



Investors' Perspectives on the Expansion of Renewable Energy Sources in Chile's Electricity Auctions

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Presentation Outline

- Introduction & A little bit of history
- Early auctions, the transition & new auctions
- Research objectives & Methodology
- Results
- Discussion



A little bit of history

- Chile pioneered the deregulation of the electricity sector in 1982, establishing a market in generation and monopolies in transmission & distribution.
 - A spot price market was set up for the transactions among generators
 - Discos purchased energy at “bus price”, calculated by the government every six months.
 - The bus price was supposed to reflect an average of the spot price in time.

A little bit of history



- Spot Market
- Long-term power purchase agreements (PPAs)

In Chile, PPAs can be obtained:

- bilateral negotiations for non-regulated consumers based on freely defined conditions.
- through the energy auctions for regulated consumers

A little bit of history



- Auctions have become an effective procurement method for the expansion of renewable energy technologies in many countries.
- The number of countries using auctions to contract renewable energy capacity increased from 5 in 2005 to more than 67 in 2017, with a total capacity of 137 GW (Kruger et al. 2018).
- The adoption of renewable energies in South America, particularly in Chile, Brazil, Argentina, Uruguay, and Peru has been driven primarily by the implementation of renewable energy auctions

A little bit of history

- In 2005, the government established auctions as the mechanism to assign the long term supply of energy and capacity to distribution companies.
- The initial design of Chilean energy auctions aimed at ensuring security of supply for the regulated market



Early Auctions

- Between 2006 & 2015 the results of the auction processed were not promising

Process	Average Price (\$/MWh)	Price Ceiling (\$/MWh)	Auctioned Energy (GWh)	Awarded Energy (GWh)	Awarded Percentage
2006/01	52,91	62,69	13568	12076	89%
2006/01-2	54,55	62,69	1130	1130	100%
2006/02	59,77	61,68	14615	5700	39%
2006/02-2	65,8	71,06	9000	1800	20%
2008/01	104,31	125,16	8788	7821	89%
2008/01-2	99,49	125,16	935	935	100%
2010/01	90,3	92,04	2696	2200	82%
2012/01	129,45	129,5	924	924	100%
2012/01-2	138,9	140	1650	248	15%
2013/01	128,93	129	5000	3900	78%
Total			58306	36733	63%

Early Auctions



- Between 2006 & 2015 the results of the auction processed were not promising
 - 94% of the energy was awarded to the 3 main incumbent companies (Endesa, Colbún & AES Gener) and a 5% to Campanario, that never operated.
 - As of 2013, Chile has one of the highest energy prices in Latin America and the second highest among mining countries worldwide
 - Although renewable generators were not explicitly excluded, the regime of supply forced them out in practical terms (24-hour supply). In the period of 2005- 2014, renewable energies accounted for only 4 % of awarded energy in all the auctions.



The Transition

- As a results, the government undertook a reform of the auction system looking to:
 - Add new generation companies
 - Increase competition
 - Lower energy prices
 - Diversity the energy matrix



