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# EFFICIENCY OF GREEN HYDROGEN PRODUCTION IN BOLIVIAN SALT FLATS FOR THE DEVELOPMENT OF THE BRINE RESOURCES INDUSTRY


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# INTRODUCTION

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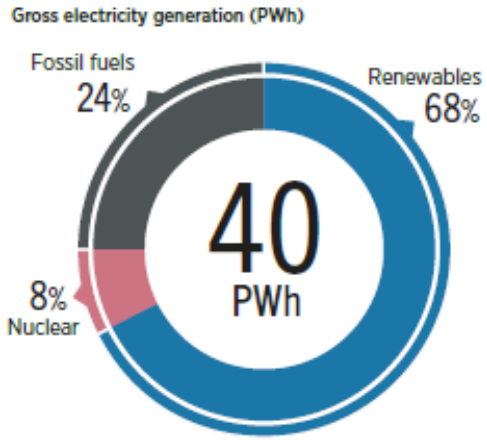
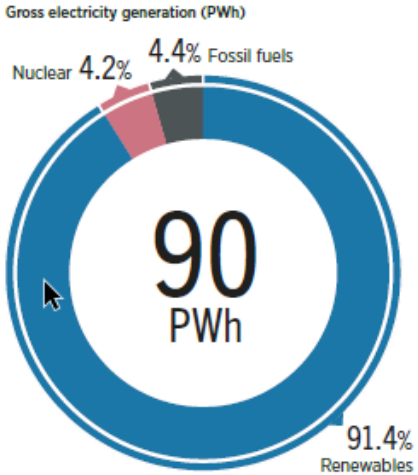


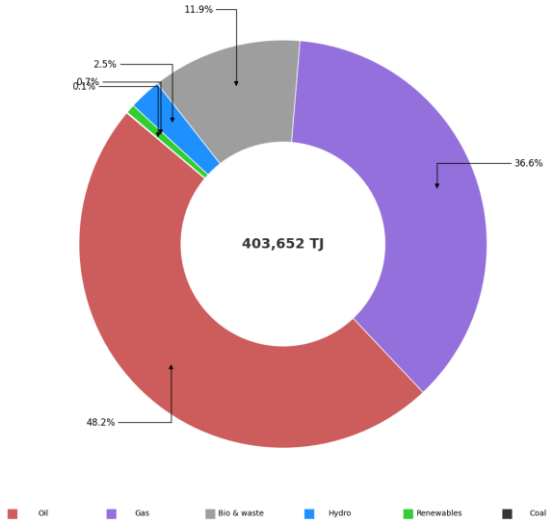

## Scenario 2030

According to the World Energy Transition Outlook 2024, about 30% of total energy corresponds to renewables, while more than 60% represents fossil fuels.



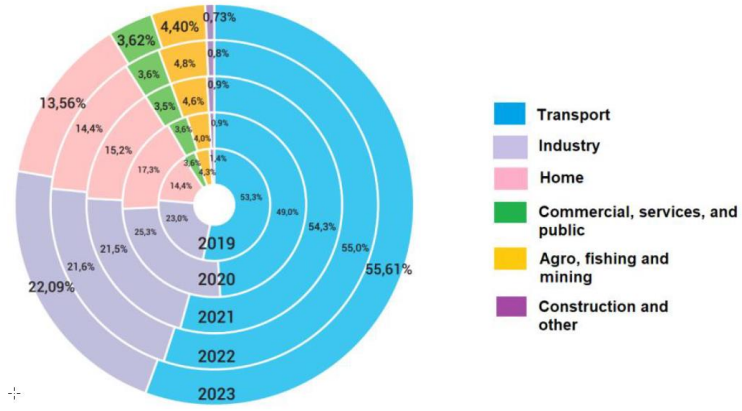

## Scenario 2050

By 2030, it is projected that more than 60% will be renewable energy and almost 24% fossil fuels.
While by 2050, it is estimated that 90% will correspond to renewable energy.




## Bolivia's Total Energy Supply 2022

According to this distribution, oil and gas make up more than 80%. In fact, the problem with these data is that Bolivia imports oil and the gas is running out.




## Bolivia's Energy Consumption by Sector

Of the total of this energy, the industry uses a little more than 22%, in a scenario where the boom of the industry persists in different areas of development, including mining.
So, the use of alternative energies is a necessity to minimize the risk of energy supply.

