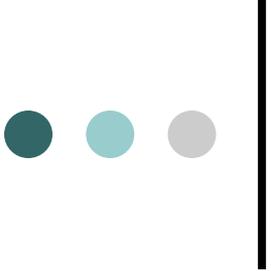


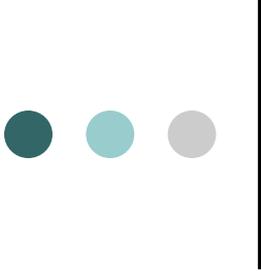
Risks for Alternative Energy Generation: Chilean “Breakthrough in Renewable Energy Generation”

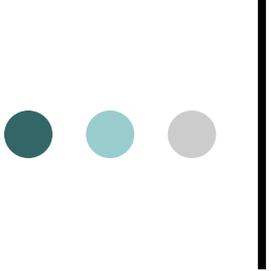
Chile – “Catch up energy development model”.

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- 
- Methodology
 - Chile's RES Potential
 - Current RES and RET Status
 - Risks and Challenges

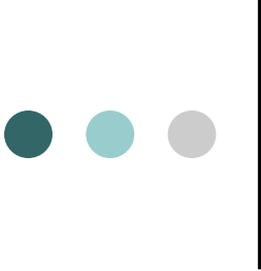
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- Politically and internationally the world can be unipolar, multipolar, bipolar or polar less.
 - Through the prism of international **conventional energy market** the world is multipolar.
 - With introduction of utilization of **renewable energy resources** and **renewable energy technologies** the world energy market experiences fragmentation of energy markets.
 - This fragmentation means de-monopolization, localization, energy source (sources) orientation.



In terms of RES and RET introduction

Chile has been taken as an analysis object because of following factors:

- 1) Chile has very limited domestic fossil energy resources. Imported fossil resources: coal, diesel and liquefied natural gas account for 70% of the country's total energy consumption.
- Growing energy demand, increasing dependence on imported energy sources have led to high electricity costs for both households and industries.
- The electricity prices have doubled since 2010 and it is forecasted that they will add 35% by 2027 (if Chile does not solve the problem of dependency on imported energy).



2) Chilean GDP substantially depends on the energy price.

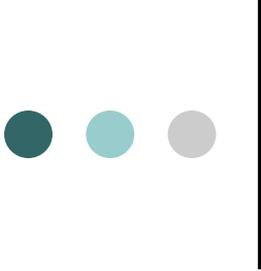
- High energy cost, shortages are **key challenges** for Chile's private sector.

- **The problem is especially serious for the mining industry in which the cost of energy now represents about 20–30% of the total cost of production.**

- In its turn this factor negatively effects national economy indicators - GDP:

 - the mining industry accounts for 20% of the GDP and 60% of exports.

Chilean mining industry pays twice as much for electricity as the mining industry in Peru.

- 
- 3) Chile is considered by many to be one of the world's top renewable energy markets
 - Ernst & Young's Renewable Energy Country Attractiveness Index (RECAI) — a quarterly updated ranking of 40 countries according to a complex of macro, technology and market specific indicators – Chile is 4th. (2016)
 - According to the World bank reports: since 2012, the RE sector in Chile has attracted US \$9.2 billion in investment (~ = 1992-2011)

Chile's renewable energy market is teeming with potential to develop RES and introduce RET.

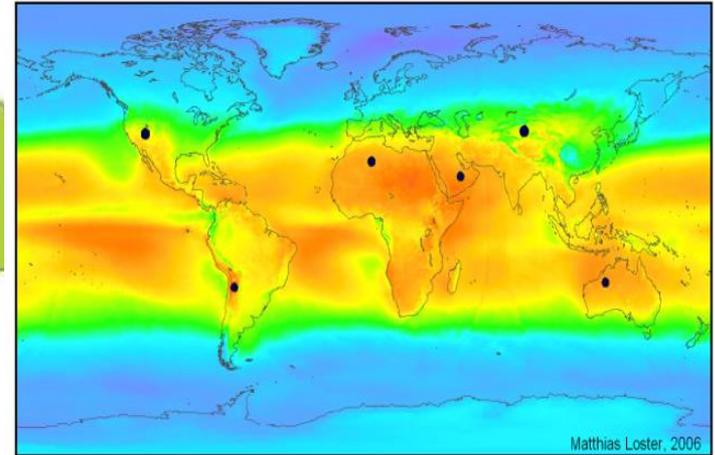
Wind: The coast in general and the far south are both wind rich areas. Just north of Santiago there are already several projects in the works.

