

FRAUNHOFER Chile Research Foundation Center for Solar Energy Technologies CSET

A POLE OF INNOVATION FOR LATIN AMERICA



Center for Solar Energy Technology CSET
Fraunhofer Chile Research

Campus San Joaquin, Macul
Santiago de Chile

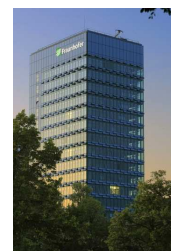
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The Fraunhofer-Gesellschaft Largest Organization for Applied Research in Europe

- 67 institutes and research units
- Staff of more than 23,000
- €2 billion annual research budget totaling
 - 66% generated through contract research on behalf of industry and publicly funded research projects
 - 33% contributed by the German federal and state governments in the form of base funding
- International co-operations
- In Chile since 2010 / Corfo INNOVA Program
 - FCR CSB /Biotechnology
 - FCR CSET / Solar Energy / PUC: Coexecutor



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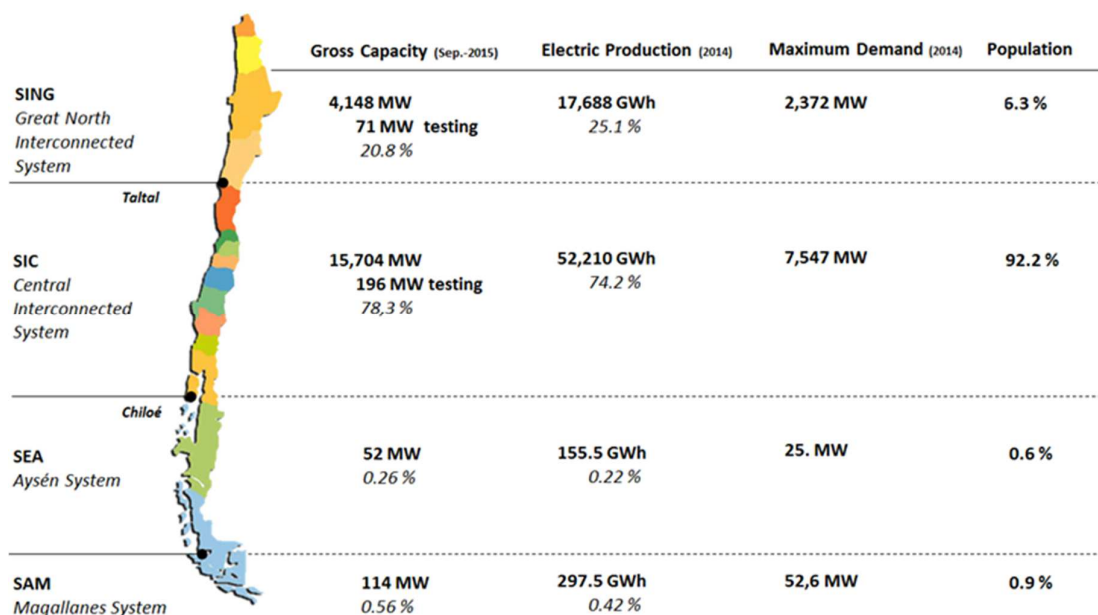
SOLAR ENERGY IN CHILE: OUTLINE

- Electricity Context in Chile
- Solar Radiation in Chile
- Solar Energy in Chile
- Context in R&D
- Development Opportunities
- Future of Solar Energy

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Solar Energy in Chile: Chile's main power systems