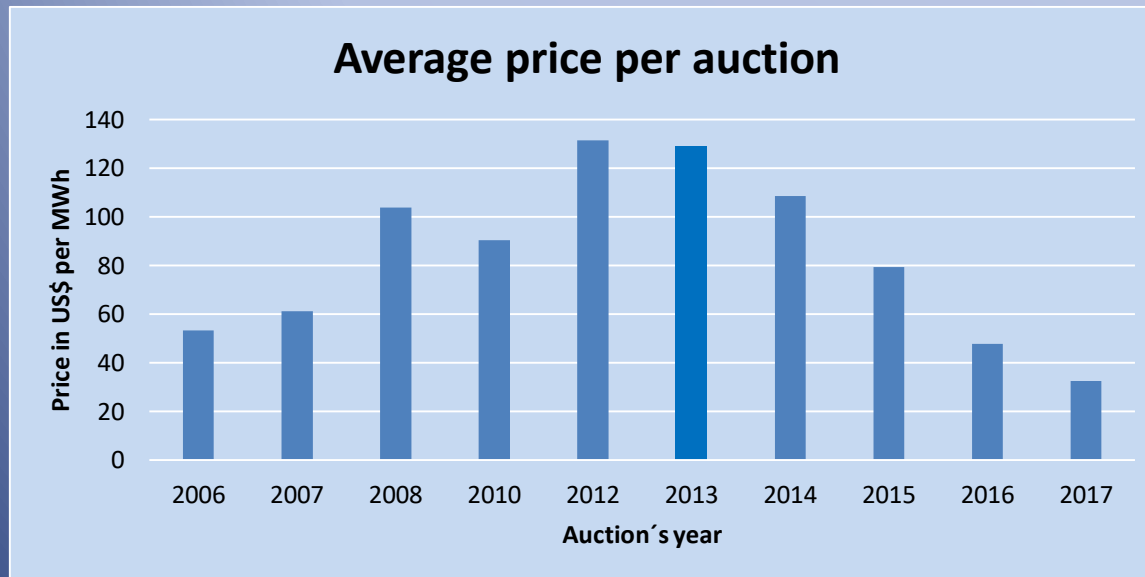
New Auctions

- In the 2016 auction, the energy offered was 7 times the awards; 22 winning bids out of 84; 2/3 of the awards went to wind and solar technologies; from incumbents only Endesa is awarded; other incumbents get nothing.

Companies	Country	Awards (GWh)
Mainstream	Ireland	3366
Endesa	Italy/Spain	5918
WPD	Germany	786.8
Ibereólica	Spain	1034.8
Acciona	Spain	506
Opde	Spain	176
Cox Energy	Spain	264
Solarpack	Spain	280
Besalco	Chile	10.4
Aela Energía	Chile	88
Total		12430

