D2.1-CL, November 2019

Auctions for the support of renewable energy in Chile

Main results and lessons learnt

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1 Characteristics of RES-E auctions in the country

1.1 Goals of the government with organizing auctions

Several context conditions should be taken into account in Chile, as they influence goals in the energy realm and the design of policies. These include significant increases in electricity demand (42% between 2006 and 2016) in the context of the four isolated electricity systems in the country (although they are now more interconnected) and low international interconnections (effectively, an electricity island), importance of the mining industry in total electricity demand (about 37%) and in its electricity consumption profile (relevance of night consumption), huge RES resources but not significant fossil-fuel reserves, problems with imports of Argentinian gas, high shares of fossil fuel imports and ambitious climate change targets as well as traditionally relatively costly electricity for final consumers (IEA 2018).

Chile's power mix is still dominated by fossil-fuel sources. The share of coal in power generation rose from 10% in 2003 to 24% in 2008/09 and has continued to grow fast (IEA 2018). In October 2019, the share of thermal energy sources in electricity generation was: coal (33.6%), gas (13.4%) and oil (0.1%). Large hydro accounted for 28.6% and non-conventional renewable electricity sources accounted for the rest: PV (10.3%), wind (8.4%), small hydro (3.1%), biomass (1.9%), biogas (0.3%) and geothermal (0.2%). The share of thermal energy sources in installed capacity is 52% and large hydro accounts for 24.7%. Regarding non-conventional renewable electricity sources, the shares of each technology in installed capacity is similar to their share in electricity generation as of October 2019: PV (10.5%), wind (8.3%), small hydro (2.1%), biomass (1.6%), biogas (0.2%) and geothermal (0.2%).

Given the aforementioned context conditions, Chile seems to have four main energy policy goals: to reduce end-use electricity prices for the consumer and increase competition in electricity market(s), to reduce outages, to facilitate the system integration of RES and to reduce CO2 emissions (see, e.g. IEA 2018). In this regard, the aim of the tenders law (Law 20805) in 2015 was to reduce electricity tariffs and encourage market competition (IEA 2018, p.93). The auctions in Chile are technology-neutral and include fossil-fuels. Although the government introduced auctions in the 2005 mechanism with the goal of providing transparent market prices, reduce uncertainty for investors, and foster competition among new entrants and existing providers, the Chilean government enacted Law 20805 which made several changes to the auction design with the objective of allowing RES to be more competitive in the auctions (Nasirov et al 2019, p. 3): it included hourly supply blocks and a price revision mechanism where the price may be modified in the event of significant and unexpected legal, regulatory, or fiscal changes (Nasirov et al 2019, p.3). The possibility to consider indexation factors when assessing the bids (levelised price) was also a new design element being adopted in this auction.

Moreover, although according to the IEA the reliability performance of the electricity sector has clearly improved (electricity outages have declined from around ten hours in 2012 to around eight hours in 2016), the National Energy Policy set the target that electricity outages should not exceed one hour per year in any location in Chile in 2050 (IEA 2018, p.109). Wind and solar have taken the majority of the market to meet incremental electricity demand of the main electricity system. Also, around 2014 when the government realized that there would be a significant influx of variable energy sources into the power system, the system integration of renewables quickly became a policy priority (IEA 2018, p.101).

Finally, reducing GHG emissions is a main goal of the Chilean government and targets for GHG emissions reductions and RES quota in electricity generation have been set. Chile, which ratified the Paris Agreement in 2017, has the target to reduce the GHG intensity of its economy by 30% from the 2007 levels in 2030. If international financial support is granted, this commitment increases to 35-45% (IEA 2018, p.112). The RES quota in electricity generation is 60% in 2035 and 70% in 2050.

While the above are general energy policy goals, there are also goals which are more specific for the auctions. According to the National Energy Commission (CNE), the goal of the auctions is that "electricity distribution companies have long-term supply contracts in order to meet the electricity consumption of those clients which are subject to price regulation (consumers and SMEs)" (CNE 2017).

Three auctions have been carried out under the auction law 20805. The focus of this report is on the 3rd one.

The two previous auctions were analysed in del Río (2017). The third call for tenders, launched in 2017, includes seven Supply Blocks which are made up of the hourly blocks numbers 1A, 1B and 1C, totalling 1,700 GWh, and the quarterly blocks numbers 2A, 2B, 2C and 2D (with a total of 500 GWh of energy), all in force from January 1st 2024 to December 31st 2043.

The previous auction in Chile (Licitación de Suministro 2015/01) was the largest one with a volume of 12430 GWh. It was analysed in del Río (2017). The first one (Licitación de Suministro 2015/02) was very small (a volume of only 1200 GWh). The present report focuses on the third one (Licitación de Suministro 2017/01), with a volume of 2200 GWh. This last auction includes changes in the design elements which make it slightly different to the previous ones, although the basic design does not change.

