

# Workshop: An overview on recent developments on PV research, strengthening strategic alliances

## Solar Energy Research Center SERC-Chile



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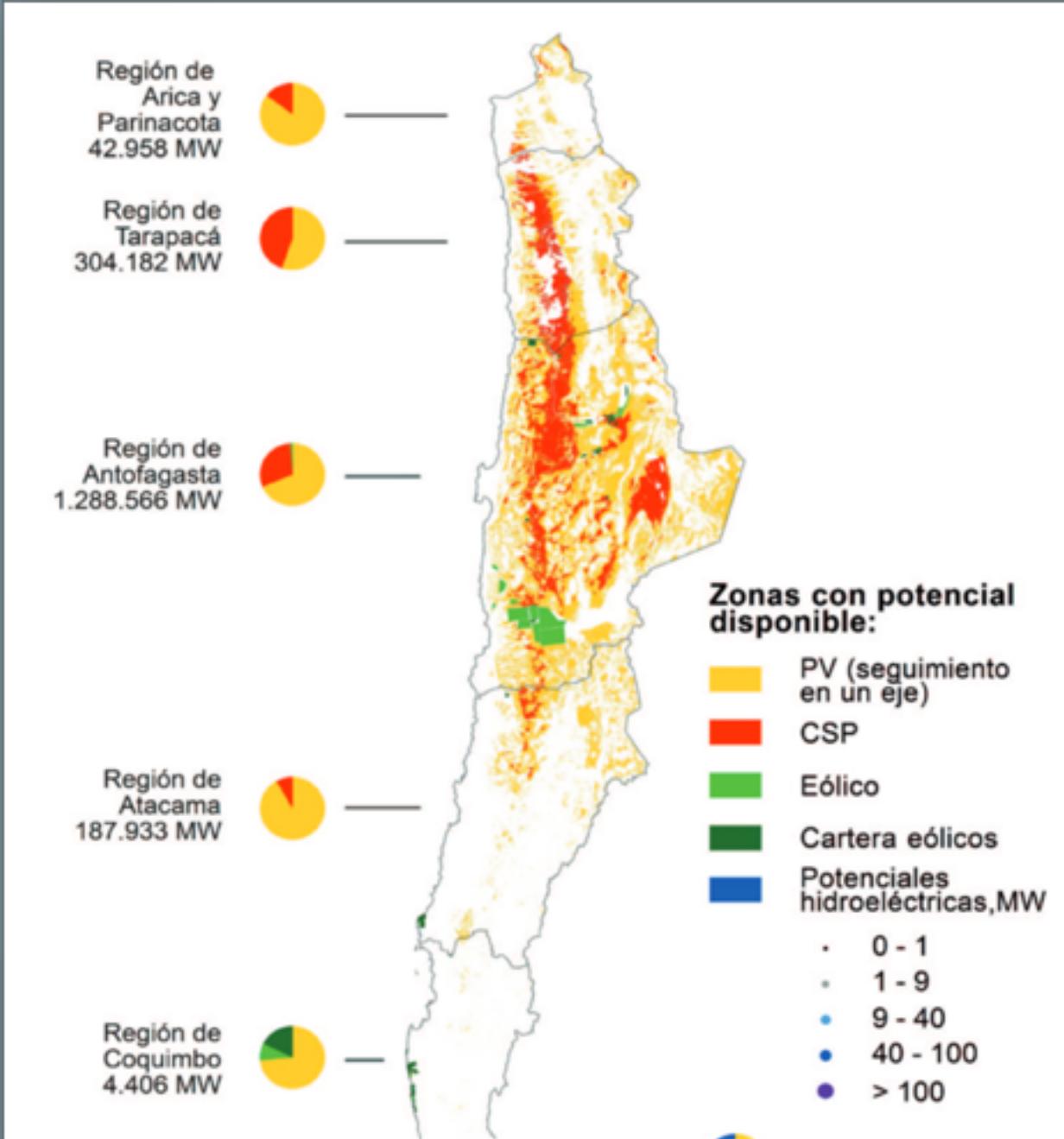
4<sup>th</sup> April, 2019, Santiago

# OVERVIEW

- Context: SERC & Energy Centre
- Examples
- Conclusions



# CONTEXT



SERC CHILE

2018 - 2022

# SERC CHILE

SOLAR ENERGY RESEARCH CENTER



UNIVERSIDAD DE TARAFACA



UA  
Universidad  
de Antofagasta



UNIVERSIDAD TÉCNICA  
FEDERICO SANTA MARÍA



UNIVERSIDAD  
DE CHILE



UNIVERSIDAD ADOLFO IBÁÑEZ



PONTIFICIA  
UNIVERSIDAD  
CATÓLICA  
DE CHILE



Universidad de  
Concepción



Fraunhofer



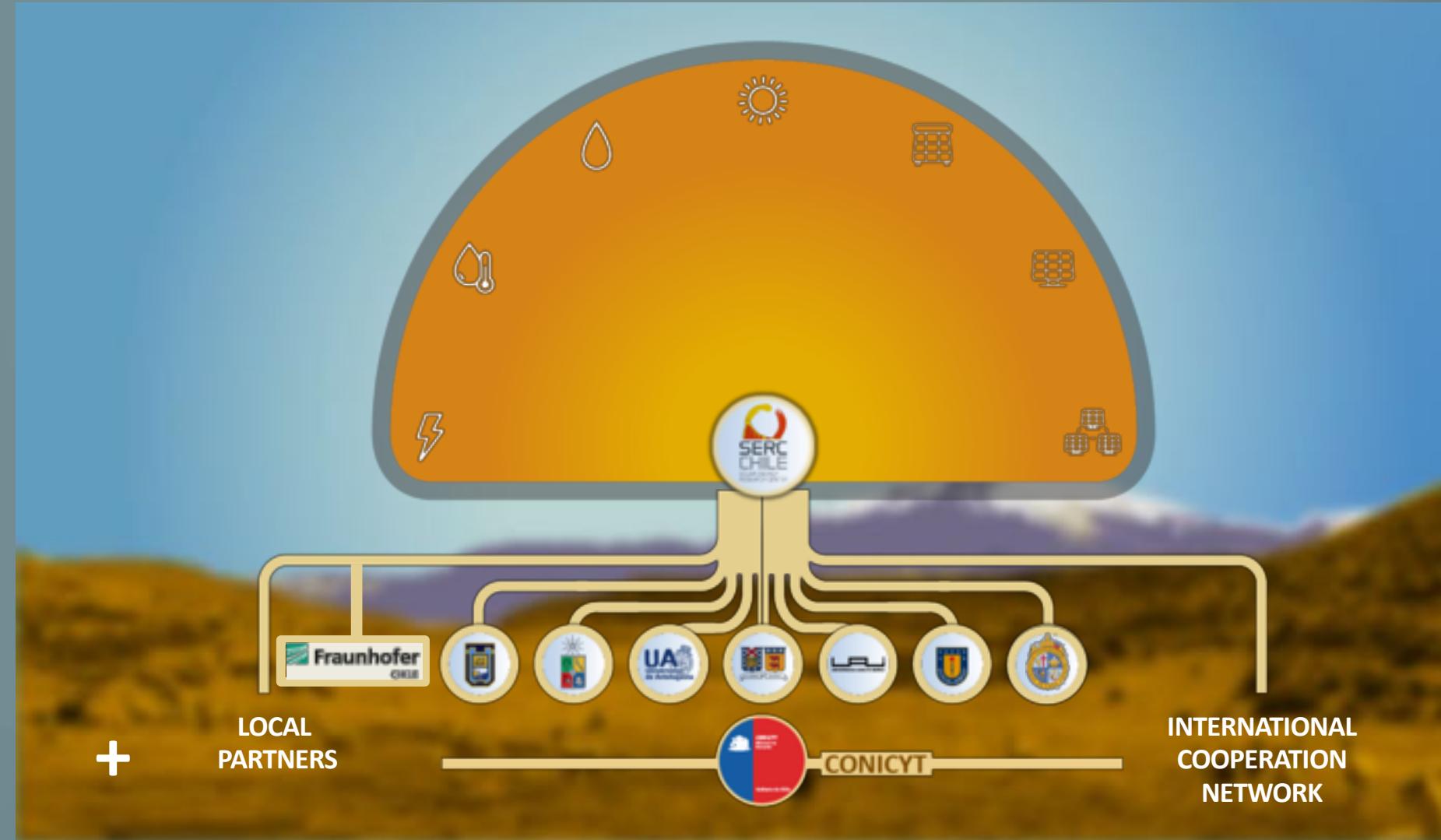
CONICYT  
Comisión Nacional de Investigación  
Científica y Tecnológica