New Auctions

- Auction prices have declined by 75% from the average price of USD 130/MWh in 2012, reaching the average price of USD 35/MWh in 2017
- Solar PV technology set a record -low bid at \$US 21.48/MWh





Research Objectives

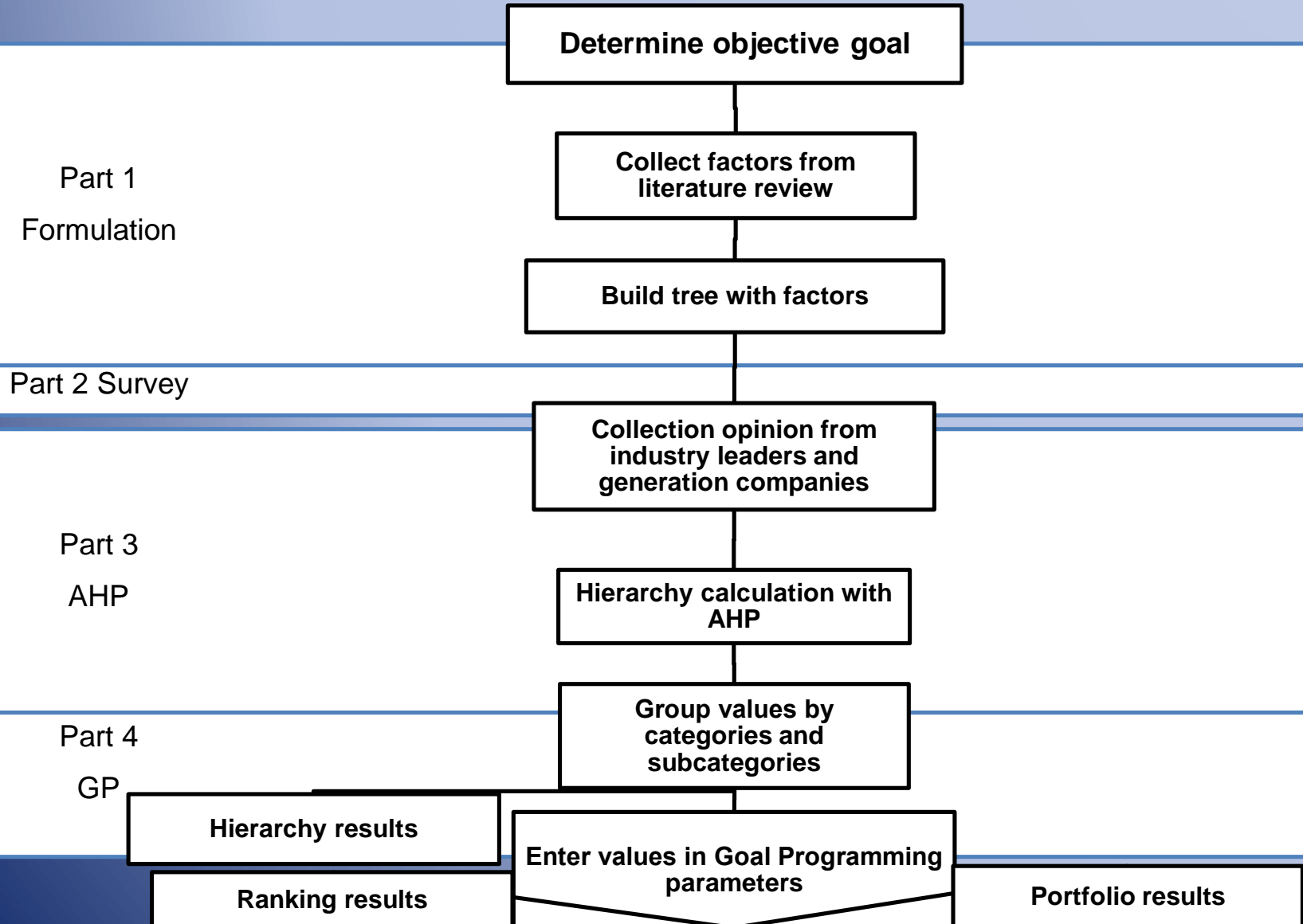
- Identify the factors that caused the change from a deficient auction system to a highly successful one
 - to identify, among all the factors, which are the most relevant in the decision from projects to participate in the auctions