1.2 Main pillars of the RES-E support policy in Chile

Several policies and measures are envisaged to promote RES-E generation in Chile, including (IEA 2018, p.147): Renewable-energy quota obligation on electricity suppliers, auctions by the distribution companies to supply electricity to regulated customers, encouraging distributed generation and self-consumption, facilitating grid access for renewable-energy plants, enabling the integration of variable renewable energy into the power system, improving the framework for geothermal exploration and exploitation and facilitating the financing of renewable-energy projects and raising awareness. The RPS deserves a special mention. It sets targets for the electricity sold by generators with an installed capacity of over 200 MW. An increasing percentage of this electricity must come from RES, reaching 20% in 2025 (Nasirov et al 2019, p.5).

1.3 Design elements of RES-E auctions

The following tables provide details on the design elements of the 2017 auction in Chile.

Table 1: Main characteristics of auctions and framework conditions.

Characteristics	Description of the auction
Characteristics of the national electricity market	Only generators may sell or buy electricity on the spot market. Power plants are dispatched in a merit order using regulated estimates of their marginal costs (audited variable costs). The marginal costs of the system are calculated on an hourly basis for each node of the system (IEA 2018). Three types of sales by the electricity generation sector can be distinguished: Sales between generators (spot market), sales to free clients (large consumers) and sales to regulated clients (electricity auctions)(Lühr 2019) Generators can sell their electricity to large consumers at a freely agreed price. In contrast, electricity sales to distribution companies with regulated customers are organised through tenders for long-term supply(IEA 2018). In the auctions, there is a bilateral contract between the awarded winner and the distribution companies. This contract sets a maximum

	annual amount of energy committed by the awarded bidder (Lühr 2019).
Name of auction scheme	Licitación Pública Nacional e Internacional para el Suministro de Potencia y Energía Eléctrica para Abastecer los Consumos de Clientes Sometidos a Regulación de Precios, Licitación Suministro 2017/01.
Contractual counterparties (auctioneer, provider of support)	Auctioneer: National Energy Commission Off-takers: distribution companies
Main features	Static, PAB, price-only, technology-neutral, multi-item auctions.Bidders compete either for time (hourly) or seasonal (quarterly) blocks.
Technology focus and differentiation (eligible technologies)	Technology-neutral auctions (including fossil-fuel sources) for long-term PPAs (20 years)
Lead time before auction	9 months. Approval of Bases: January 2017. Submission of bids: October 2017
Min./max. size of project	Neither maximum nor minimum sizes are required.
What is auctioned? Auctioned bids (in terms of budget, electricity or installed capacity)	Electricity (GWh)
Budgetary expenditures per auction and per year	Undefined
Frequency of auctions	Not previously set schedule. They have taken place every year or every two years.
Volume of the tender	2.200 [GWh/year], divided into 7 supply blocks: Volume defined per block. Two types of blocks (hourly and seasonal)(see Table 3 for details).
Costs related to grid connection/access	Grid connection costs fall on the awarded bidder.
Balancing and profile costs	Unavailable.

Table 2: General auction design.

Design elements	Description
Auction format	-Multi-unit auction -Static auction
Pre-qualification requirements - Financial	-Three years' worth of company accounts proving financial solvency (IRENA, 2017). -Three types of guarantees: 1. Any generator who wins a contract must be a registered company in Chile and her bond rating must be BB+ or higher. Alternatively, if the generator is not yet registered in Chile, it must pledge a bid bond to back its bid. This bond is for 100 Unidades de Fomento (around 3700€) per GWh bid on for the last year of the contract. 2. The amount of the bid bond (Garantía de Seriedad de la Propuesta) will be UF 200 per GWh (i.e., 7400€/GWh) offered by the bidder. The Unidad de Fomento (UF) is a unit of account which is adjusted