# CONTEXT

Created in year 2012 by CONICYT

The objective of this center is to become a leader of scientific research in solar energy, especially developing the potential of the Atacama Desert in Chile.

- First association of institutions devoted to the development of solar energy in Chile!
- 80 researchers, 300 students
- Non profit Inclusive spirit





# CONTEXT



## Four strategic focuses

I. Massive integration of large-scale solar energy to the electric interconnected system



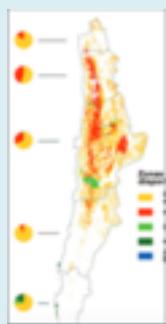
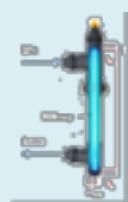
II. Solar energy based mining in Chile



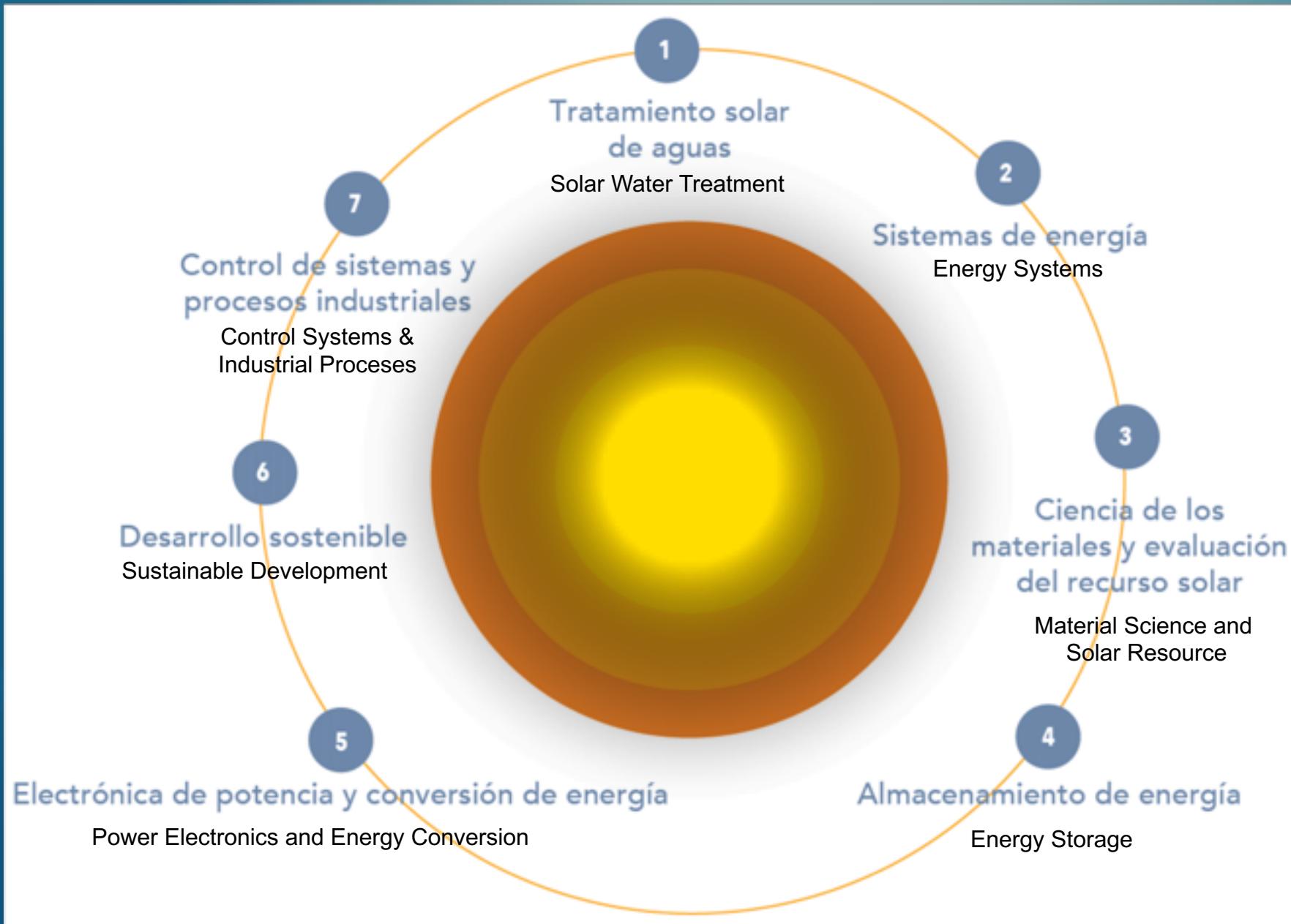
III. Development and widespread adoption of small-scale solar solutions