Methodology

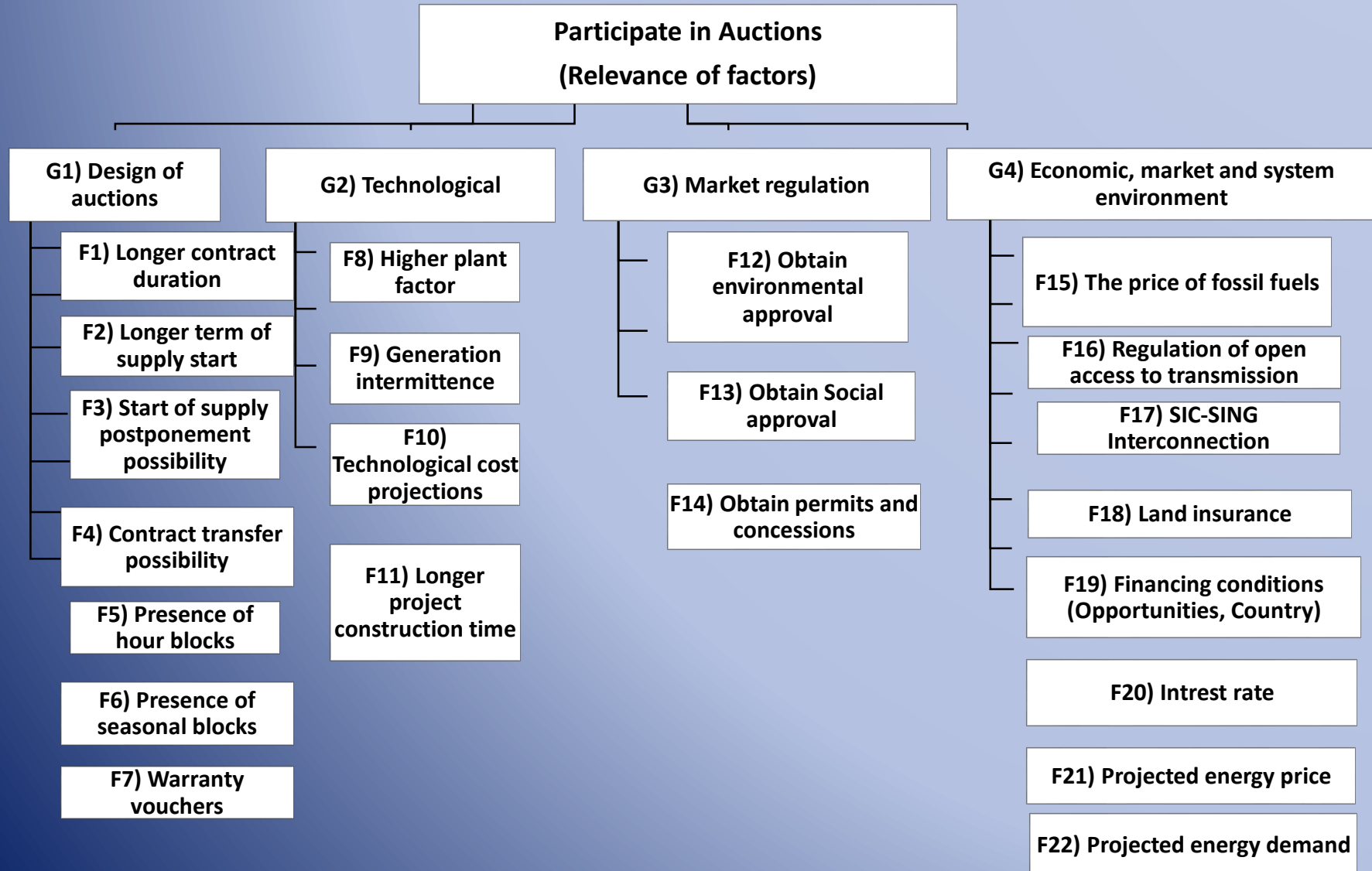


- The proposed methodology is a Multi-Criteria Decision-Making (MCDM) tool – a hybrid AHP (Analytic Hierarchy Process), Goal Programming (GP) that evaluates which factors have the highest influence for auction participants.
- Multi-criteria decision-making methods is a branch of operations research models that is appropriate for addressing multi-objective complex problems containing high uncertainty, conflicting objectives, different forms of data and information, and multi interests and perspectives.
- AHP technique allows the decision makers to incorporate both quantitative and qualitative judgments into a decision problem
- While the Goal Programming is GP is a mathematical programming optimization method and is more sophisticated way to rank and prioritize the alternatives.

