

# ***ASSESSING THE PERFORMANCE OF A NEW TENDER FOR FREQUENCY REGULATION SERVICES IN CHILE***

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## **Overview**

The Chilean National Electric System (NES) has integrated Variable Renewable Energy (VRE) generation capacity at one of the fastest rates in the world [1]. As of 2019, the daily production of wind and solar energy during some days exceeded 20%. However, the Chilean electric system is still mainly hydrothermal. Coal generation dominates the northern region of the country, while hydroelectric facilities are more abundant in the central and southern regions.

The physical structure of the Chilean NES and regulatory definitions create a unique interaction between energy and operating reserve market. In 2018 and 2019, coal and gas generation facilities supplied most of the primary and secondary reserves in the north, while in the central-south region the reserves were supplied by reservoir hydroelectric generation. In the central-south region only a small portion of the reserves were supplied by natural gas. Once the northern and central system were fully interconnected with a 500-kV transmission system in June 2019, the Independent System Operator (ISO) decided that zonal requirements for frequency regulation services were not necessary.

Until December 2019, the Chilean NES utilized a cost-audited based market for energy and reserves. However, new requirements defined in Law 20.936 in 2016, specifically those defined in Article 72°-7, defined that the ISO had to design a tender for ancillary services. As part of the new requirements, the ISO would have to evaluate the level of competition for the proposed tender and if the level of competition was not adequate, the ISO could procure the ancillary services directly. Additionally, if the tender was not fully subscribed the ISO could also procure the ancillary services directly.

To assess the level of competition in the ancillary services market, the ISO performed a *pivotal rent* test. Through such test the profits that an agent can make under different market structures were estimated [2]. The primary objective of the analysis conducted by the ISO was to determine if by establishing a tender, market power could be exerted by market participants to deviate the ancillary services market from the economic equilibrium which could be achieved by a truly competitive market or a cost-audited market. In its analysis the ISO determined that in the ancillary services market, the competition level was sufficient to establish a tender for secondary frequency control (SFC) and tertiary frequency control (TFC) services [3]. Thus, the ISO proceeded establish a market to tender reserves.

On January 1<sup>st</sup>, 2020, a daily tender for reserves began operating in Chile. Prior to establishing the tender, reserves were allocated based on audited costs. Thus, the reserves were allocated by determining the opportunity costs of not supplying energy to the system. In the new scheme, the energy market remains cost-audited, but part of the ancillary service market is now bid based. In the daily tender for secondary frequency control (SFC) and tertiary frequency control (TFC) services, market participants submit bids to the ISO and compete to supply the reserves based on their bids, not their audited costs. Therefore, operational reserves are now under a *pay-as-bid* payment scheme, similar to Australia and PJM [4] [5]. The daily tender in Chile is cleared through the following steps [4]:

1. The bidding period starts at 6pm two days prior to market operations.
2. The bidding period ends at 11 am the day prior to market operations.
3. The ISO runs a security constrained unit commitment which considers the bids submitted by the participant and which supplies the demand at a minimum cost, subject to reliability constraints.
4. At 6pm the day prior to market operations ISO publishes the winning bids and the maximum prices for reserve services.

In the procedure prior to the establishment of the tender, the reserves were allocated running a security constrained unit commitment which assigned reserves based on audited costs. With the establishment of the new tender, the security constrained unit commitment is still used to allocate reserves, however prices submitted in the bids are used instead of the audited costs. In both procedures, the amount of reserves allocated have to meet the reserve requirements established by the ISO.

The objective of this paper will be to assess the performance of the newly established tender for frequency regulation services in Chile and identify opportunities to for improvement. The assessment will be performed by comparing the performance of the planned operations of the electricity system under the new bid-based mechanism and the previously used cost-audited mechanism. Specifically, by comparing the resulting planned system operational costs and reserve allocation of the previous and current procedure to allocate reserves (in the day ahead program). Further, the differences in the allocation of programed reserves by using the existing and the previous procedure will be analyzed.

## Methodology

The methodology used for the development of the paper consists of four parts. For the first part, the old and new Chilean ancillary services market structures (i.e. without and with auction scheme) will be briefly characterized, the analysis will aim to highlight the main differences between the market structures and present the implications for the operations of the power system. A conceptual analysis of the existing regulation and procedures will be performed. During this first stage, relevant previous research and reports will also be reviewed and analyzed [7].

As a second step, the day ahead programs published by the ISO from January 1<sup>st</sup> to March 31<sup>st</sup>, 2020, which contain the results a security constrained unit commitment considering the bids, will be analyzed. To determine the day ahead program the ISO uses PLEXOS, which simulates the security constrained unit commitment. The simulation conducted to determine the day ahead program co-optimizes the cost audited energy production costs of generation facilities and the price bids<sup>1</sup> for reserves submitted through the new tender. Since the bids themselves are not published until three months after the tender, it is not possible to fully replicate the ISOs day ahead market simulation. Therefore, the results will be extracted directly from the day ahead plans published by the ISO without conducting further simulations.

The third step will consist of using the day ahead plans published by the ISO and PLEXOS to simulate an alternative program for each day between January 1<sup>st</sup> and March 31<sup>st</sup>, 2020 considering the audited variable costs of the units, instead of the bids. In the alternative program the reserves will be determined by the model based on the opportunity costs of not providing energy, using the audited variable costs of the units. As performed prior to the establishment of the new reserves tender. The alternative program simulation will produce comparable results to those published by the ISO as part of the day ahead program, except the results of the alternative program will be produced considering audited costs instead of bids to allocate the system's reserves and determine the optimal systems operations.

The last step will consist of comparing the results of the day ahead program produced by the ISO considering the bids and the alternative program generated considering audited costs instead of bids. The main goal of the comparison will be to identify significant changes in the reserve allocation results for both programs and determine the differences in operational performance, with a special focus on the resulting differences in total operational costs. The analysis will help identify some of the challenges and opportunities created by the structure of the new ancillary services market, as well as its impact on the energy market. Finally, recommendations to improve the current market structure will be presented. These recommendations could be in the form of potential policy or operational improvements.

## Expected Results

The following are the expected results which will be presented as part of this paper:

1. A review of the Chilean ancillary services market rules (DS 113), the main modifications introduced in the Law 20.936 in year 2016, specifically those define in Article 72°-7 and the procedures defined for the new reserve tender mechanism defined by the ISO.
2. An overview of the impact the new ancillary services market has had on the operations of the Chilean NES. The impact will be determined by comparing the planned system operations considering the existing reserves tender compared to the previous mechanism.
3. An identification of the opportunities and challenges introduced by the new market mechanism.

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<sup>1</sup> According to the current Ancillary Services Market structure, just the prices for the reserves decided by the generator not the quantity. The quantity of available reserves depends just on the generator's technical specifications.

4. Policy and operational recommendations to improve the performance of the electricity system operations and the procedure to allocate reserves will be presented.

## References

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