	according to Chile's inflation. 1 UF = $ 26.561,42 Pesos Chilenos; € 1 Euro = $ 722,44 Pesos Chilenos; 1UF = 37€. This bid bond is maintained until 25% of the project is built (Lühr 2019) 3. The generator must pledge a bond to guarantee contract performance. A performance bond for UF 600 per GWh bid on for the last year of the contract (about 22200€/GWh) needs to be provided. The performance bond is redeemed if the generator does not meet its supply commitments. This bond is executed if the project is not built in the first year of electricity supply (Lühr 2019). Alternatively, the generator can take out an insurance policy for the same amount (UF 600 per GWh bid) (Muñoz and Galetovic 2017, CNE 2017). Insurances: To cover possible third-party damages during construction or operation of the new power plant, the winning generator must purchase insurance of up to US$3 million. There is an additional insurance of US$3 million to cover catastrophic risks during plant construction or subsequent operation.
Pre-qualification requirements - Material	-The bidder's credit rating (published by a reputable company) must meet minimal requirements. Bidders have to provide a report on their credit rating, elaborated by any of the entities included in Annex 3 of the tender documents (Feller-Rate, Moody's, Standard and Poor's, Fitch Ratings, Humphreys Ltda and ICR Chile Ltda). -A specific-purpose company must be formed in order to participate in the auction (if the bidder is not a limited company, it must choose a limited company in Chile as legal form). -Information that has to be provided by the bidders in order to back their bids. Among others: - Identification of existing and projected generation sources (name, type and installed capacity). - Name of the owner company of each generation source. - Location (existing or expected). - Estimated date of entry into operations. - Primary fuel and origin of the fuel. - Connection point (current or projected). - Physical features of the power lines. - Own production of energy in the last 5 years. - Copy of the balance sheets and consolidated income statements in the three years before the year of bid submission. - Commercial and financial background of the bidder (Muñoz and Galetovic 2017, del Río 2017).
Auction volume	2.200 [GWh/year], divided into 7 (hourly and quarterly) supply blocks.
Pricing rule	Pay-as-bid

Award procedure	Price-only. PAB. The auction is organised per Supply Block. A Supply Block is defined as "the maximum supply commitment that can be assumed by the bidder in its bid and represents the total amount of energy to be awarded by the bidders in the current auction for the corresponding period. Each Supply Block included in the current auction will be divided into Sub-Blocks for the purpose of submission of bids by bidders". Each Block includes a Base component and a Variable component (the latter represents 10% of the Base component). The Sub-Blocks have the same size (same quantity of annual energy). The auction uses the so-called *levelised price*, which is calculated on the basis of the bid price, the indexes chosen by the bidder and the projections of those indexes (ACERA 2017). See below and section 9.2.4.1.1 of the auction basis for further details.
Price limits	For each block, the maximum price of the bids was limited by the Reserve Price (81,500 USD/MWh) and the so-called "reserve margin" (margen de reserva): The bids above the ceiling price but less than 2.5% above that price are allowed to modify their offer price. Ceiling prices are not disclosed (they are disclosed before the publication of the winning bids but after the bidders send their bids). Under the previous Law 20805, the ceiling price was disclosed before the bids were submitted.
Support period	20 years: January 1st 2024 – December 31st 2043
Favorable treatment of specific actors	No
Realization time limit	January 1st 2024
Penalties	Failure to deliver energy in the contracted supply blocks (whether hourly or quarterly) requires projects to settle the difference at spot market prices (Kruger et al 2018, p.32). There is a "technical audit" which controls the achievement of building milestones and a fine of 30 UF/GWh for non-compliance with two milestones is charged (Lühr 2019).
Form of support auctioned	-Electricity generation-based support. No specific RES-E support is auctioned, instead generators compete for PPAs through technology-neutral electricity auctions.
In case of premium schemes describe the method of reference wholesale price calculation	-
Support level adjustments	Contracts are denominated in USD and adjusted periodically according to the indexation factors chosen by the awarded winners (e.g., United States' Consumer Price Index).
Transferability of support right	Yes.

Other	- The terms and conditions of the bidding procedure provide a polynomial with several indexes, including a fuel price index. Bidders may build their own indexation formula, and decide on their own weights. Bids for RES-E were 100% indexed to the US CPI, instead of being indexed to fuel prices. It should be taken into account that the bid price is not the only element being assessed. A LEC is calculated in order to compare bids which are indexed to different indexes. Those bids being indexed to fuel (i.e., not to the CPI), are more expensive, since fuel prices are expected to grow more than the US CPI. - The auction terms and conditions also allow start-up of the project backing the contract to be postponed for up to two years, paying a fine of UF10 per month of delay for each GWh contracted (only in case of causes attributable to the bidder)(1 UF=35€ as of August 29th 2019 https://es.coinmill.com/CLF_EUR.html). - Within the first three years of signing the contract, and on the grounds of third-party liability, the generator can request abandonment of contract by paying UF 360 per GWh that should have been supplied over the last year (del Río 2017).

Compared to the previous two auctions, the following innovations in design are now in place:

- Seasonal (quarterly) blocks (in addition to hourly blocks).