Solar: The Atacama desert makes solar an attractive, but largely unexploited resource in the north of Chile.

Bio-mass: Waste from Chile's thriving forestry industry make bio-mass an attractive source of renewable energy.

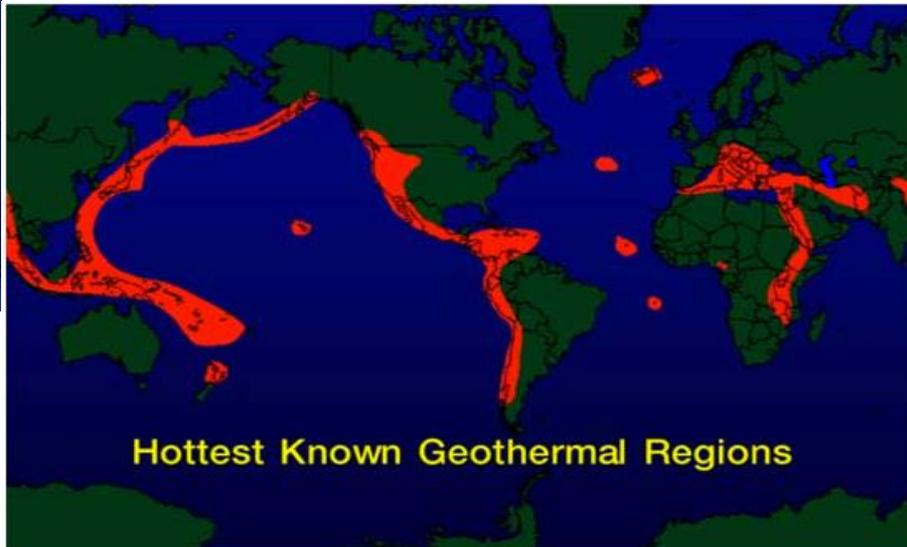
Mini-hydro: An abundant network of lakes and rivers in Central and Southern Chile makes mini-hydro another option.

Geothermal and Wave: A 4200Km coast and high volcanic activity make these two resources very attractive, but little exploration has been done to date.

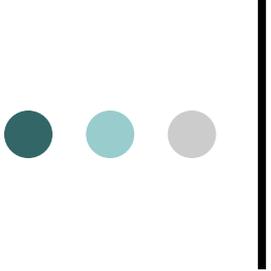


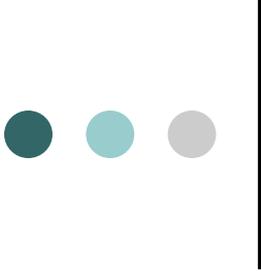
0 50 100 150 200 250 300 350 W/m²

Σ ● = 18 TWe



- Solar energy (Atacama Desert)
- Wave and tidal energy
- Wind (the El Arrayán Wind Farm (launched in 2014) is one of the largest in the country, utilizes Siemens-produced turbines to serve the energy needs of approximately 200,000 households per year.)
- Geothermal power (“Pacific-Ring of Fire”).