Methodology diagram



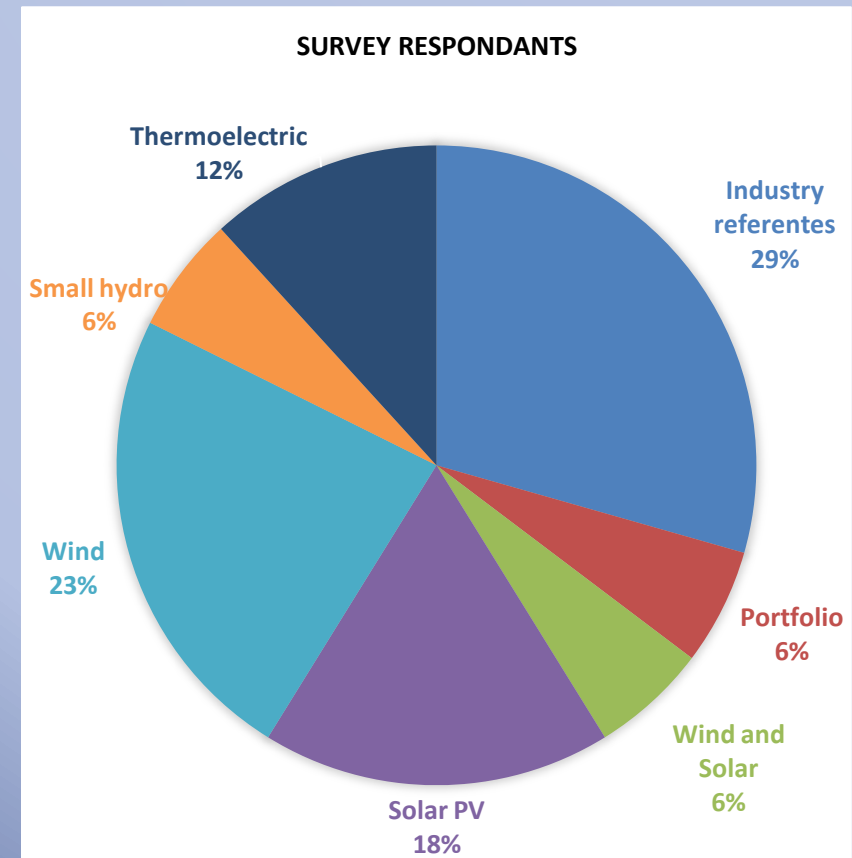
Methodology



Survey

- The survey's goal is to obtain experts opinion **from industry leaders and generation companies** of each factor's relevance
- The number of answers in of the surveys is 17, where each response is technology specific

Scale	Definition	Explanation
4	Absolutely positive	As the parameter grows, the higher the incentive to participation in auctions. (Driver)
3	Strongly positive	
2	Moderately positive	
1	Minimally positive	
0	Irrelevant or with very little impact	Very low relevance in decision making.
-1	Minimally negative	As the parameter decreases, the higher the disincentive to participation in auctions. (Barrier)
-2	Moderately negative	
-3	Strongly negative	
-4	Absolutely negative	



Results



Project	Industry referents					Portfolio	Thermoelectric	Wind & S. PV	Solar PV					Mini Hydro	Average	
G1	34%					14%	38%	30%	63%				33%		33%	30%
G2	30%					14%	13%	11%	55%				16%		17%	20%
G3	28%					14%	13%	11%	30%				23%		17%	18%
G4	34%					57%	38%	48%	53%				28%		33%	32%
F1	7%					1%	7%	8%	18%				9%		8%	7%
F2	5%					3%	7%	5%	6%				4%		2%	4%
F3	5%					3%	9%	3%	7%				2%		12%	4%
F4	4%					1%	4%	1%	6%				4%		3%	3%
F5	6%					3%	4%	5%	14%				6%		3%	5%
F6	4%					3%	6%	5%	6%				3%		3%	3%
F7	4%					3%	2%	3%	7%				4%		3%	3%
F8	9%					4%	3%	1%	21%				4%		2%	6%
F9	5%					4%	3%	1%	6%				4%		2%	3%
F10	10%					4%	5%	5%	14%				6%		10%	7%
F11	7%					4%	3%	5%	14%				3%		2%	5%
F12	9%					5%	5%	2%	10%				9%		6%	6%
F13	11%					5%	6%	4%	11%				6%		6%	7%
F14	8%					5%	3%	4%	8%				8%		6%	5%
F15	3%					8%	7%	3%	4%				2%		1%	3%
F16	4%					8%	3%	9%	5%				3%		5%	4%
F17	4%					8%	2%	9%	5%				3%		5%	4%
F18	4%					8%	2%	5%	8%				3%		5%	4%
F19	5%					8%	5%	5%	11%				4%		5%	5%
F20	3%					8%	4%	5%	9%				4%		8%	4%
F21	6%					4%	7%	3%	5%				3%		3%	4%
F22	5%					4%	8%	0%	6%				5%		1%	5%



Discussion

- Initial results shows that changes in **market reforms /conditions** in general contributed more in attracting investment, causing at the same time, an increase in competition.
- The results show that the most relevant factors for solar PV are related to higher plant factor, the design of auction scheme, including the length of contracts, & the hourly supply blocks.



Discussion

- The very low prices have raised doubts about economic feasibility of awarded projects
- Guarantees pledged are rather insufficient to guarantee the realization of projects
- Other issues may come into play to archive energy matrix objectives:
 - Aging transmission infrastructure and congestion issues
 - Increasing conflict levels with local communities



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¿Questions or Comments?