The main innovation with respect to the previous auctions was the adoption of the quarterly blocks, in addition to the hourly blocks. The goal of the hourly blocks is to get the lowest price for every 24 hour period possible. The goal of the quarterly block is to lower annual prices. In this case, seasonal renewables may have an advantage. Hydro energy is more readily available in winter: the second and third quarters of the year. Similarly, Patagonian wind tends to peak in summer (fourth and first quarters) (James 2017). The following table provides details on the blocks being auctioned in the 2017/01 Auction. The "Variable" component represents 10% of the energy required in the "Base" component.

Table 3. Characteristics of the blocks auctioned in the Auction 2017/01

Type of supply	Number of the Supply Block	Details of the Block	Base energy being auctioned (GWh/year)	Variable energy being auctioned (GWh/year)	Total energy being auctioned (GWh/year)	Number of sub-blocks	Size of sub-blocks (GWh/year)
Hourly	1-A	00:00hrs-07:59hrs and 23:00hrs-23:59hrs	480.0	48,0	528	85	6.2
	1-B	08:00hrs-17:59hrs	707.3	70,7	778	85	9.2

	1-C	18:00hrs-22:59hrs	358.2	35,8	394	85	4.6
Quarterly (seasonal)	2-A	01 Jan – 31 Mar	113.6	11,4	125	25	5.0
	2-B	01 Apr – 30 Jun	113.6	11,4	125	25	5.0
	2-C	01 Jul – 30 Sep	113.6	11,4	125	25	5.0
	2-D	01 Oct – 31 Dec	113.6	11,4	125	25	5.0

Source: ACERA (2017).

- Bids with restriction.

The auction included the possibility to submit bids with restrictions between the blocks of the same type (hourly or quarterly). For example, as explained by ACERA (2017), a bidder could provide a bid in the Supply Block number 1A, one in the Supply Block 1B and another in Supply Block 1C subject to the condition that all of them are awarded.

- Sub-blocks mechanism.

There was a possibility to specify a minimum number of sub-blocks in the bid. 63% of the bids used this mechanism (ACERA 2017).

- Award Mechanism.

In the evaluation of the bids, the hourly blocks were awarded first, followed by the quarterly blocks (ACERA 2017). Those bids with a restriction which had been submitted in the hourly blocks, and which had not been awarded will jointly participate in the award procedure of the quarterly blocks. In this case, the bid price will be the weighted average price offered in the hourly blocks (ACERA 2017).

- More stringent financial prequalification requirements.

Compared to previous auctions, in this one there was an increase in the bid bonds required. Both the bid security bond and the performance bond doubled from 100 UF/GWh to 200 UF/GWh and from 300 UF/GWh to 600 UF/GWh, respectively. In addition, the government announced in 2017 new rules for upcoming auctions, with higher penalties for project cancellations, to minimise unrealistic bids and ensure project delivery (IEA 2018).

1.4 Further regulations supporting auctions

Other policies which support the auctions results can be summed up as follow:

- Small RES generators (< 9MW) are exempted from the transmission toll.
- Removal of the costs of the transmission grid from the generators. The law guarantees non-discriminatory open access to the transmission grid. It also changes the way the access charges (transmission tolls) are paid. Under the 2016 law, the tolls are borne completely by the consumers. Previously, they were paid 80% by the generators and 20% by the consumers in the former Area of Common Influence. Removing the costs of the transmission grid from the generators enables variable renewable energy (VRE) developers to choose more-distant and resource-rich areas for generation (IEA 2018).

2 Evaluation of the auction results

Efficiency

Given the very low weighed average price of **32.5 USD/MWh,** the *efficiency* of the auctions seems to have been high, both with respect to international experiences (James 2017) and previous auctions in Chile. The average prices in the previous auctions were 47.6 USD/MWh (see more below). This is probably related to the high level of competition. 24 firms participated, with 193 bids, a total volume of 22098 GWh and a maximum amount of energy which can be awarded of 12,109 GWh/year, which is about 5.5 times the volume of the auction.

According to ACERA (2017), only one bidder submitted a price which was above the reserve price and this bidder changed his/her bid, as indicated in the bidding bases. The following table provides details on the prequalified bids.

Table 4. Prequalified bids.

Number of Block	Energy auctioned (GWh/year)	Number of bidders	Number of bids submitted	Number of bids submitted (range of sub-blocks)	Energy offered (GWh/year)	Minimum price offered (USD/MWh)	Maximum price offered (USD/MWh)	Average price offered (USD/MWh)
1-A	528.	16	32	19	5833	25.389	77952	48.206
1-B	778	16	31	27	10032	21.480	77.952	36.415
1-C	394	17	33	23	4589	25.389	77.952	47.518
2-A	125	4	7	3	395	39.150	57.350	52.265
2-B	125	4	7	3	395	39.150	57.350	52.265
2-C	125	5	10	4	430	39.150	63.050	55.486
2-D	125	5	10	3	425	39.150	63.050	55.486
Total	**2200**	**21**	**130**	**82**	**22098**	**21.480**	**77.952**	**46.777**

Source: (ACERA 2017).