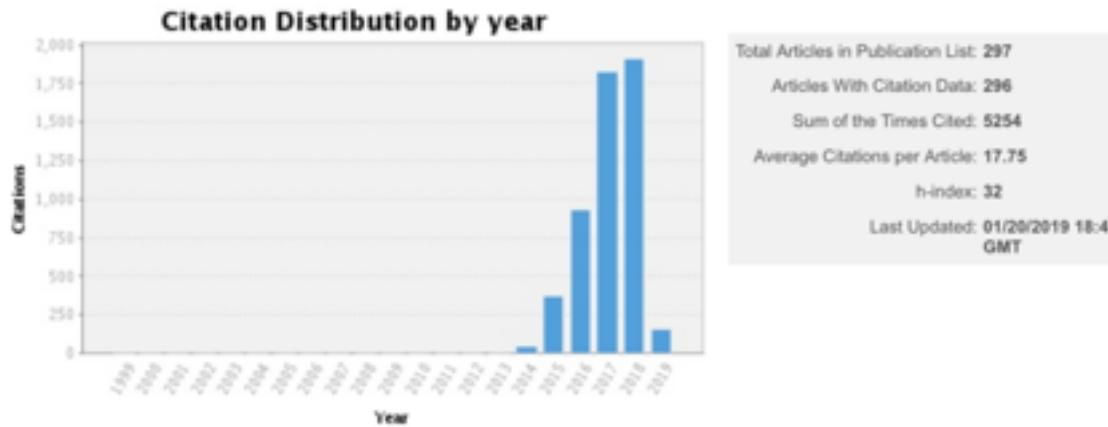
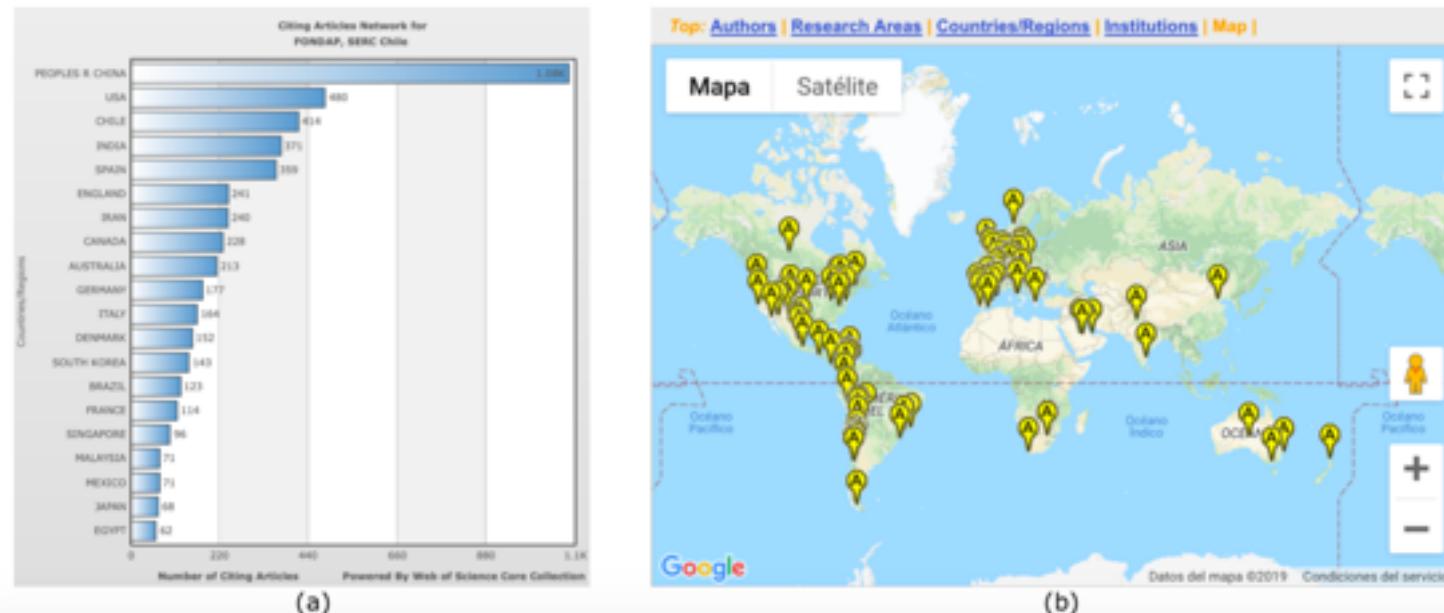


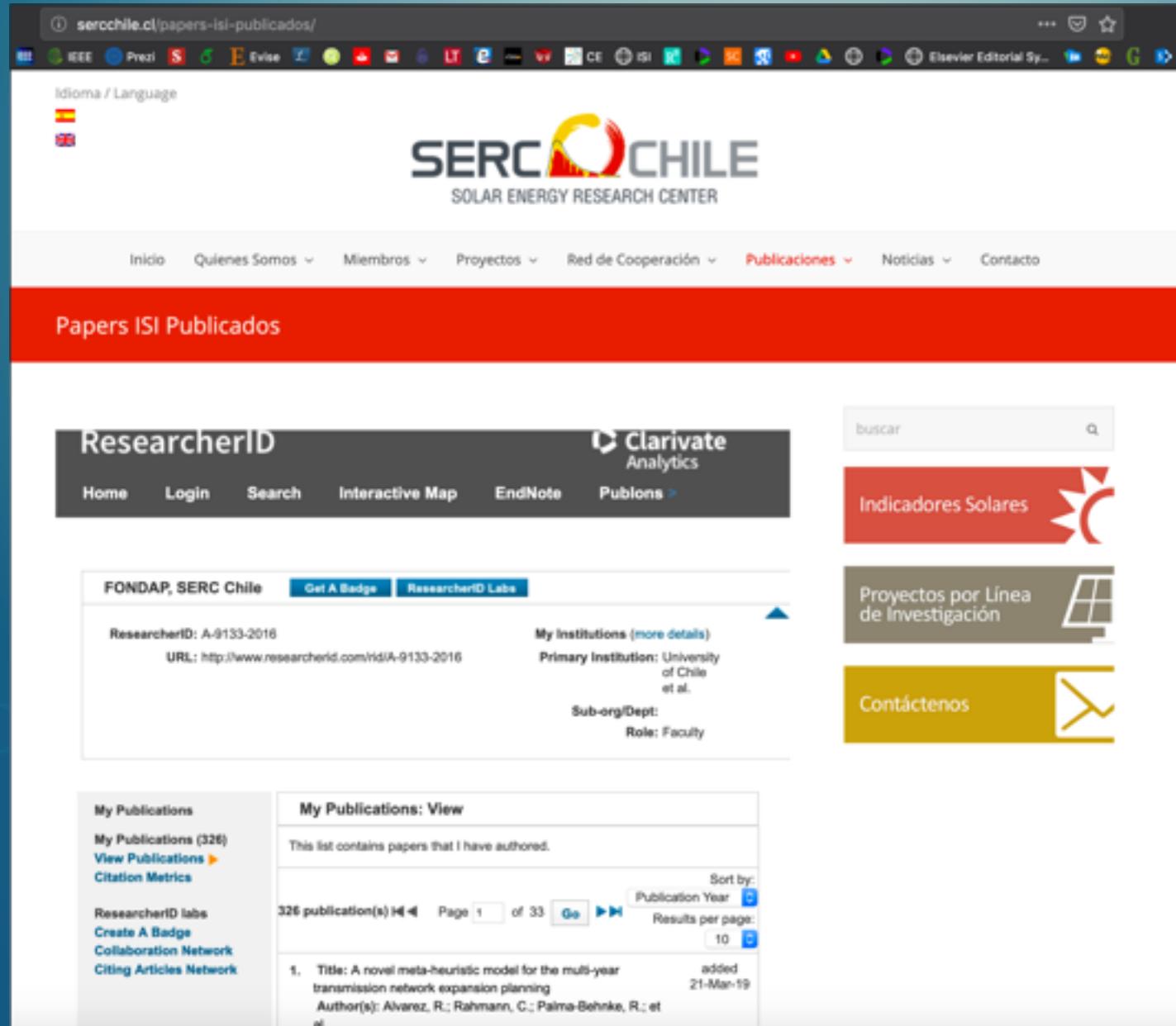
IV. Optimization and characterization of materials and solar resource under local conditions



# CONTEXT



**Figure 1:** Distribution of the number of citations of articles published by SERC researchers.**Figure 2:** Origin of articles citations published by SERC researchers. (a) Countries that have cited SERC articles. (b) Collaboration Network of SERC in ISI papers.