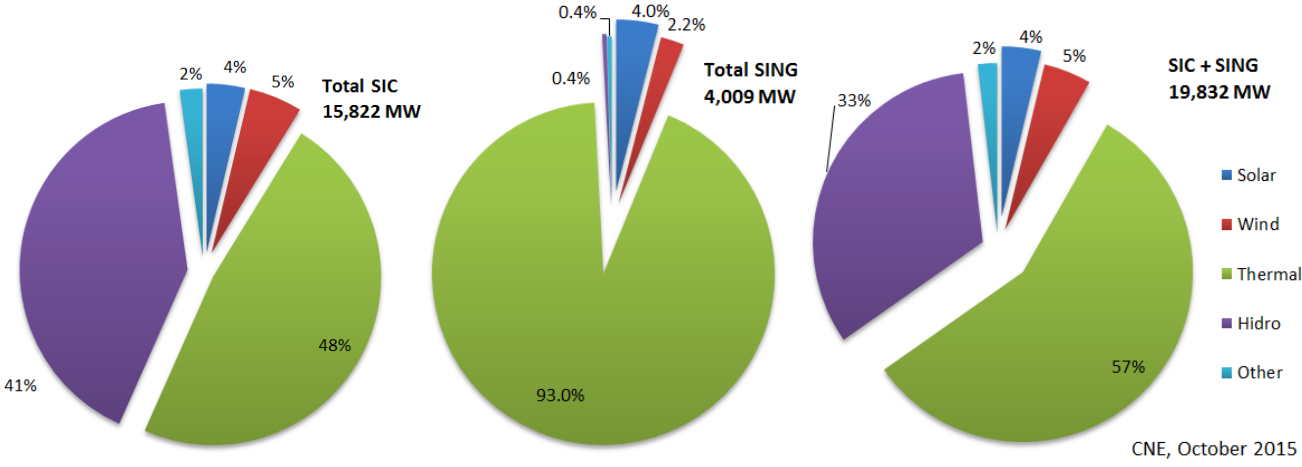
CNE, CDECs

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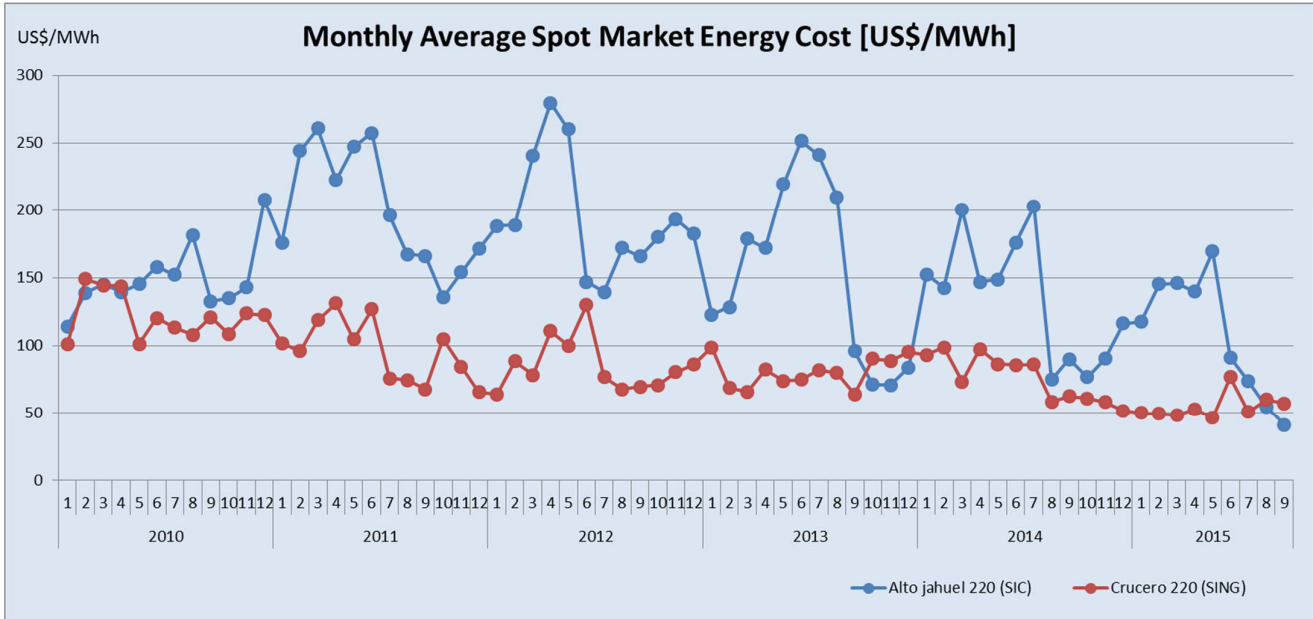
Solar Energy in Chile

Energy Matrix Composition (Electricity)



