

# Green Hydrogen and Geothermal Energy: an opportunity for a sustainable circular economy

Dr. Diego Morata

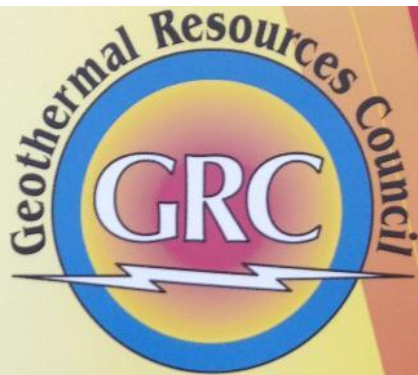
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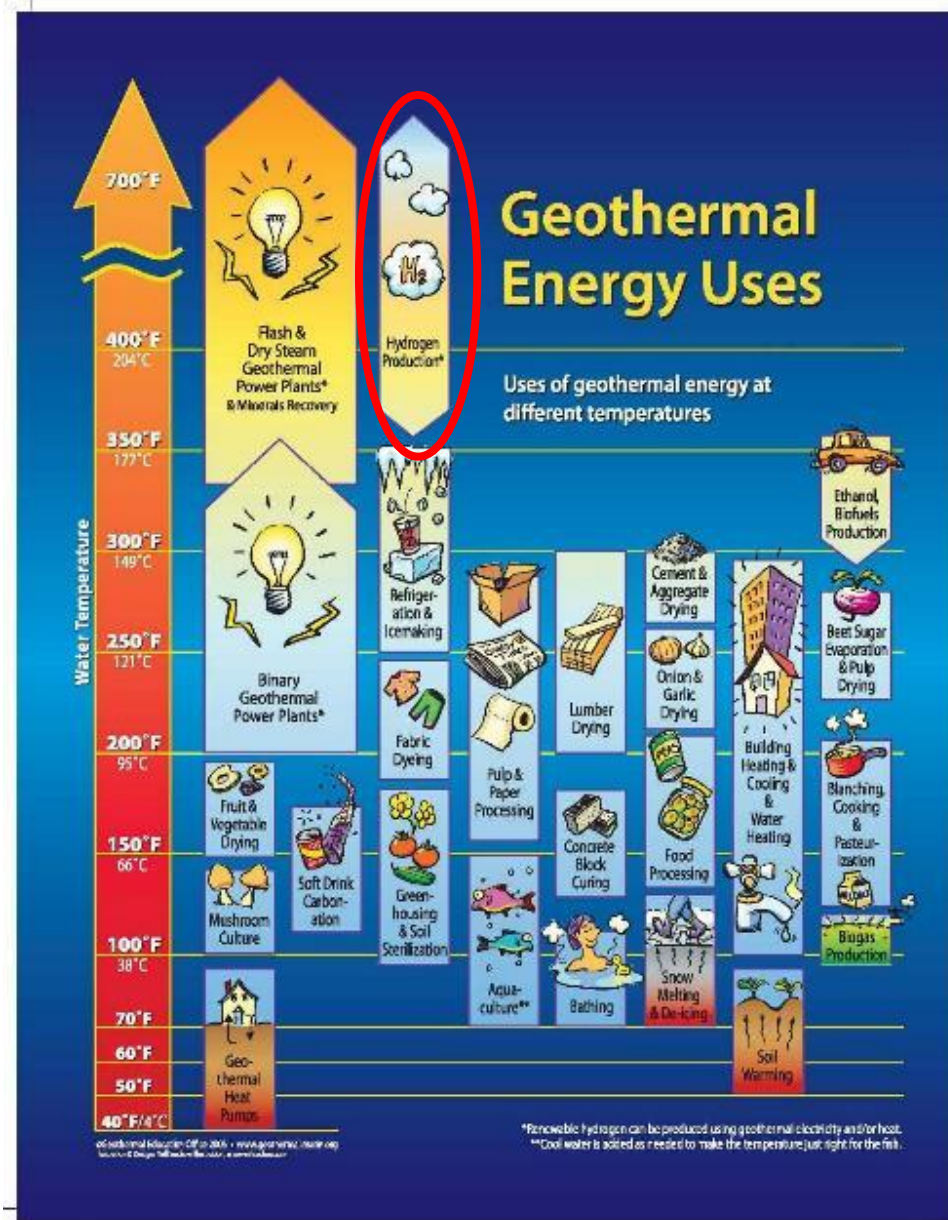
*“CE is important for its power to attract both the business community and policy-making community to sustainability work, but it **needs scientific research** to secure that the actual environmental impacts of CE work toward sustainability”. (Korhonen et al, 2018, Ecological Economics, 143, 37-46)*