The screenshot shows the SERC CHILE website interface. At the top, there's a navigation bar with links to 'Inicio', 'Quienes Somos', 'Miembros', 'Proyectos', 'Red de Cooperación', **Publicaciones**, 'Noticias', and 'Contacto'. Below this is a red header bar with the text 'Papers ISI Publicados'. The main content area features a 'ResearcherID' integration. On the left, there's a sidebar with links to 'My Publications', 'My Publications (326)', 'View Publications', 'Citation Metrics', 'ResearcherID labs', 'Create A Badge', 'Collaboration Network', and 'Citing Articles Network'. The main content area displays a list of publications, with the first entry being:

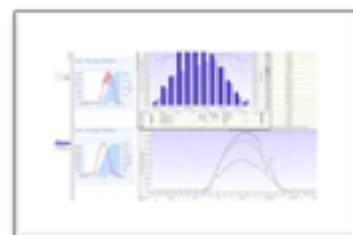
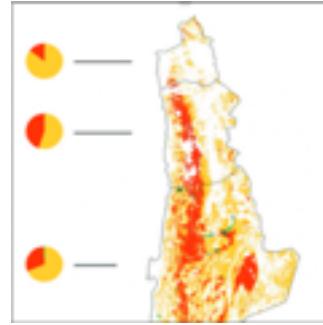
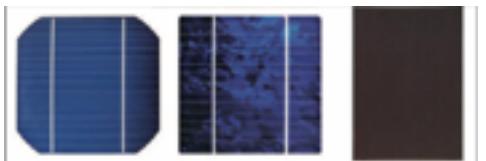
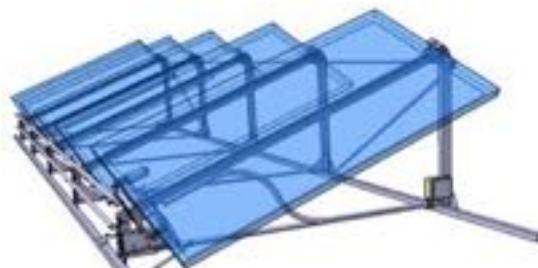
1. Title: A novel meta-heuristic model for the multi-year transmission network expansion planning  
Author(s): Alvarez, R.; Rahmann, C.; Palma-Behnke, R.; et al.

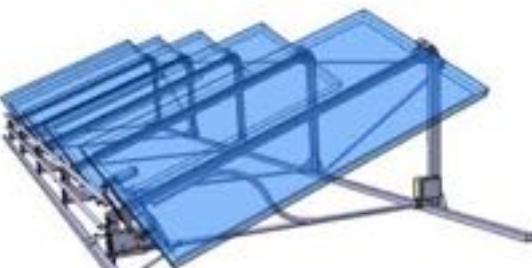
# OVERVIEW

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## PV added value chain

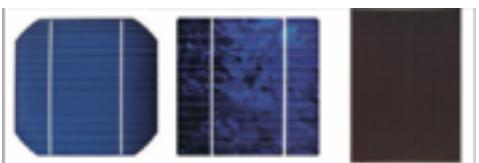




Structures



Modules



Cells



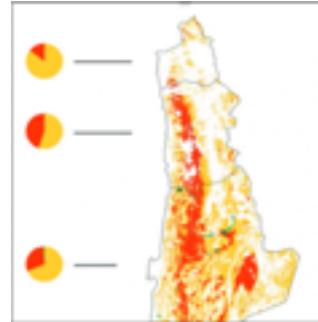
Materials



BoS O&M



Converters



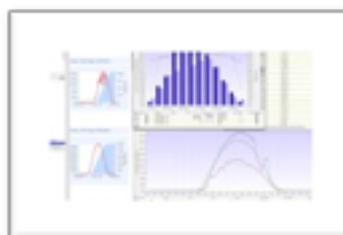
Characterization



PV solutions



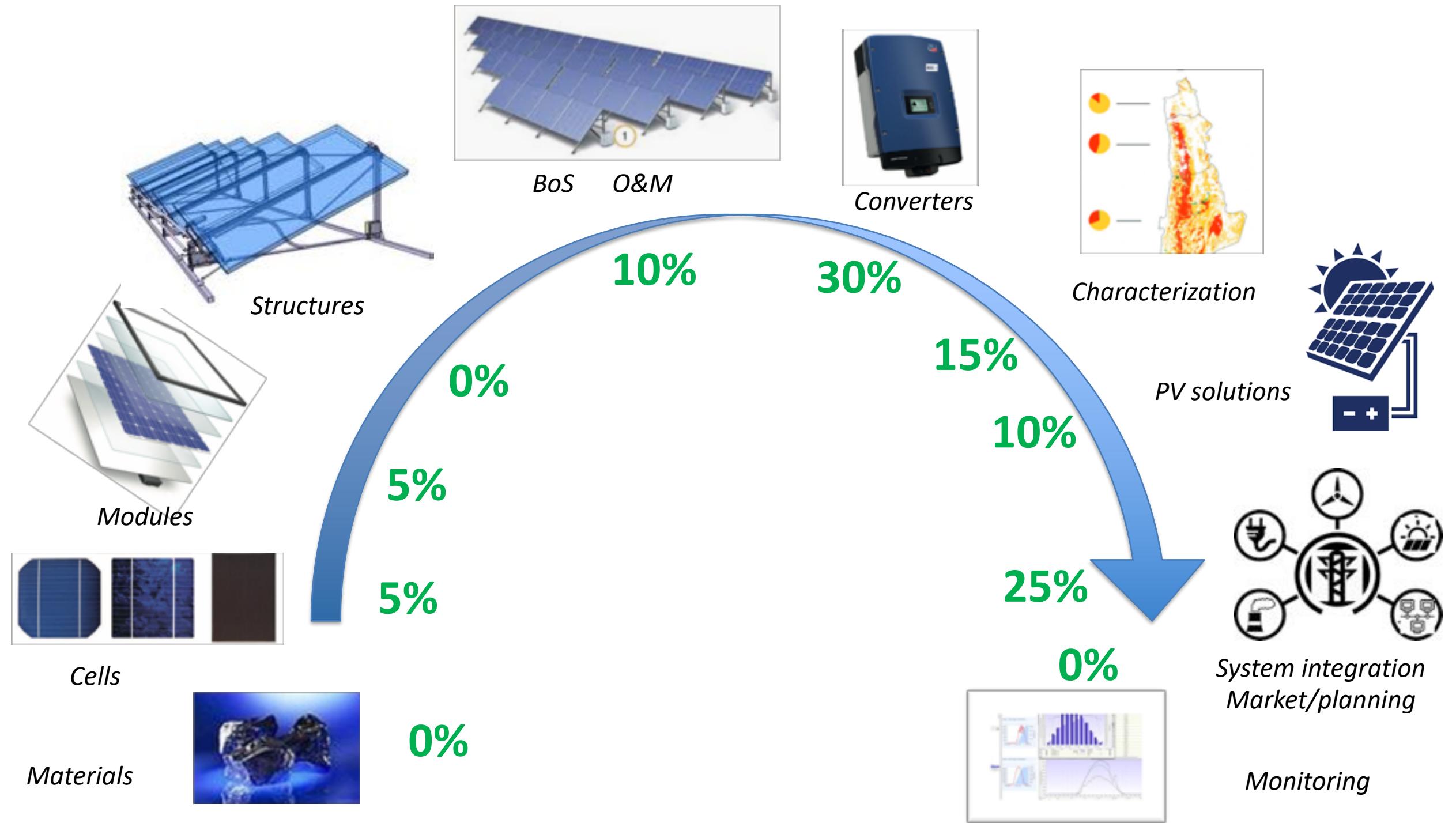
System integration  
Market



Monitoring / planning

137 / 326

42%



# Examples

- I. Massive integration of large-scale solar energy to the electric interconnected system