Solar Energy in Chile

Spot market energy price evolution



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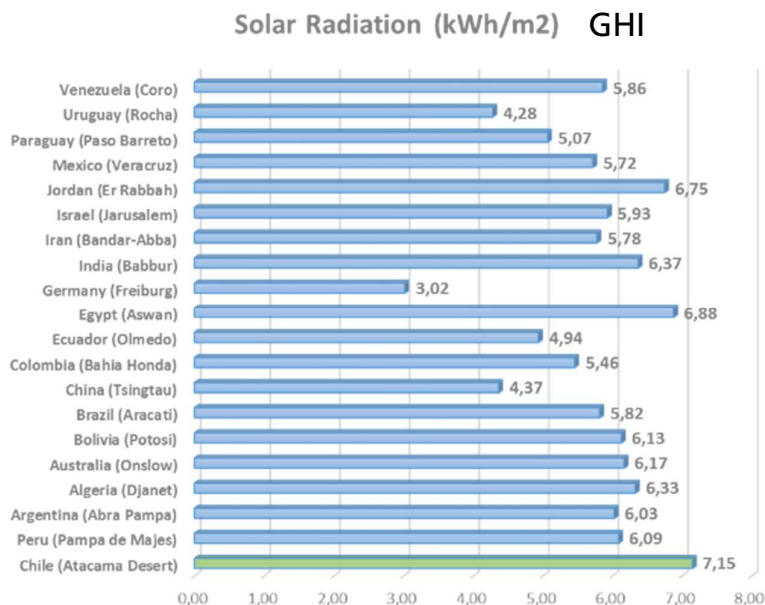
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Solar Radiation in Chile Resource Map



DNI: Up to 3400 kWh/m²-year

Source:

8 http://www.sealite.com.au/technical/solar_chart.php

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Solar Radiation in Chile

Conclusion



In Solar Radiation, Chile is not just Champion in South America

Chile is the World Champion!!!

