA.

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