To supply 30% of the electricity consumption in Southamerica

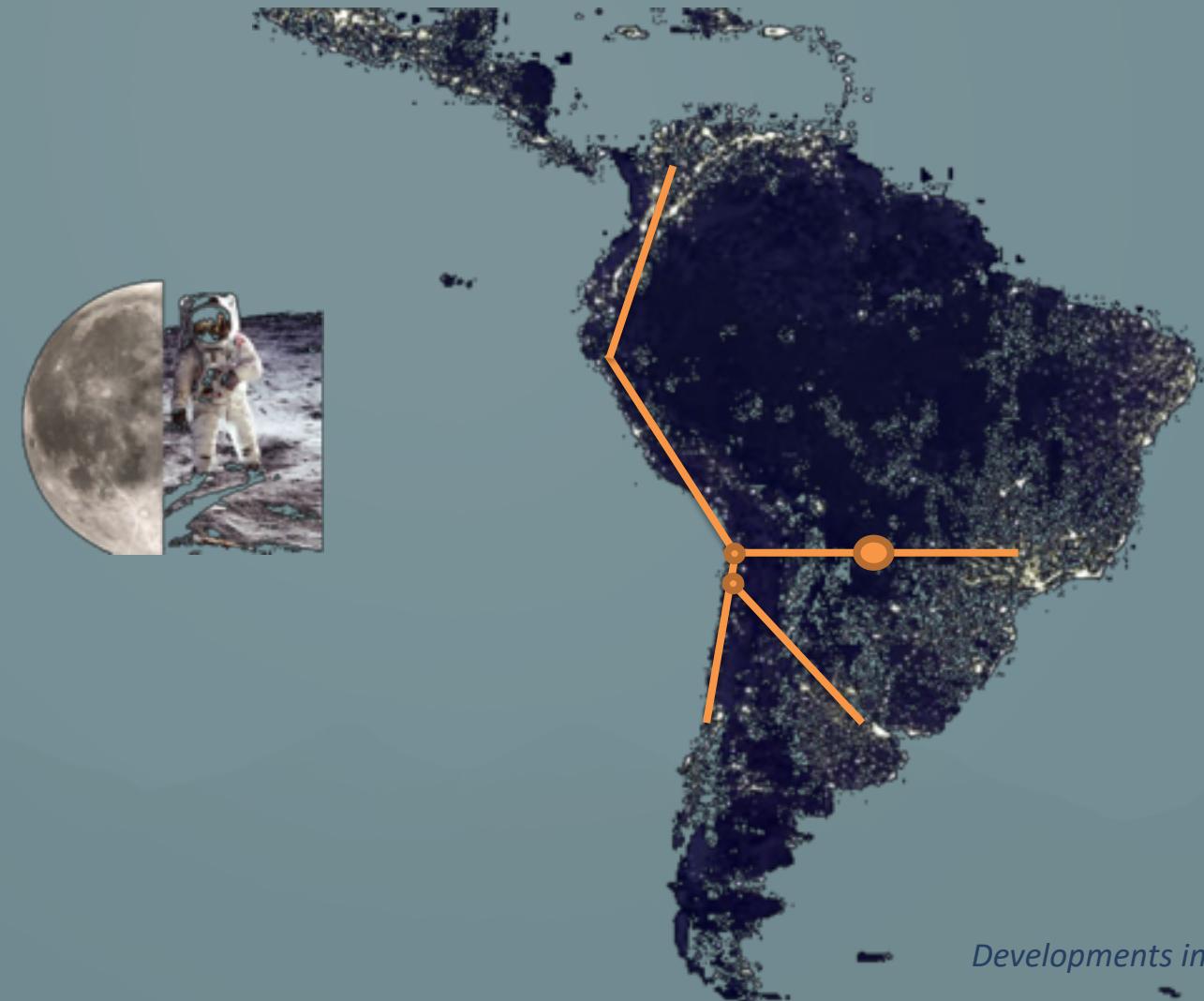
200.000 MW

~ 6.000 km<sup>2</sup> (3ha/MW)