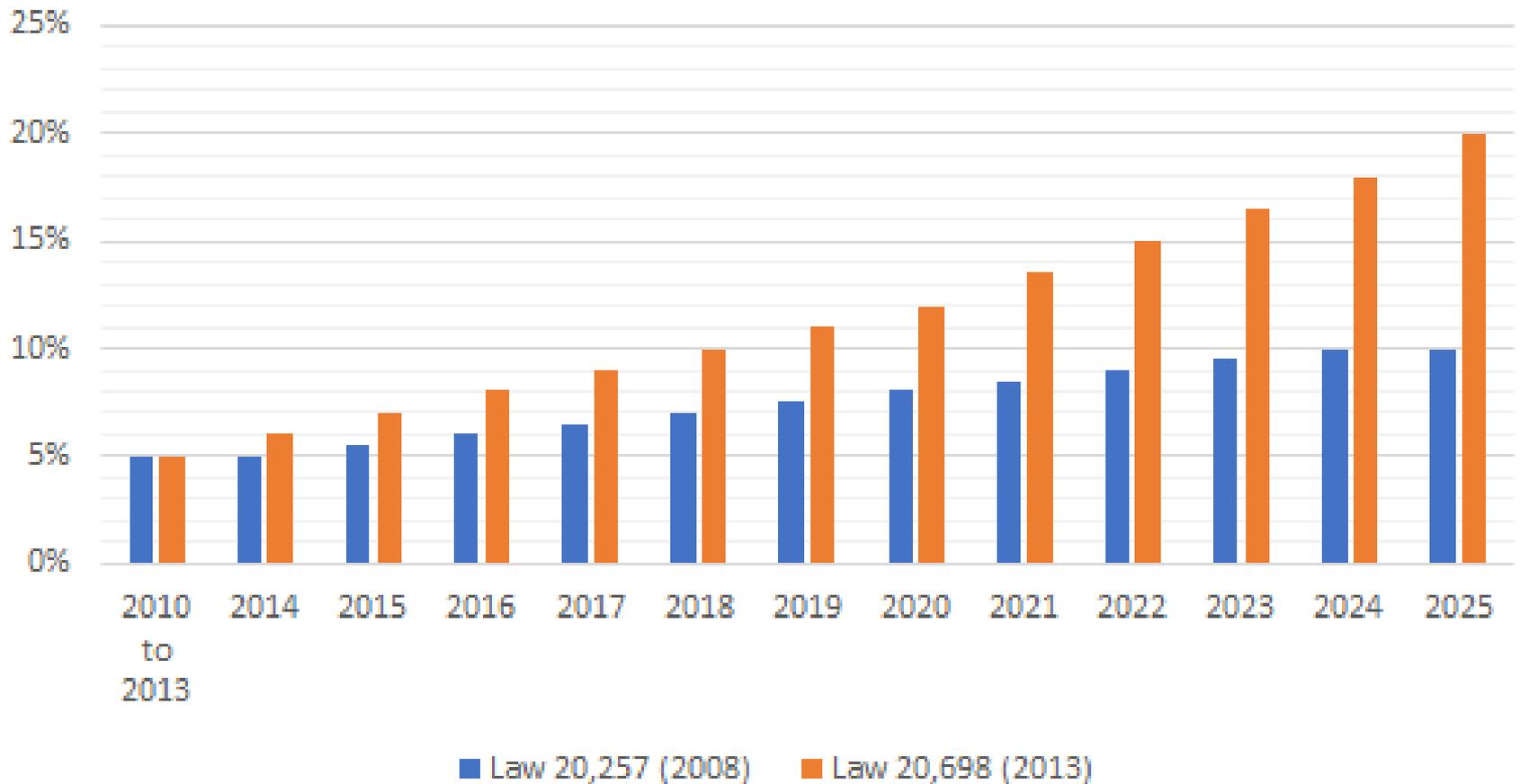
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- “1 April 2008 - The Law № 20257 better known as Non-Conventional Renewable Energy Law (NCRE Law) aims to fulfill future energy requirements by developing non-conventional renewable energy sources, such as geothermal, wind, solar, tidal, biomass and small hydroelectric plants.
 - The law requires electricity providing companies, withdrawing electricity to supply their contract commitments, to demonstrate that a certain percentage of their total energy committed was injected in the system by non-conventional energy sources. The energy can be produced by their own plants, or by contracting from third-parties.
 - (12 laws since 2000)