There was more competition (bidders and bids) in the hourly than in the quarterly blocks. According to ACERA (2017), this might be related to the fact that the auction allowed to carry out a "transfer of bids" from the hourly blocks to the quarterly blocks if some conditions were fulfilled when the bids were submitted. Overall, 60 bids were submitted for the hourly blocks (14680 GWh), which were "bids with restrictions", i.e. each would be offered in the quarterly blocks in case they were not awarded in the hourly block (ACERA 2017, p.5).

The following table provides details on the awarded bids per block.

Table 5. Results of the awarded bids per block.

Supply Block	Total energy being auctioned (GWh/year)	Total energy being awarded (GWh/year)	Average awarded bid price (USD/MWh)
1-A	528	528	31,8
1-B	778	778	31.6
1-C	394	394	31.8
2-A	125	125	35.3
2-B	125	125	35.3
2-C	125	125	35.3
2-D	125	125	35.3
Total	**2200**	**2200**	**32.5**

Source: CNE 2017.

The prices for the awarded bids could be compared to prices in the SIC system of 45$/kWh in 2017, according to official data from the National Energy Commission (2019).

There were 3 awarded bidders per hourly block and 5 awarded bidders per quarterly block.

The bids awarded in the quarterly blocks had originally been submitted but not awarded in the hourly blocks (i.e., bids with restrictions). These bids competed with the bids originally submitted in the quarterly blocks (ACERA 2017). The hourly blocks had the largest volume of energy being offered, as well as the highest and the lowest bids (ACERA 2017). The following table provides more details on the bids awarded.

Table 6. Bids awarded.

Supply Block	Awarded bidder	Sub-blocks awarded	Energy awarded (GWh)	Bid price (USD/MWh)
1-A	Enel Generación Chile S.A.	57	354.1	34.679
1-A	Energía Renovable Verano Tres SpA	27	167.7	25.389
1-A	Cox Energía SpA	1	6.2	40.771
1-B	Enel Generación Chile S.A.	57	521.7	34.679
1-B	Energía Renovable Verano Tres SpA	27	247.1	25.389
1-B	Cox Energía SpA	1	9.2	26.829
1-C	Enel Generación Chile S.A.	57	264.2	34.679
1-C	Energía Renovable Verano Tres SpA	27	125.2	25.389
1-C	Cox Energía SpA	1	4.6	40.771
Total		**255**	**1700**	**31.7**

Supply Block	Awarded bidder	Sub-blocks awarded	Energy awarded (GWh)	Bid price (USD/MWh)
2-A	Atacama Energy Holdings S.A.	6	30	34.098
2-A	Enel Generación Chile S.A.	2	10	34.679
2-A	Cox Energía SpA	3	15	34.390
2-A	Cox Energía SpA	3	15	34.463
2-A	Atacama Solar S.A.	11	55	36.500
2-B	Atacama Energy Holdings S.A.	6	30	34.098
2-B	Enel Generación Chile S.A.	2	10	34.679
2-B	Cox Energía SpA	3	15	34.390
2-B	Cox Energía SpA	3	15	34.463
2-B	Atacama Solar S.A.	11	55	36.500
2-C	Atacama Energy Holdings S.A.	6	30	34.098
2-C	Enel Generación Chile S.A.	2	10	34.679
2-C	Cox Energía SpA	3	15	34.390
2-C	Cox Energía SpA	3	15	34.463
2-C	Atacama Solar S.A.	11	55	36.500
2-D	Atacama Energy Holdings S.A.	6	30	34.098
2-D	Enel Generación Chile S.A.	2	10	34.679
2-D	Cox Energía SpA	3	15	34.390
2-D	Cox Energía SpA	3	15	34.463
2-D	Atacama Solar S.A.	11	55	36.500
Total		100	500	35.3

Source: CNE 2017

The National Energy Commission announced the result of the auction with some fanfare: "The lowest value of energy in the history of auctions in Chile" (CNE 2017). In fact, it is not only the auction with the lowest prices under the Law 20805. It has also lower prices than any of the auctions organized before 2015 (Table 7). The lower prices have gone in tandem with the higher number of participants. In the 2012 tender, there was just one participant. In 2013, two generators participated. In both tenders, the highest prices resulted. Since then, the number of participants have increased per volume awarded (until 2017, also in absolute terms) (IEA 2018, p.94).

Table 7. Average prices, electricity volumes awarded and number of bidders in Chile's electricity auctions.