0.8% of the Chilean surface

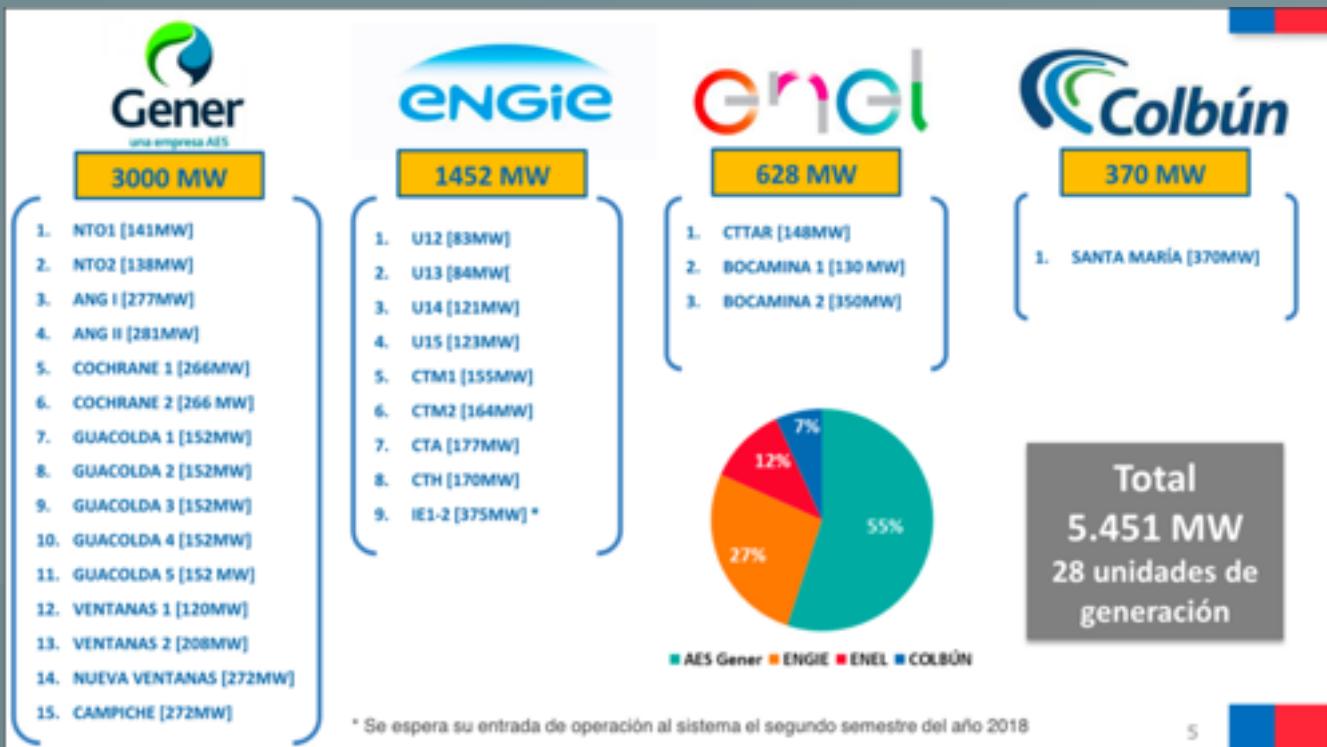
5% of the Desierto de Atacama

6 times the current Chilean consumption

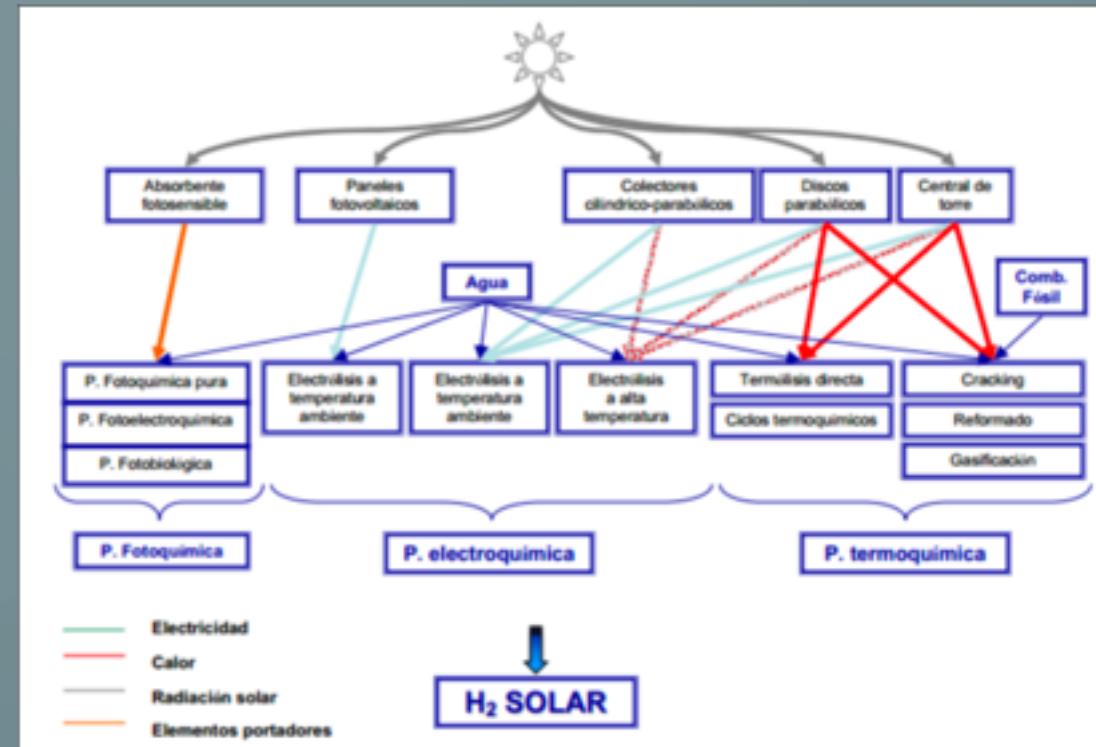


# Examples: Other Options of Massive Integration

- Solar Fuels → H<sub>2</sub>
- Attraction of industry → Sustainable energy pole
- Decarbonization of Chile → decommissioning of existing fossil fuel power plants.



Ref: Ministerio de Energía

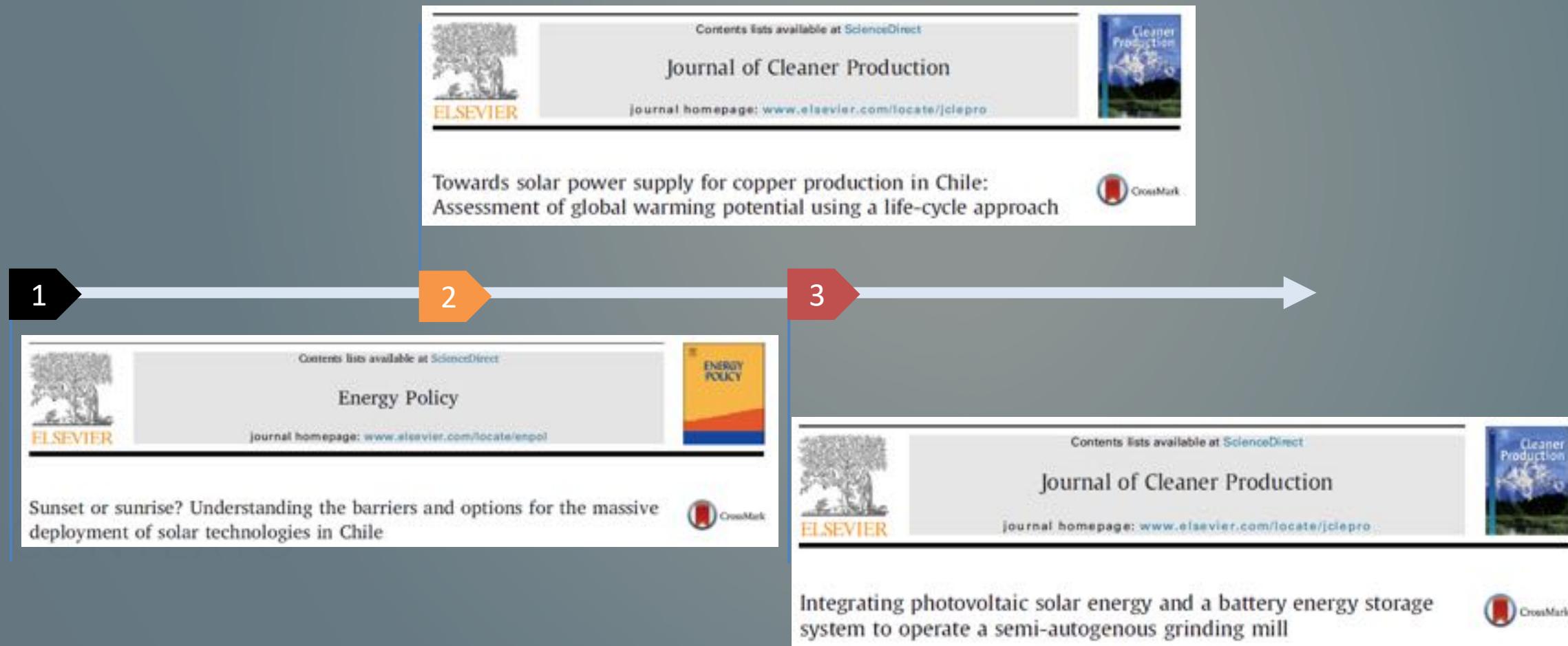


Ref: Producción de hidrógeno, empleando energía solar, Revista Elementos, 5, junio, 2015.