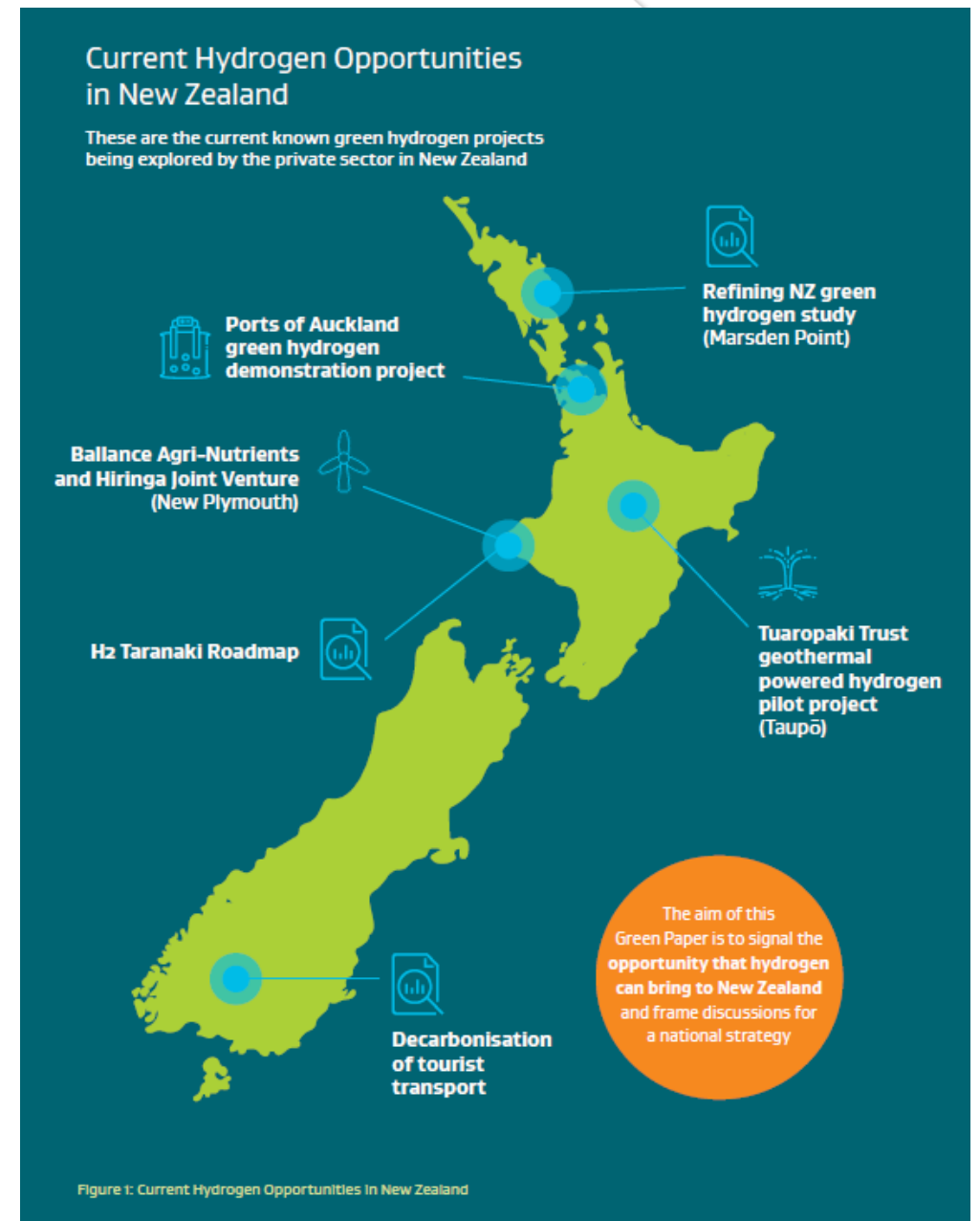
# Why Geothermal?