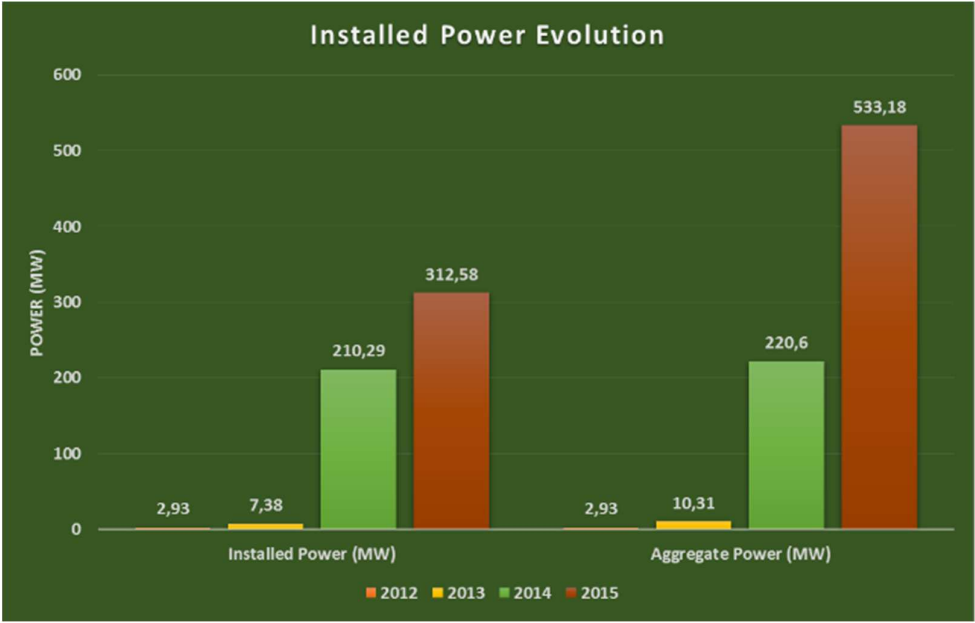


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Solar Energy in Chile

Photovoltaic Power Evolution



Source: CNE statistics, CDEC-SIC

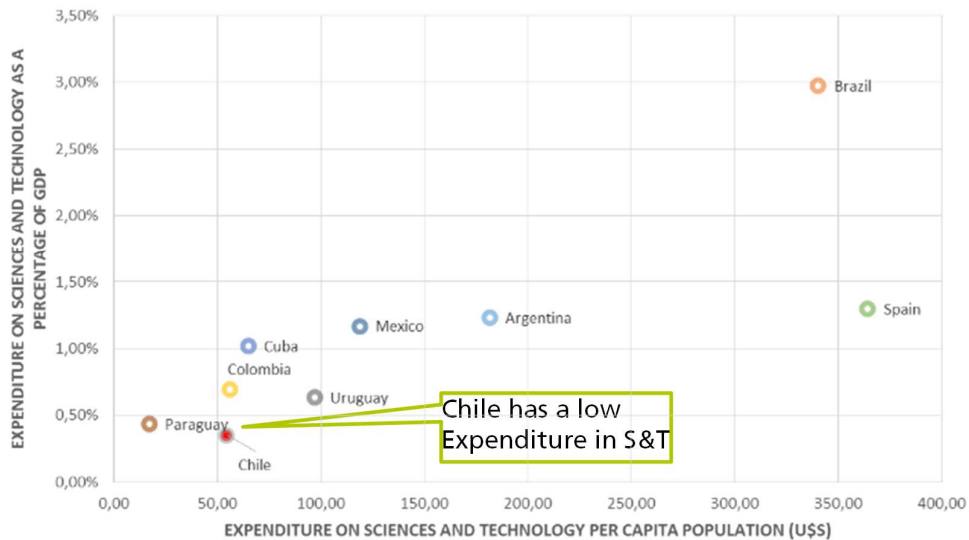
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R&D in Chile

Expenditure on Science and Technology

2012 Expenditure on Sciences and Technology



Source: www.ricyt.org

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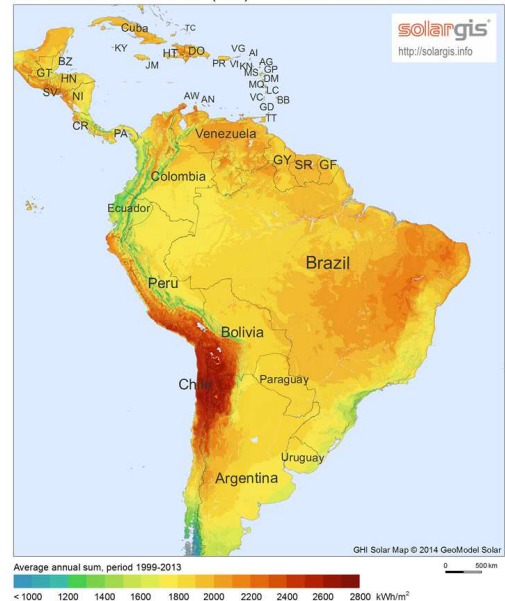
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Why in Chile?

Enormous potential – high challenges

- Up to approx. 2.800 kWh/m² global horizontal irradiation per year
- North of Chile has the potential to supply all of Chile with clean solar electricity + even export electricity to neighboring countries
- Challenges: high UV, high temperature gradients, dust, salts, water scarcity, ...
- Grid integration: Electricity storage and transport technologies will be important
- R&D on „high radiation solar“ needed → opportunity for Chile
- Increase local contents, local jobs

Global Horizontal Irradiation (GHI) Latin America and the Caribbean



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- FCR CSET Activities / Development Opportunities
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Solar Energy in Chile Development Opportunities



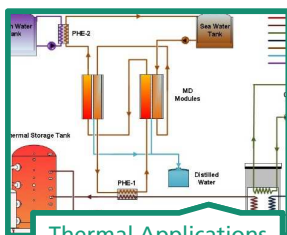
Solar Concentration



Agriculture Uses



Solar Electrolysis



Thermal Applications
Polygeneration



Solar Storage



Water Treatment

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Fraunhofer Research in Solar CSET – Research Lines

Solar Electricity Generation

- Measuring solar resource
- Concentration technologies CPV and CSP
- Off-grid and On-grid systems
- Grid Integration NCRE

Solar Heat for Industry

- Heat for industrial processes in mining, food, others
- Solar cooling for food industry
- Solar polygeneration (heat, cold, electricity, water)

Solar Water Treatment

- Water decontamination
- Water purification
- Water Desalination
- Industrial water treatment

Business Development

- Generating links, contacts and coordination with the industry and public sector.
- Contact with international organizations.
- Studies and strategic consulting to government agencies and private sector.
- Strategic support to the Research Lines.