# SolarMining research activities related to mining processes

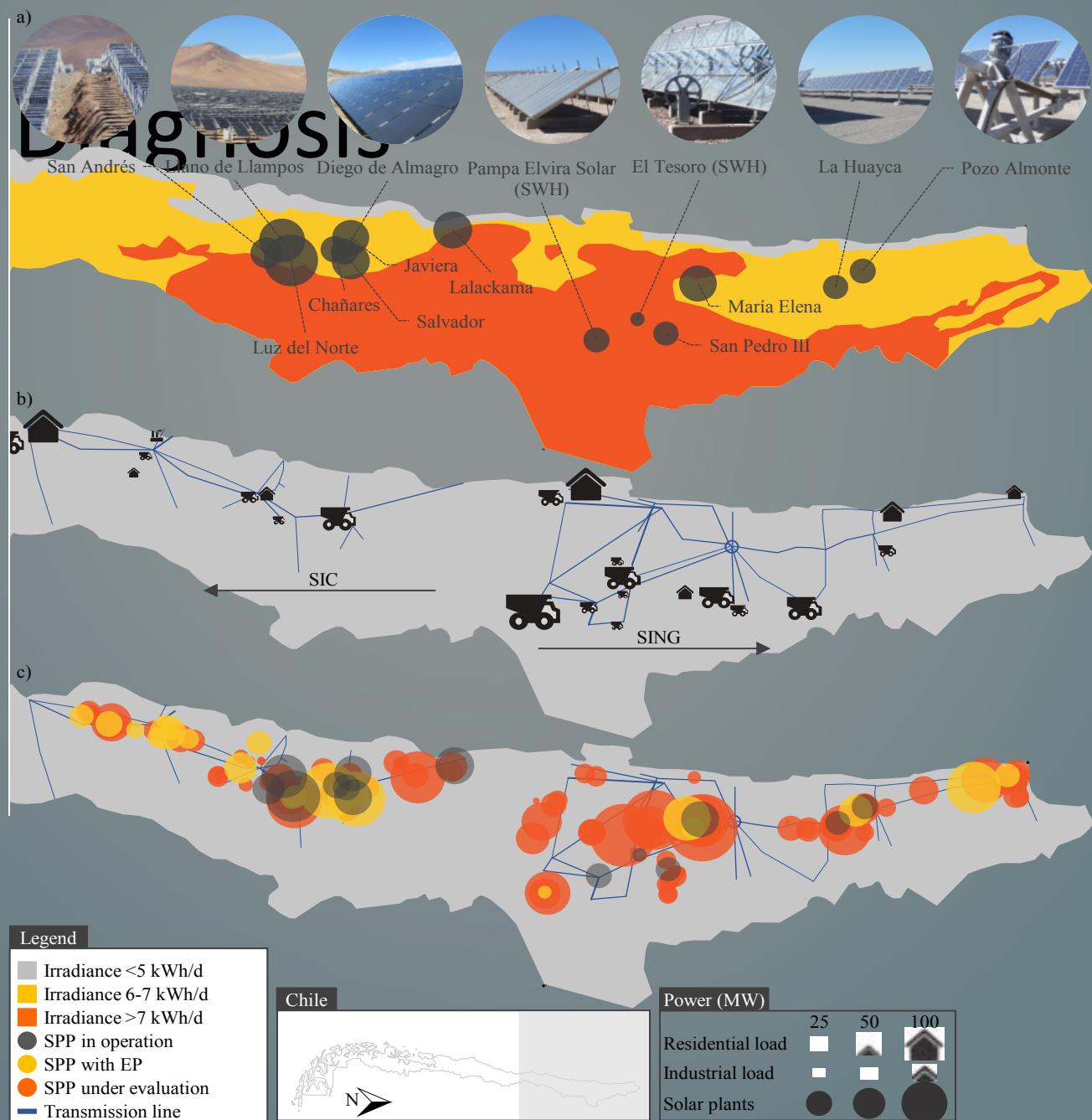
	<i>PV plant LCA + LCOE</i>	<i>CSP tower LCA + LCOE</i>	<i>CSP PT LCA + LCOE</i>	<i>Li Prod LCA + LCOE</i>	<i>Grinding + DSM + Solar</i>	<i>Zero Emission Trucks</i>	<i>LCA of Chilean Cu prod</i>	<i>Solar cooling, CS Li</i>	<i>CSP tower PV I/O matrix</i>	<i>S. Furnace metal. LCOE</i>	<i>LCA of Chilean Fe prod</i>	<i>Sunrise or Sunset</i>	<i>Li pipelines</i>	<i>Tires pyrolysis</i>	<i>Fresnel LCA + LCOE</i>	<i>Bf LO + LCOE</i>	<i>Macro-economic</i>
Electricity supply	●	●	●	●	●	●		●		●	●	●		●	●	●	
Min. extr.				●	●	●				●							
Concent.			●	●		●	●			●							
Refining				●			●			●		●					
Smelting						●			●	●	●		●				
Tailing						●				●							
Min. trans- portation					●							●					
Waste													●				

# Journal publications



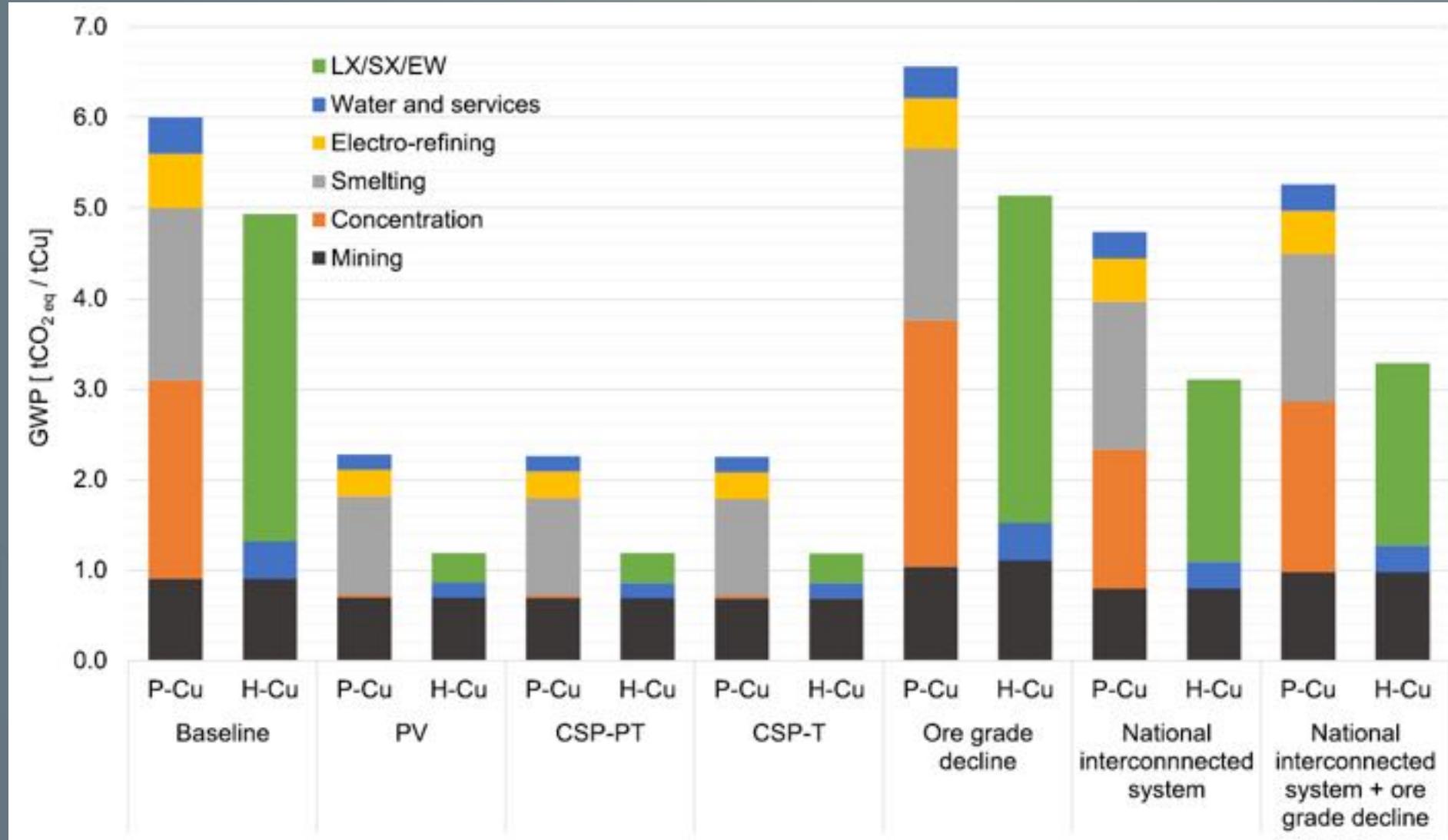
## Solar relation with mines

- **HIGH POTENTIAL SINERGY** between mining activities and solar plants
- **LATENT BARRIERS** to reach a higher use of the huge solar energy resource
- **POTENTIAL SOLUTIONS** to achieve a massive deployment of solar technologies in Chile