- ▶ **Reliability:** Baseload power production 24 hours a day, 7 days a week, 365 days a year regardless of how much wind or sunlight is available.
- ▶ **Versatility:** Geothermal energy can be used to produce power in utility-scale facilities or for a wide variety of direct use applications, such as heating greenhouses, de-icing sidewalks and dehydrating agricultural products.
- ▶ **Small Environmental Footprint:** Geothermal power plants emit lower levels of emissions than fossil fuel plants, and use less land per megawatt than other renewable energy sources.

Temperature ranges determining the possible utilization are best represented on the Lindal diagram (Source: IGA)



# Geothermal Energy and Green Hydrogen: the international experience





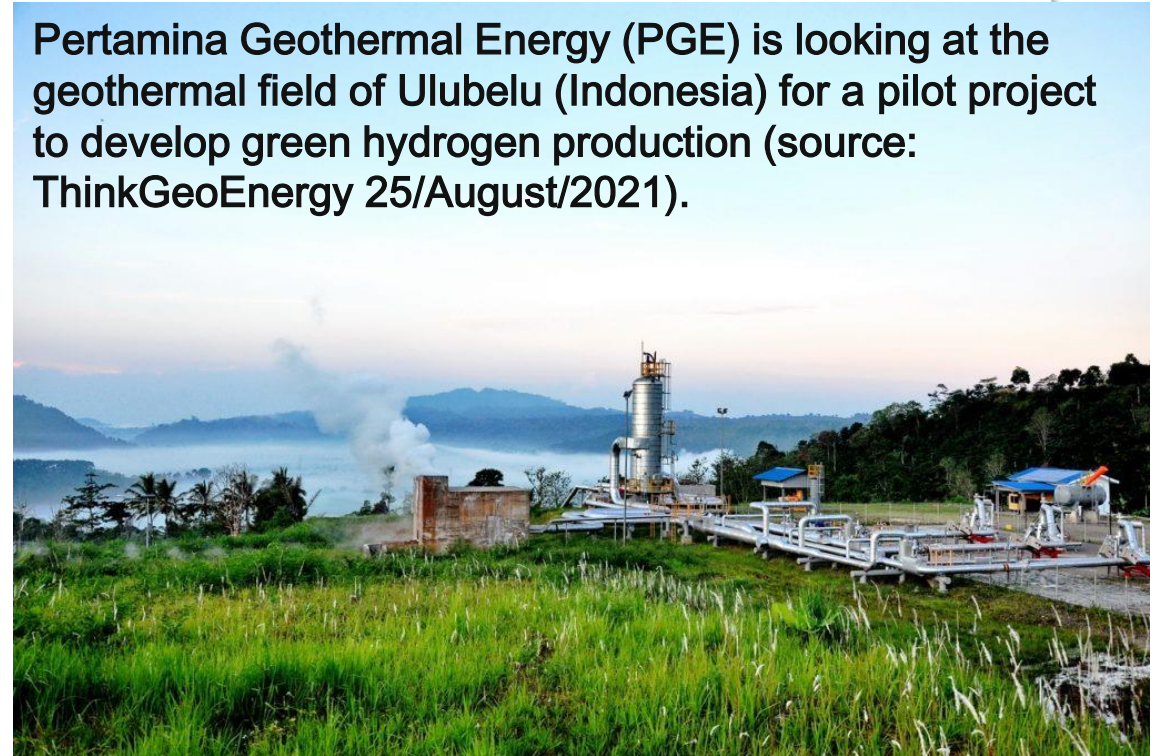
# Geothermal Energy and Green Hydrogen: the international experience