	2006	2007	2008	2010	2012	2013	2014	2015	2016	2017
Bidders (nº)	N.A.	N.A.	N.A.	N.A.	1	2	18	38	84	24
Volumes awarded (GWh/year)	13206	7500	11286	2200	1172	3900	12705	1200	12430	2200
Number of bidders per GWh awarded (nº/GWh)*100	-	-	-	-	8.5	5.1	14.1	316.6	67.5	109.0
Prices (USD/MWh)	53.1	61.2	100.7	90.3	131.4	128.9	108.4	79.3	47.6	32.5

Source: Own elaboration based on data from Venegas (2017) and IEA (2018).

The results show that the lowest-price bids were awarded in the hourly blocks, but also the most expensive ones. However, on average the energy auctioned has been at a lower price in the hourly blocks than in the quarterly ones. ACERA (2017) argues that there are two reasons for the low bid prices in the hourly blocks:

1) Given that the hourly blocks have a more precise time definition than the quarterly blocks, they end up being a more specific bid product, which allows bidders to submit more competitive bids.

2) In addition, the potential transfer of bids from the hourly to the quarterly blocks. In fact, the bids which were finally awarded in the quarterly blocks had originally been submitted in the hourly blocks. This explains that the average prices of the bids awarded in the quarterly blocks are lower than the minimum prices offered in each of them (ACERA 2017, p.10). The lowest prices corresponded to PV, wind and CSP (ACERA 2017, p.12)[1].

In a press statement, Andrés Romero, Executive Secretary of the National Energy Commission (CNE), argued that "today the price which households are paying is 90 USD/MWh. They are the result of contracts which were signed until 2014. We now expect that, with this auction, the prices will go gradually down to 50 USD/MWh, which will benefit households" (CNE 2017). ACERA (2017) calculated that the presence of RES in the 2017/01 auction led to savings for the final consumers in the order of 946 million dollars (ACERA 2017, p.13). However, these savings will only be achieved in the long-term.

All in all, the approach for electricity auctions in Chile seems to be to minimise direct costs, and not system costs (as in Mexico). The best-suited areas for both solar and wind are far away from load centres (cities) located in the centre of the country. Climatic conditions and distance from the load centres make deployment in these areas relatively more difficult (IEA 2018).

[1] Individual bids, not bids offering a mix of those technologies.

Effectiveness

Regarding effectiveness, some authors are concerned that the time allowed for project completion (projects have to start producing electricity in 2024, i.e., 6 years after being priced, in October 2017) may be too long and there could be a risk that something happens until then that prevents meeting the deadline. This 6-year period certainly is an opportunity for bidders to wait for the price of solar panels to drop further. But, as argued by James (2017), things may happen in the meantime which may lead to prices not evolving as expected: panel cost declines are starting to flatten out and the likelihood of continued significant price drops decrease, interest rates which are low now may increase and international trade agreements, firmly in place when the auction was organized, may be affected by the trade war.

This concern may be aggravated by the fact that the government allows up to five years "to postpone the term of beginning of the energy supply or put an early termination to the contract if, for reasons not attributable to the successful bidder, its generation project is delayed or it becomes unviable", according to article 135 ter of Law 20805 (López 2018). New projects may postpone or cancel their supply in the case that the projects are delayed by processes that their developers cannot control (IEA 2018, p.94).

While it is also too early to analyse the effectiveness of the two previous auctions organized under the new Law 20805 (auctions 2015/1 and 2015/2) there are some signs that penalties and financial prequalification requirements in those two auctions were not stringent enough. Kruger et al (2018, p.33) argue that the Chilean auctions have some of the lowest qualification requirements. In the last auction (2017), the financial guarantees increased substantially with respect to previous auctions. Both the bid security bond and the performance bond doubled from 100 UF/GWh to 200 UF/GWh and from 300 UF/GWh to 600 UF/GWh, respectively (CNE 2017). On the other hand, in January 2017, the CNE announced new rules for the auctions, which include higher penalties for project cancellations to reduce unrealistic bids and to ensure project delivery (IEA 2018, p.94).

Notwithstanding, it should be taken into account that, in case of failing to meet the electricity generation commitments, the legislation allows for specific auctions only for renewable energy, if insufficient progress has been made towards meeting the renewable-energy targets set by law. The Ministry of Energy must monitor the compliance with these targets. Every three years, the Ministry estimates the likely share of electricity generated from RES in the forthcoming years, considering the existing and under-construction projects. So far, such auctions have not been needed, as the yearly NCRE target has always been met (IEA 2018, p.148).

Regarding the technological diversity in this technology-neutral auction, the projects awarded have been all RES projects, mostly PV and wind (table 8).