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Fraunhofer Research in Solar CSET – Innovative Services

Research and Development



- Hybridization Systems and Technologies
- Energy Efficiency
- Design of Energy Storage Systems
- Soiling
- Integrated Systems Cogeneration
- Polygeneration Systems

Technology Transfer



- Technology Adaptation to Local Conditions
- Solar Technology for Water Treatment and Processing
- AgroPV

Studies and Specialized Consulting



- Evaluation Technical-Economic Feasibility Great Generation Systems and Medium Scale.
- Solar Resource Assessment.
- Consultancy, Studies and Specialized Engineering.
- Identification of PV plant failures.
- Financing Models

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Examples of CSET Activities

Monitoring Stations

- Solar Resource Evaluation in place.
- Installation and monitoring of on-field weather & solar measurement stations.
- Added value for our clients:
 - Accurate production forecasting.
 - Limit the variability of the resource through measurements.
 - Minimize the project financial risk.



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Examples of CSET Activities

Solar applications in Wine Industry

- Polygeneration: Production of Process Heat and Cold via Solar Energy.
- Process layout, detection of critical units, gathering heat process demand information.
- Design a Solar thermal Polygeneration System that generates both heat and cold process.
- Results:
 - 30.000 kWh of heat process.
 - 13.000 kWh of cold process.



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Examples of CSET Activities

Solar Energy in Desalination and Water Treatment

- PV Driven Reverse Osmosis
- Membrane Distillation
- Water Desalination / Water Treatment / Solar Pumping
- Consultancy / Testing services for Mining / Energy Applications in progress



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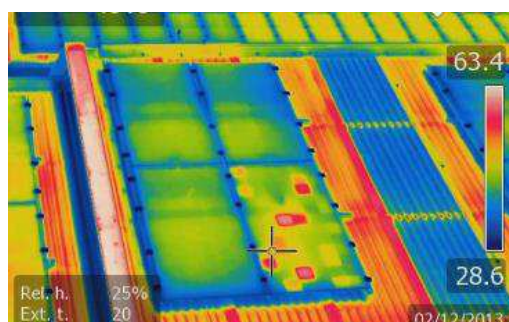
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Examples of CSET Activities

Monitoring from the Air

Air monitoring of PV plants by drones

- Analysis of defects in modules using thermography from the air
- Detection of damage as hot spots
 - Reducing time
 - Reducing cost
 - Easy/fast failure detection



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Examples of CSET Activities

Damage Analysis

Analysis of PV modules by Electroluminescence

- Visual analysis of defects invisible for the eye
- Outdoor and indoor analysis by same camera
- Flexibility and easy characterization of PV modules
- Detection of damage as cracks
 - Reducing time
 - Reducing cost
 - Easy/fast failure detection



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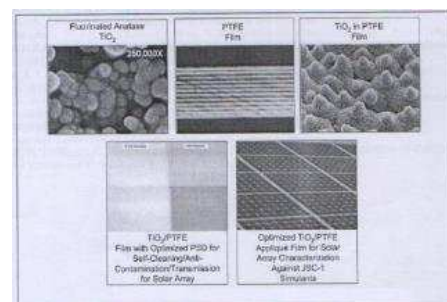
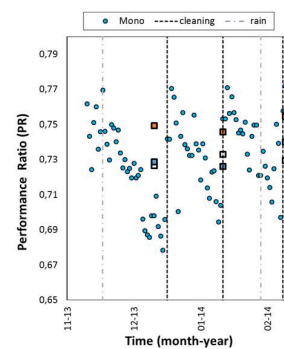
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Examples of CSET Activities

Soiling Tests

Soiling test in specific meteorological conditions

- Analysis of performance and soiling effect in PV modules
- Quality control of installed PV modules
- Analysis of anti-soiling coatings
- Reduction of losses in PV plants
- Remote plant monitoring



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Examples of CSET Activities Certification

Certification of solar collectors and thermal systems

- Certification of solar PV / Thermal technologies with the support of Fraunhofer ISE/Germany
- Complete Project Certification possible
- Local investigations: Quality issues under extreme Chilean conditions
 - High UV
 - Soiling
 - Seismic conditions



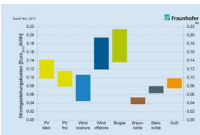
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Examples of CSET Activities Energy System Analysis