Hydrogen production project kicked off at Mokai geothermal plant, New Zealand (source: ThinkGeoEnergy 13/September/2020)



*Halcyon Power, a joint venture between Tuaropaki Trust and Japan's Obayashi Corp. kick off construction of a 1.5 MW hydrogen production facility at the Mokai geothermal power plant near Taupo, New Zealand.*

Pertamina Geothermal Energy (PGE) is looking at the geothermal field of Ulubelu (Indonesia) for a pilot project to develop green hydrogen production (source: ThinkGeoEnergy 25/August/2021).



# Geothermal Energy and Green Hydrogen: the international experience



## Iceland to use geothermal energy for green hydrogen production

*A new production facility is slated to convert the hot water in Iceland's underground to fuel for the transport sector*

*(Source:*

*<https://energywatch.eu/EnergyNews/Renewables/article13190418.ece>)*

# Chile and Green Hydrogen: the national proposal....



**Gobierno de Chile**  
gob.cl

**ESTRATEGIA NACIONAL DE  
HIDRÓGENO VERDE**  
Chile, fuente energética para un planeta cero emisiones

Energía eléctrica renovable  
Agua

**Hidrógeno Verde**

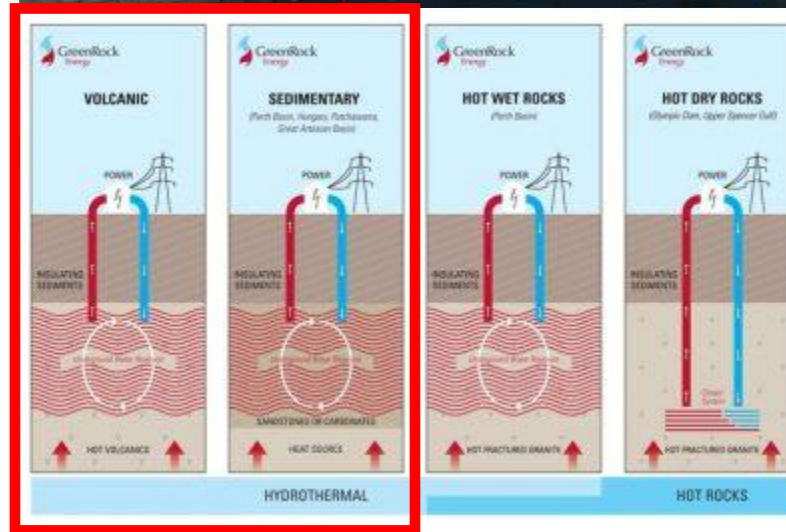
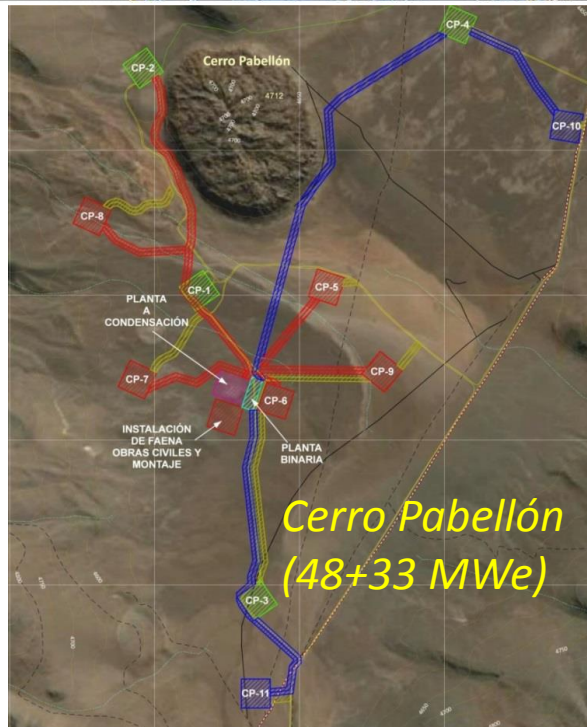
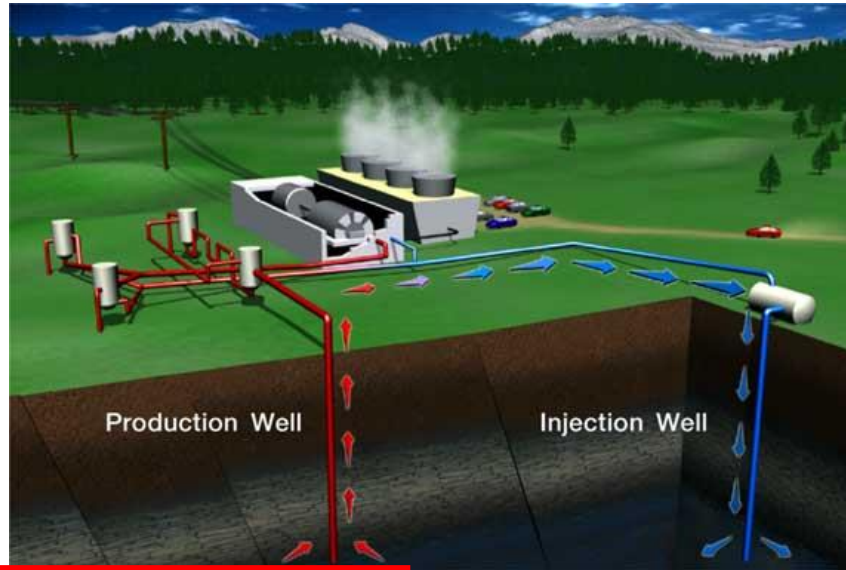
O<sub>2</sub>  
H<sub>2</sub>