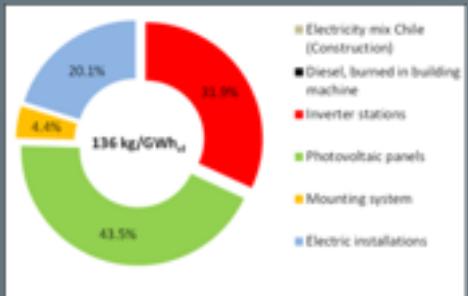
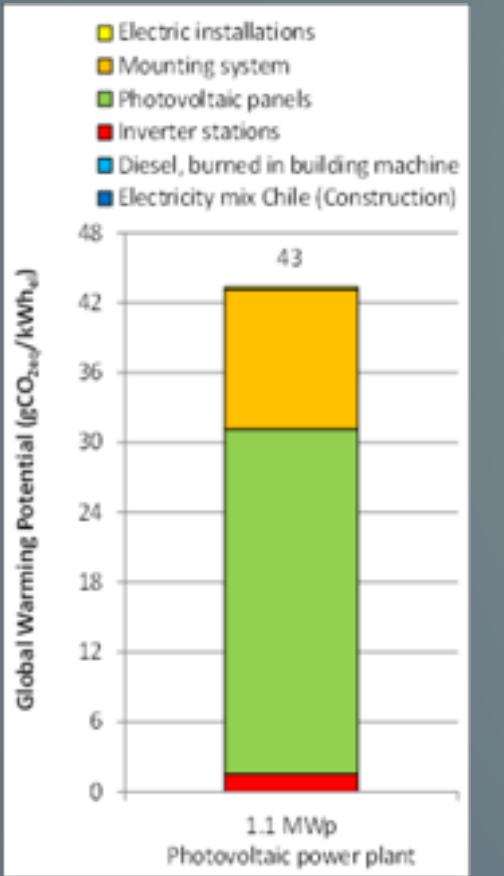


# Huge potential for environmental-impacts reduction through solar energy

SolarMining scientific contributions



## SolarMining technology briefs



**Solar Mining Technology Options – Techno-economic-ecological datasheet**

**Concentrated Solar Power**

**Parabolic Trough with storage**

**Solar power tower with storage**

**Description of technology**

The Parabolic Trough technology can be CSP technology. In 2015 approximately 94% are parabolic trough power plants [2]. Chile (Minera Escondida, at El Teniente, Solar thermal brenta María Elena 2002) and four projects announced [10]. In general, a parabolic trough solar field array, a thermal storage, water system (heat recovery steam generator) composed of rows of parabolic shaped reflectors in the focal point. The receiver tubes heat (PTC). Normally the PTC used is a heat exchanger to store the generated heat or to convert it to electrical energy. The receiver tubes are filled with a mixture salt molten between 300°C and 400°C. In the case ADPC and 100 bar pressure can be achieved.

**Proposed of a Solar-melting CSP plant**

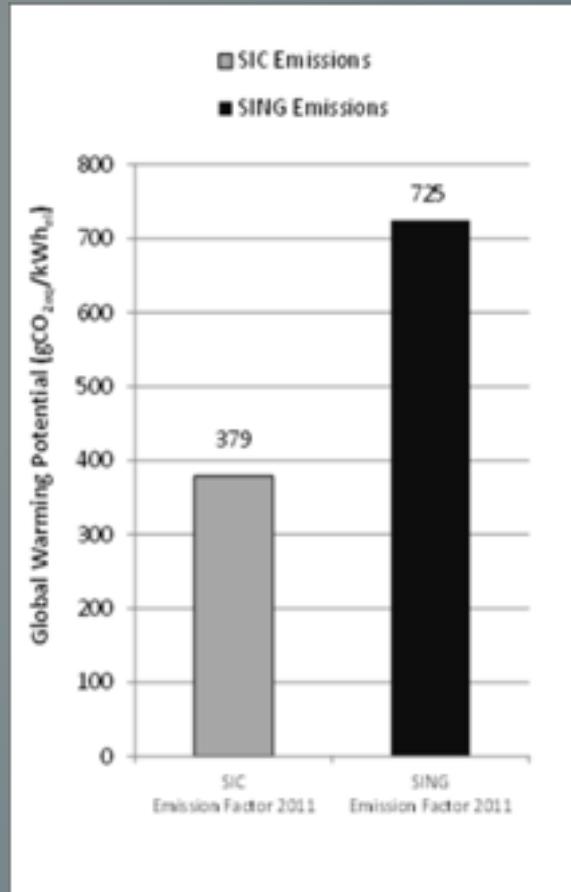
In the wind resource rich regions potential between solar energy and renewable energy use of the waste materials and competitive and so paper shows the potential energy concentrated solar system under conditions supplies mining waste modeled, based on [12], has 1400 GWh/a, of storage capacity ensures operation in terms of lifetime of 30 years and an investment of 200 US\$ /MWh, of invested 12.4 kg/tCu/MWh, of copper daily

**Description of technology**

Solar tower is a type of concentrated solar power (CSP) plants, where the components of the system are mirrors, flat or slightly curved, which reflect light to a specific receiver unit at a focus and were up to a heat transfer fluid (HTF) which converts it into a thermal energy that is used to produce steam (water or steam) to drive a turbine (Rankine cycle [2]) and then electricity through a generator (Rankine cycle [13] [14]). The tower can be either open air water or indirectly, through heat transfer fluid (HTF) [15]. Every tower cell (receiver), can receive independently with two directions of radiation, to maximize the potential of the receiver those three are the receiver, solar power tower [16] and the central tower [17] due to atmospheric attenuation and angular variation deviation [17-19]. In comparison with other CSP technologies, solar towers can achieve the greatest solar concentration [20-22] causing them to high operating temperatures (2000-3000 °C) and provide enough efficiency. However, HTF is more expensive than LF and PT due to the great installation of the receiver, which requires a more complex system to change the HTF temperature [23]. For instance, HTF operating capacity is currently around 600 MWh, 10% is invested in USA, and 452 MWh are under construction [24], whereas 120 MWh are located in Chile, under the Alumbrera project [25]. Furthermore, which consider a solar tower plus 25.5 hours of thermal energy storage

**Proposed of a Solar-melting CSP technology option for the mining industry in Chile**

In the last resources-rich regions of Chile an important option potential difference after energy and mining needs, shows the intensive-energy use of the mining sector, the potential is highly relevant for achieving the country's goal as terms of energy costs, emissions and competition and sustainable material extraction. This paper shows the potential resources required by special electric power generation systems, such as solar power plants, which produces electricity with low environmental impact. Such a concentrated solar power plant can be considered as an opportunity for Chilean mining companies.

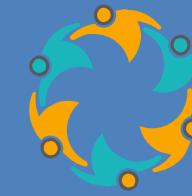
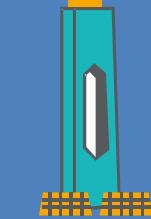


Technology briefs available at:  
[serc.cl/solar-mining](http://serc.cl/solar-mining)

# Final Document

SolarMining set of proposals

Ore concentration	Tailings	Smelting and refining	Mine operation and planning	Hydro-metallurgy
2+	3+	2+	6+	2+



INSTITUCIONES SERC CHILE EJECUTORAS:



SOCIOS ESTRATÉGICOS:





## Región de ARICA Y PARINACOTA

The main objective of this project is to **create human capital** in order to promote and reinforce the **sustainable development** of urban and rural communities through the use of **solar energy**, in accordance to the needs of each area.





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