# CHARACTERIZATION

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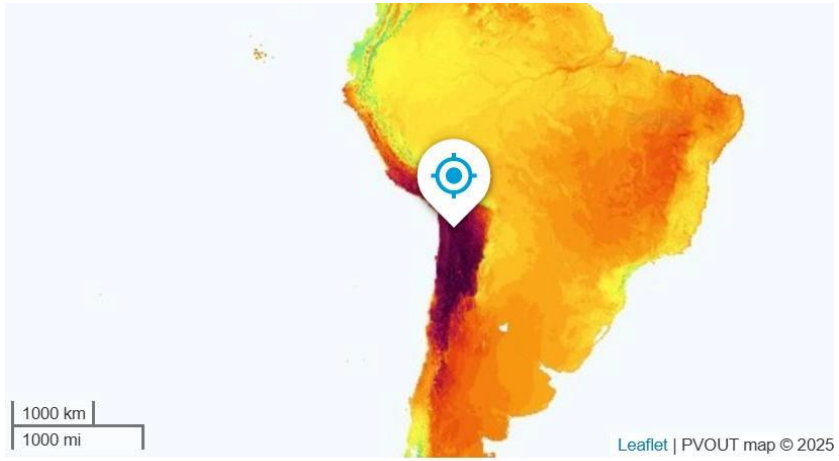
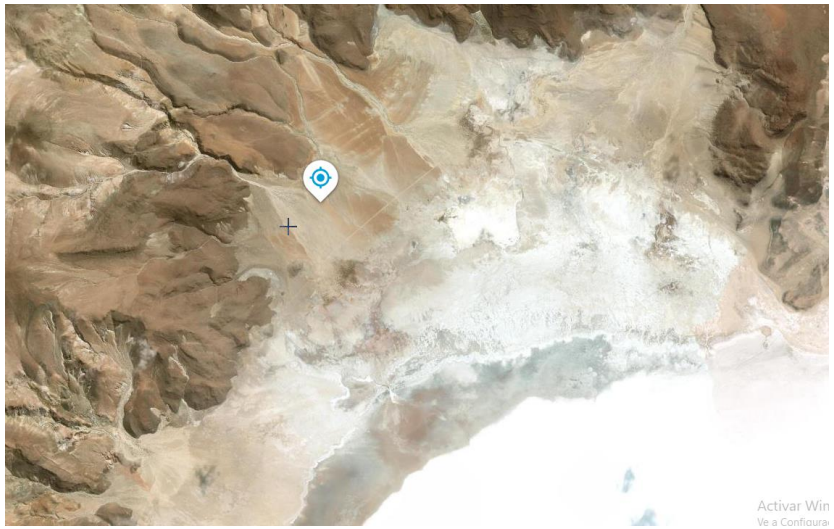
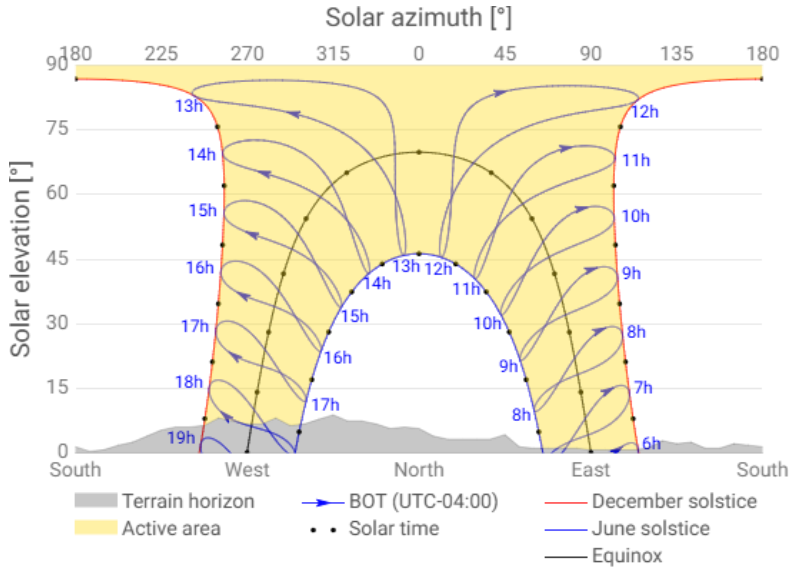
IRRADIATION MAP