The image shows a scenic view of snow-capped mountains and a lake. In the top right corner, there is a logo for the Chilean Government (Gobierno de Chile) with the website gob.cl. The main text reads 'ESTRATEGIA NACIONAL DE HIDRÓGENO VERDE' and 'Chile, fuente energética para un planeta cero emisiones'. Below this, a diagram illustrates the production of green hydrogen: 'Energía eléctrica renovable' and 'Agua' are inputs to a process that produces 'Hidrógeno Verde', with 'O<sub>2</sub>' and 'H<sub>2</sub>' as outputs.

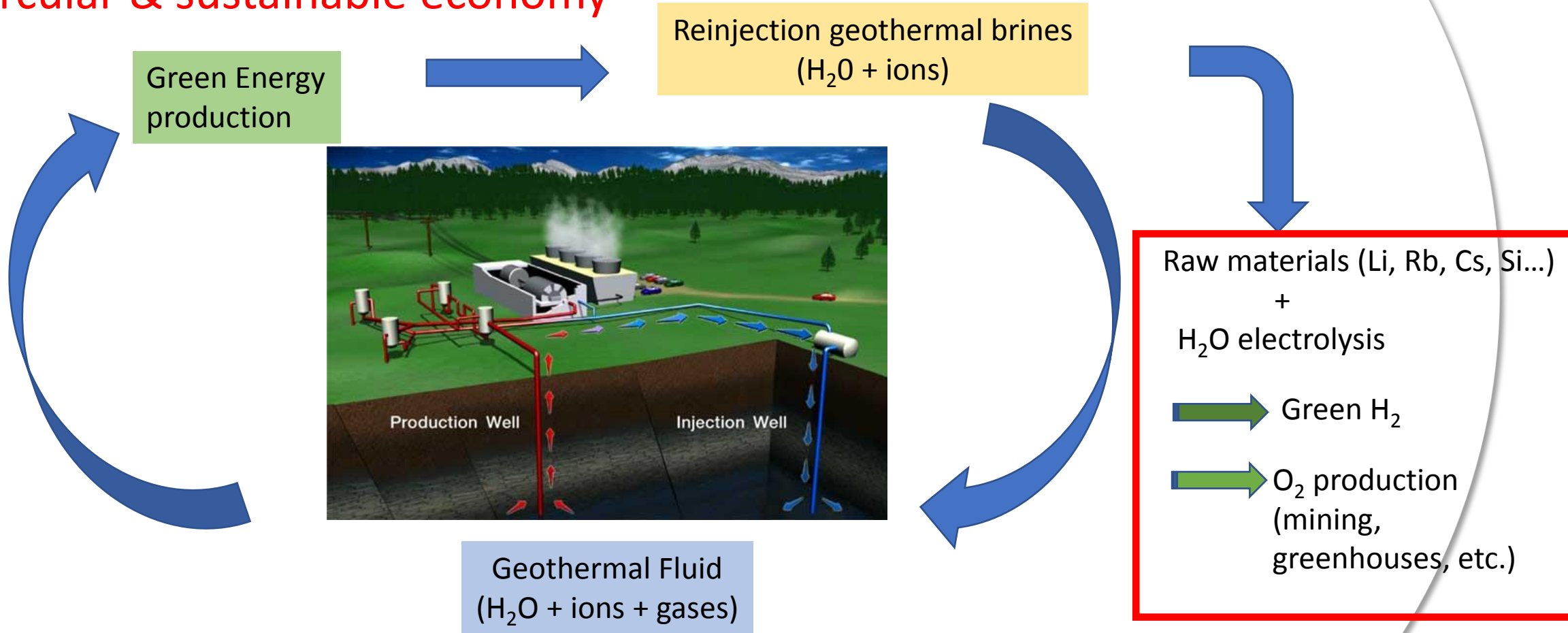




# Electricity production with Geothermal Energy

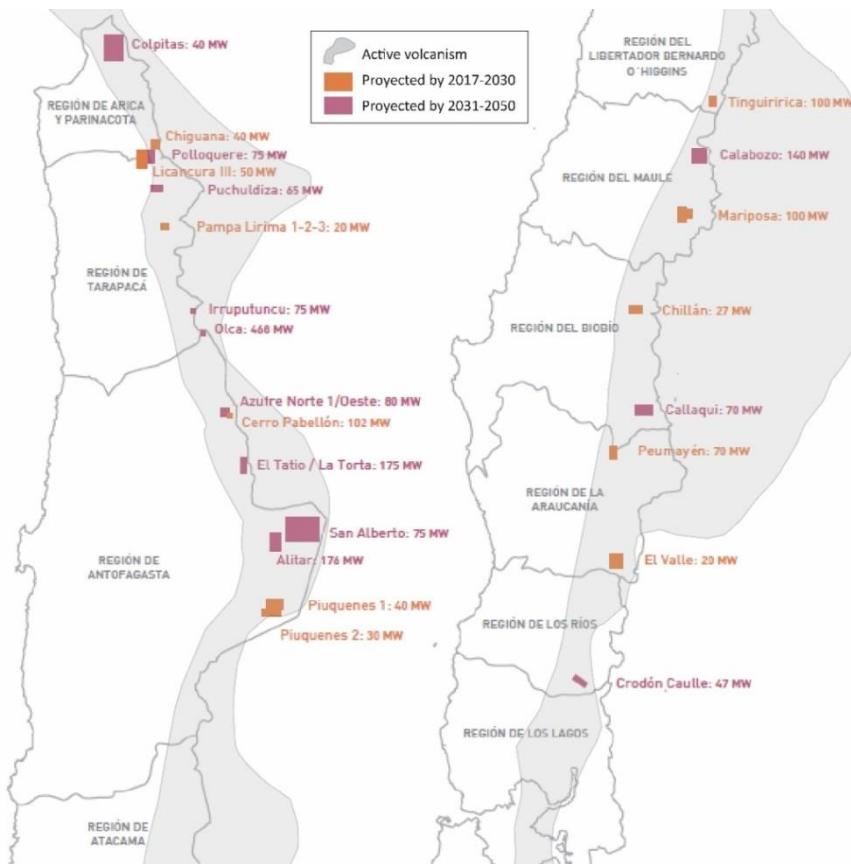


# Geothermal Energy and Green Hydrogen: a proposed example for circular & sustainable economy





# Geothermal potential to be installed by 2030 & 2050.....



Source: Mesa de Geotermia 2017  
 (<http://www.minenergia.cl/mesa-geotermia/>)

| Period                 | Minimum Capacity (MW) | Maximum Capacity (MW) | Reference Capacity (MW) |
|------------------------|-----------------------|-----------------------|-------------------------|
| 2017-2030              | 471                   | 599                   | 599                     |
| 2031-2050              | 827                   | 3,243                 | 1,487                   |
| <b>Total 2017-2050</b> | <b>1,298</b>          | <b>3,842</b>          | <b>2,086</b>            |

# The first steps....



Federal Ministry of Education and Research

brine mine

## BrineMine

Sustainable mineral and fresh water extraction from geothermal brines in Chile

**25** may  
15:00 pm | Germany