Photos © Fraunhofer ISE



Techno-Economic Assessment of Energy Technologies



National and Regional Energy Supply Concepts



Market Analysis and Business Models



Modeling of Energy Supply Scenarios



Planning and Operating Strategies of Power Plants

Competences developed in Fraunhofer ISE/Germany

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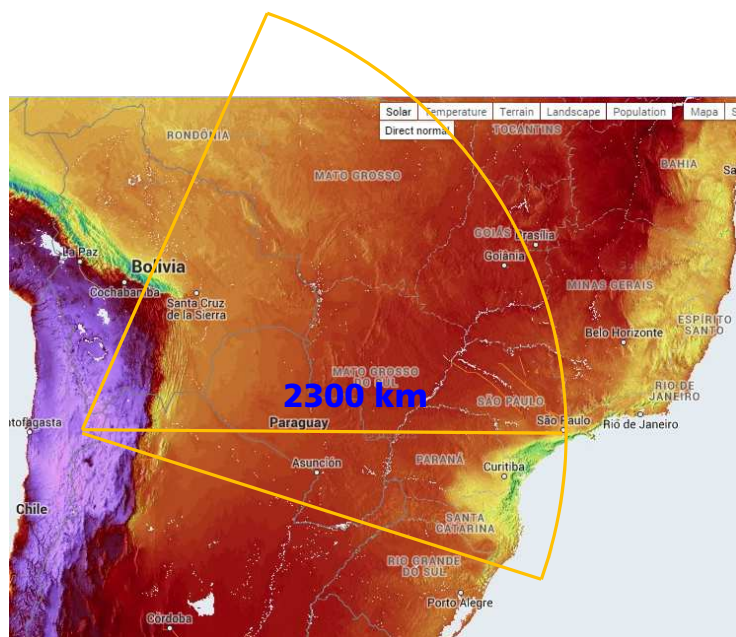
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A Regional View

- A solar hub in northern Chile could supply energy to a large portion of central South America
- Range of 2300 km, to Sao Paulo region (South of Brazil, Peru, Bolivia, North of Argentina, Uruguay, Paraguay)
- 2300 km of transmission lines is not difficult, many examples worldwide



Source: Internal Analysis – Fraunhofer Chile Research - Solargis

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Solar Energy Economy

An Opportunity for Chile

- A **near-100% renewable energy system is possible**, at similar cost as today's energy supply.
- Big challenges, big opportunities:
 - **Storage** (Pump storage, BESS, H₂, etc)
 - **Grid Integration** / Solar (North) + Hydro (South) / LATAM Grid
 - **Transmission** capacity needed – Critical issue!
 - Solar + **Large Desalination Centers** : Solar Energy → Water!
- Chile can take a leading role in the field of R&D for „**high radiation solar**“ technologies.
- Chile can develop a **strong solar industry** (new jobs) to supply power with high level of security of supply and at competitive prices.
- The global energy transformation is **the challenge of our generation**, as first step of the needed transformation to **sustainability**.....key to face Climate Change