Table 8. Technologies in the awarded projects

N°	Name of bidder	Project	Technology	Net installed capacity (MW)	Region
1	Atacama Energy Holdings SpA	Parque Eólico Punta de Talca	Wind	86.4	Coquimbo
2	Atacama Energy Holdings SpA	Parque Eólico Campo Lindo	Wind	126	Biobío
3	Atacama Energy Holdings SpA	Parque Eólico Los Trigales	Wind	154.8	La Araucanía
4	Atacama Energy Holdings SpA	Parque Eólico Victoria	Wind	259.2	La Araucanía
5	Atacama Solar S.A.	Parque Fotovoltaico Atacama Solar	PV	250	Tapacá

6	Cox Energía SpA	Parque Fotovoltaico Sol de Vallenar	PV	250	Atacama
7	Enel Generación Chile S.A.	Not yet defined	PV	116	Antofa-gasta
8	Enel Generación Chile S.A.	Not yet defined	Wind	93	La Arau-canía
9	Enel Generación Chile S.A.	Not yet defined	Geothermal	33	Antofa-gasta
10	Energía Renovable Verano Tres SpA	Parque Solar Punta del Viento	PV	165	Coquimbo
			Total (MW)	1.533,4	

Source: Own elaboration based on CNE data.

According to Lühr (2019), bids for non-conventional renewable energy sources accounted for 27% of the energy offered and 46% of the energy awarded in the auction. Bids from renewables for the energy offered were from CSP (9% of the energy offered), PV (6%), wind (6%), solar/wind (3%), biomass (1%) and hydro (1%). The percentages of the energy awarded to renewable energy sources is as follows: solar/wind (25% of the energy awarded), solar (16%) and wind (5%)(Lühr 2019). As it can be observed in the next table, CSP, small hydro, natural gas and biomass were not awarded given their relatively high average bids.

Table 9. Average offered and awarded prices.

Technology	Average offered price (USD/MWh)	Average awarded price (USD/MWh)
Solar/wind	26.2	25.4
Solar	35.7	33.6
Existing mix	38.8	34.7
Wind	46.8	34.1
CSP	48.1	-
Small Hydro	57.0	-
Natural gas	75.4	-
Biomass	82.4	-

Source: Lühr (2019)

Although the auction is officially technology agnostic, it is designed in a way which favours certain technologies. There is a consensus that the design of the hourly blocks and the quarterly blocks favour the participation of RES, attracting more bids and encouraging competition (Romero 2017, López 2018, James 2017, Kruger et al 2018, Deign 2017, IEA 2018).

Whereas quarterly blocks benefit wind and hydro, the hourly blocks particularly benefit PV. Historically, the tenders for electricity supply for regulated customers held for flat blocks of electricity for a whole year were

in principle compatible with wind power. It exposed solar generators to considerable short-term price risk, especially during night-time hours, as they would have had to purchase on the wholesale market the electricity they could not generate (IEA 2018, p.103). The introduction of the daylight block was particularly beneficial for PV, since it can only bid in this block, in line with its generation profile. Whereas PV plants are more restricted in the range of generation blocks they can bet on, those including wind or other generation sources in their portfolios have been able to bid for nighttime electricity supplies where there is less competition (Deign 2017).

Regarding actor diversity, according to CNE (2017), the auctions have favoured the participation of new actors in the electricity market, most of which belong to the renewable energy world. However, awarded bids are concentrated in a few firms (only 5). The following table provides details on the amount of energy awarded to each bidder. According to ACERA (2017), the bids submitted were backed by both new projects and (53%) and existing projects (47%).

Table 10. Awarded bidders.

Awarded bidder	Awarded energy (GWh)	Average bid (USD/MWh)	Participation
Enel Generación Chile S.A.	1180	34.7	54%
Energía Renovable Verano Tres SpA	540	25.4	25%
Atacama Solar S.A.	220	36.5	10%
Cox Energía SpA	140	34.4	6%
Atacama Energy Holdings SpA	120	34.1	5%
Total	**2200**	**32.5**	**100%**

Source: (CNE 2017)

3 Conclusions

Regarding the "efficiency" indicator, the case study of Chile shows that RES can successfully compete with fossil-fuel technologies in technology-neutral auctions, especially if designed in a way which takes into account their dispatch profiles. RES projects will be built without subsidies. This case shows that the trade-off between increasing the share of RES and higher (retail) electricity prices can be a thing of the past. It can show the way to other countries that still publicly support RES, although it should be taken into account that Chile has a huge potential for renewable energy production, given its excellent resources.

In reality, this case can also be regarded the other way around: it suggests that market design can adapt to take into account RETs which have matured to the point that they can generate electricity at competitive prices, but with a given dispatch profile.