## The potential of raw material extraction from thermal brines – Successful milestones of the BrineMine project

By V. GOLDBERG, D. WINTER, F. NITSCHKE, M. RATH, S. HELD, L. SPITZMÜLLER, I. BUDACH, M. PAVEZ, D. MORATA, J. KOSCHIKOWSKI and T. KOHL\*

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### Abstract

The BrineMine Project is a German-Chilean interdisciplinary research project realized by research and

industry partners. The focus is on development of strategies for raw material and water extraction from geothermal springs (Brine Mining) in Chile. The topics can be separated into a geological-geochemical part and a mechanical engineering part, which are processed in close cooperation by the project consortium. In the first part, the economic potential of the dissolved raw materials in thermal spring waters in Chile is assessed by analyzing existing geochemical data of different sites. This is complemented by hydrogeochemical and geophysical exploration campaigns. The second part focuses on the development, construction and implementation of a prototype for pre-treatment and concentration of geothermal brines. With the comprehensive expertise of the team, a treatment strategy was developed and tested in a geothermal power plant, enabling controlled silica precipitation in order to overcome this limiting factor for geothermal energy production and associated raw material extraction.

In this study, successful milestones of the BrineMine project are presented. The economic potential of ele-

ments in Chilean thermal waters is demonstrated. Additionally, the global potential of Brine Mining is outlined. The development of the silica treatment strategy is further described, as well as a possible integration of a prototype into an operating geothermal power plant. Finally, the construction and implementation of a large-scale first-generation prototype are presented with promising field results.

### Introduction

The energy transition and the associated demand for non-energy, mineral raw materials have prompted the German government to expand research and development activities along the entire value chain. The focus is on economically strategic raw materials, of which the availability for future technologies and the high-tech industry must be secured to reduce dependence on the world market. The development of new resources offers the potential to complement conventional raw material extraction and thus to achieve the

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(Photo: stock.adobe.com)



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## In conclusion...

- **Green Hydrogen can be produced using geothermal energy**
- **Geothermal energy: 24/7 electricity production**
- **Geothermal fluids: H<sub>2</sub>O dominated**
- **Possibility for a green mining recovering raw materials and generating water**
- **Balance between brine reinjection and H<sub>2</sub> + O<sub>2</sub> production**
- **O<sub>2</sub> production could be used for mining industry (leaching processes, metal recovery, geometalurgy, ...) and also for agriculture (between other applications)**
- **Huge geothermal potential in Chile**
- **Regional distribution of high-T geothermal reservoirs along the Chilean Andean Cordillera**
- **An excellent opportunity for R+I+D programs**