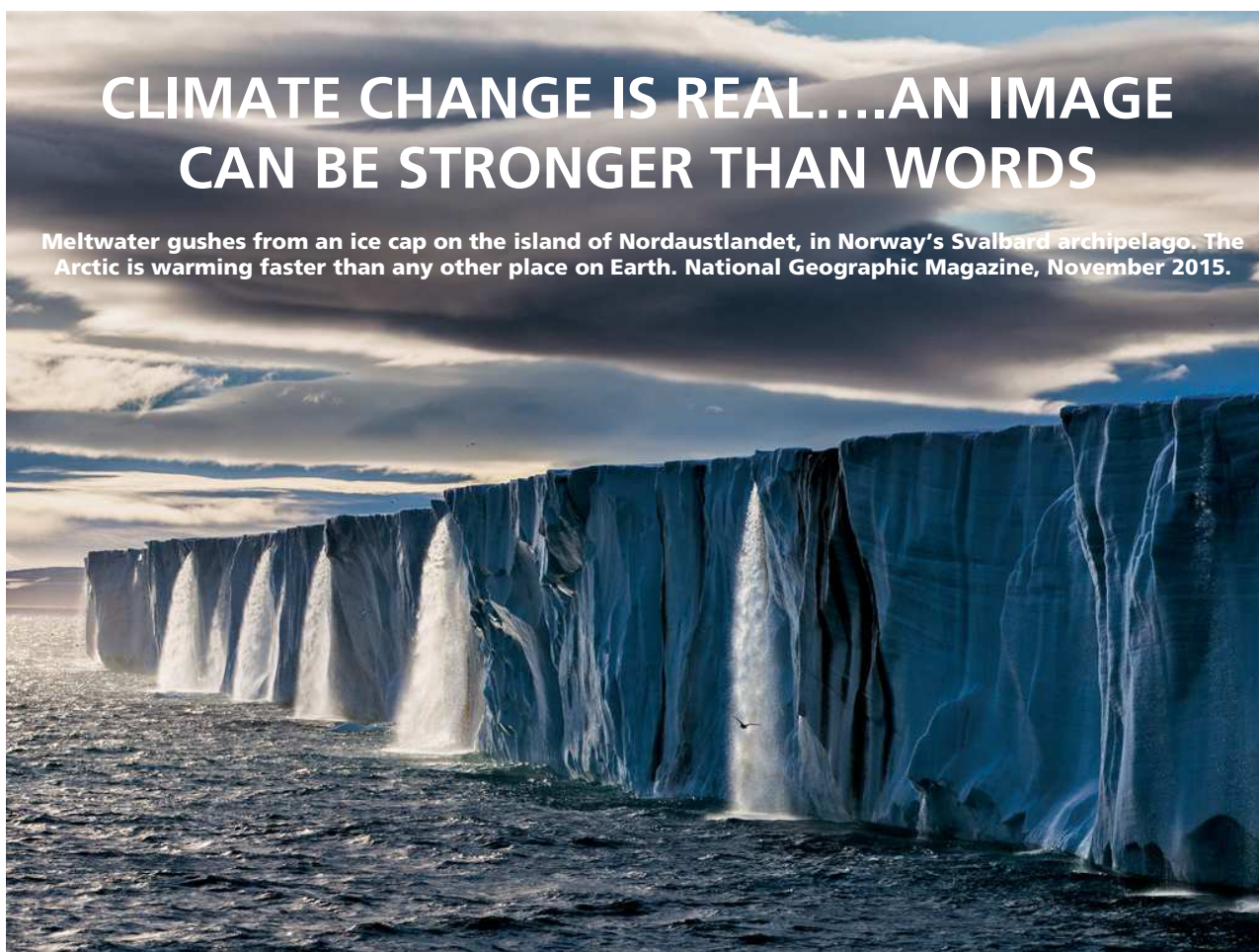
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CLIMATE CHANGE IS REAL....AN IMAGE CAN BE STRONGER THAN WORDS

Meltwater gushes from an ice cap on the island of Nordaustlandet, in Norway's Svalbard archipelago. The Arctic is warming faster than any other place on Earth. National Geographic Magazine, November 2015.



SOLAR Energy in Chile: Quotes and Sentences



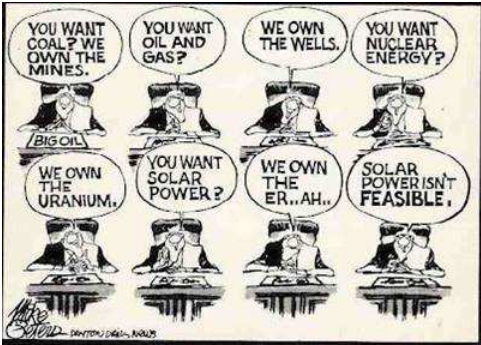
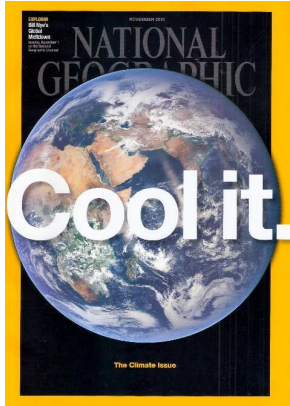
"Our future is what we build it to be. The jobs and industries of the 21st century will be centered around clean renewable energy."

President Barack Obama



"I'D PUT MY MONEY ON THE SUN AND SOLAR ENERGY. WHAT A SOURCE OF POWER!"

THOMAS ALVA EDISON (1847-1931)



Thank You

For a Solar Future of Chile

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