In addition to the hourly and quarterly blocks, RES investments have benefited from the setting of long-term contracts. However, often times auction design involves difficult trade-offs. A drawback of those long-term contracts is consumer lock-in, i.e. it deters competition for a long time, excludes consumer choice and hinders competition on additional services by retailers (IEA 2018, p.108).

The (maybe too) long realization periods represent a source of concern regarding the effectiveness of the scheme. Although this probably facilitates the closing of finance, a shorter period would have probably been less risky from an effectiveness point of view.

Finally, it should be taken into account that the auction design is not the only factor which may have promoted RES in the Chilen auctions. Nasirov et al (2019, p. 5) argue relevant factors in this regard include "technological advances, attractive business conditions, attractive renewable resource potentials, new transmission laws, high energy prices, expectations on cross-border energy trade, simplification of public land use procedures for renewable projects, and the Renewable Portfolio Standard (RPS) law".

4 References

ACERA (Asociación Chilena de Energías Renovables y Almacenamiento AG)(2017). Resultados del proceso de Licitación 2017/01. Análisis ACERA. Report. Santiago, Chile.

ACERA (2019). Estadísticas. Sector de generación de energía eléctrica renovable. October 2019. https://acera.cl/wp-content/uploads/2019/11/2019-10-Bolet%C3%ADn-estad%C3%ADsticas-ACERA.pdf

CNE (Comisión Nacional de Energía)(2017). Valor de la energía más bajo en la historia de las licitaciones en Chile. Retrieved from: https://www.cne.cl/prensa/prensa-2017/11-noviembre-2017/valor-de-la-energia-mas-bajo-en-la-historia-de-las-licitaciones-en-chile/

CNE (2019). Estadísticas. Precios. https://www.cne.cl/estadisticas/electricidad/

Deign, J. (2017). Chile's Latest Auction Signals Growing Interest in Solar-Plus-Storage. Retrieved from: https://www.greentechmedia.com/articles/read/chile-auction-signals-growing-interest-solar-plus-storage

IEA (2018). Energy policies beyond IEA countries: Chile. Retrieved from: https://www.iea.org/publications/freepublications/publication/EnergyPoliciesBeyondIEACountriesChile2018Review.pdf

IRENA (2017). Renewable energy auctions. Analysing 2016. Retrieved from: https://www.irena.org/publications/2017/Jun/Renewable-Energy-Auctions-Analysing-2016

James, C.S. (2017). Chile's creativity comes to the fore in its 2017 energy auctions. The Latin American Energy Review (Sept. 2017). Retrieved from: https://carlosstjames.com/renewable-energy/chiles-creativity-comes-to-the-fore-in-its-2017-energy-auctions/

Kruger, W., Eberhard, A., & Swartz, K. (2018). Renewable energy auctions: A Global Overview. Energy and Economic Growth Research Programme. UKAid and University of Cape Town.

Lopez, L. (2018). Chile Launches 2018 Power Supply Auction. Retrieved from: http://cleanenergyamericas.org/blog/chile-launches-2018-power-supply-auction

Lúhr, C. (2019). Licitaciones de suministro en Chile. Presentation by Cristian Lühr, head of the Electricity Auctions Unit, National Energy Commission. May 2019.

Muñoz C & Galetovic, A. (2017). Energy Auctions in Chile: Guarantees and Leverage. Retrieved from: http://www.brevesdeenergia.com/blog/posts/energy-auctions-in-chile-guarantees-and-leverage/

Nasirov, S., Cruz. E., Agostini, C. and Silva, C. (2019), Policy Makers' Perspectives on the Expansion of Renewable Energy Sources in Chile's Electricity Auctions. Energies 2019, 12, 4149; doi:10.3390/en12214149

Romero, A. (2017). Licitaciones de suministro en Chile. Comisión Nacional de Energía. Report April 2017. Retrieved from: https://investchile.gob.cl/wp-content/uploads/2017/04/CNE-Licitaciones-Andrés-Romero_Abr-17.pdf

Del Río, P. (2017). Auctions for renewable support in Mexico: instruments and lessons learnt. Report of the EU-funded AURES project. Retrieved from: http://auresproject.eu/news/res-e-auctions-in-chile-mexico-peru-and-zambia

Venegas, J. (2018). Generación de energía solar en Chile: Situación actual y desafíos. Report presented at Proyecta Solar 2019. Retrieved from: https://acesol.cl/images/acesol2018/proyecta-solar-2019/9-30_1_Jose-Venegas-CNE-ACESOL-23-04-2019.pdf

AURES II is a European research project on auction designs for renewable energy support (RES) in the EU Member States.

The general objective of the project is to promote an effective use and efficient implementation of auctions for RES to improve the performance of electricity from renewable energy sources in Europe.

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