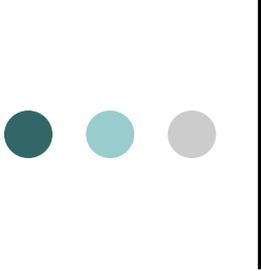
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- This quota came into force at the start of 2010, and until 2014 required 5% of electricity to come from non-conventional renewable energy sources. Starting from **2015**, the obligation increased by 0.5% annually, **to reach 10% by 2024.**

- On 14 October 2013, the law was reformed and mandates that electric utilities with more than 200MW operational capacity should **generate 20% of electricity from renewable sources by 2025.**

(Law 20698, known as “Law 20/25”)

Chile's Non Conventional Renewable Energy Target





Chile

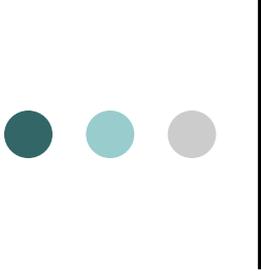
- 2015, the government prepared an energy roadmap, where a more ambitious goal is established to have 70% of renewable energy (including large hydro) in the matrix in Chile by 2050 (Ministry of Energy, 2015).
- **2016:** The installed capacity in renewable energy sources reached 3,119 MW. This corresponds to **17,4%** of the total power capacity in the system (Reuters).

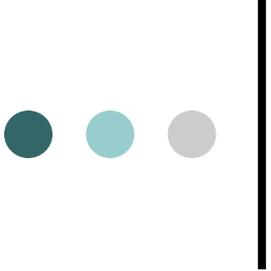
The EU

- 2008 issued the 2020 Climate and Energy Package with a target of 20% of RES by 2020.
- 2014 issued the 2030 Climate and Energy Policies Framework with a target of 27% by 2030.

The US

- 50% by 2050.

- 
- “Power generation in Chile is organized around 4 grid systems:
 - 1) Sistema Interconectado del Norte Grande (SING), the northern grid, which accounts for about 19% of national generation;
 - 2) the Central Interconnected System (SIC), the central region's grid, which accounts for 68.5% of national generation and serves 93% of Chile's population;
 - 3) the Aysén Grid in southern Chile (0.3% of total generation);
 - 4) the Magallanes Grid, also in southern Chile (0.8% of total generation).
 - Electricity transmission and distribution takes place through the four grids, as well as 36 electricity distribution companies.”



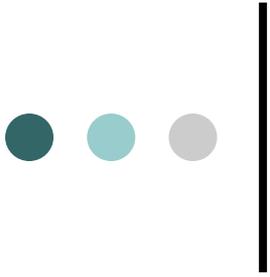
Key risks and challenges

- Lack of comprehensive, efficient energy policy.
- Uncertainty in institutional decision making process.
- “Spot prices reached zero in parts of the country on 113 days through April 2016, a number that’s on track to beat 2015 total of 192 days” . Bloomberg. Chile Has So Much Solar Energy It’s Giving It Away for Free 2016-06-02 19:14:25.678 GMT
- Large number of developers in the same place.
- Deficit of trust of investors.
- Lack of infrastructure (transmission lines or lack of transmission capacity (e.g. disconnected central grid and northern grid))
- RES are not viable on liberalized energy market (in opposite to planned economy and centralized market)[\[1\]](#).
- Full and rapid decarbonization of energy sector is unreachable. (Deployment of RES/RET rely on CES/CET) => 70% to fast.
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[\[1\]](#) Jorge Blazquez, Rolando Fuentes-Bracamontes, Carlo Andrea Bollino, Nora Nezamuddin. The renewable energy policy Paradox // Renewable and Sustainable Energy Reviews. 82, 2018. pp. 1-5.

METHODOLOGY

- Multi-criteria decision method (MCDM) have been applied to numerous decision-making problems in the general field of renewable energy.
- The most common tool of MCDM is - Analytic Hierarchy Process - a method of prioritization.
- The AHP method develops priorities among all the criteria and sub-criteria within each level of the hierarchy by using measurements from pair-wise comparisons and relying on the judgment of experts to derive priority scales.
- Analytic hierarchy process



- Thank you for your attention
 - Questions
 - Remarks