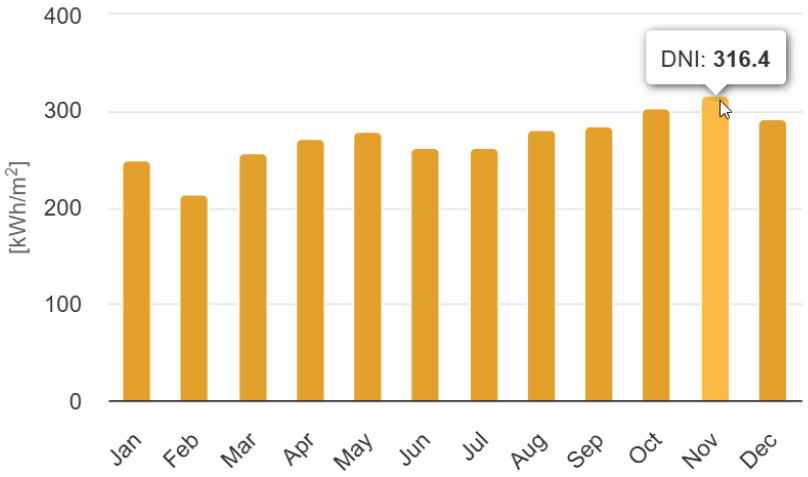

MAP ACCORDING TO COORDINATES



HORIZON AND ZONE PATH




DIRECT NORMAL IRRADIATION




It was identified that the territories of Chile and Bolivia have the greatest energy potential due to solar irradiation. It can also be appreciated that an important feature is that solar radiation both per month and during the day is stable.

The site where it is suggested to implement a solar plant has industrial plants that require heat energy since the transportation of fuel either oil or gas has a high cost.

# RESEARCH FINDINGS

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## Solar Irradiation Comparison

| Location | Average Solar Irradiation (kWh/m²/day) | Comparison |
|---|---|---|
| Empexa | >7.3 | Benchmark |
| Germany (leader) | ~2.9 | ~60% lower |
| California | ~6.2 | ~20% lower |
| Atacama (Chile) | ~7.2 | Slightly lower |
| Worldwide | ~4.0 | ~45% lower |

The global average for horizontal solar irradiation is approximately 3.5 to 4.5 kWh/m²/day.

The region where the Empexa salt flat is located naturally receives extremely high solar radiation. At an altitude of 3,717 meters above sea level, it enjoys a dry environment with clean air. Furthermore, relatively low temperatures further enhance efficiency and the stability of solar radiation throughout the year, as can be seen in Figures 1 and 2, provided by the Global Solar Atlas.

## Chemical composition of the main salt flats of Bolivia

| Salt Flat | % brine concentration mg/l | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Li | Mg | K | Na | Ca | B | Cl | SO4 |
| Uyuni | 0.13 | 2.5 | 1.76 | 5.21 | 0.03 | 0.21 | 15.97 | 2.3 |
| Coipasa | 0.05 | 2.06 | 1.35 | 7.01 | 0.02 | 0.1 | 12.43 | 5.58 |
| Pastos Grandes | 0.09 | 0.230 | 0.59 | 9.64 | 0.16 | 0.05 | 16.70 | 0.280 |
| Empexa | % brine concentration mg/l | | | | | | | |
| | 0.224 | 6.91 | 6.71 | 115.12 | 0.58 | 0.28 | 190.15 | 18.3 |
| | % concentration in surface waters mg/l | | | | | | | |
| | 2.4 | 81.3 | 51.7 | 786.6 | 273.7 | 13.4 | 1740.3 | 356 |

All sodium hydroxide or potassium hydroxide is manufactured artificially by chemical processes such as causticization, where hydrogen, oxygen, and sodium molecules react (for example, calcium hydroxide and sodium or potassium carbonate); as well as by the electrolysis of sodium or potassium chloride solutions.

Potassium hydroxide (KOH) consistently demonstrated a marginal but statistically significant performance advantage over sodium hydroxide (NaOH) under identical conditions [4]. This is attributed to its superior ionic conductivity, which resulted in higher production rates and greater responsiveness to operational changes.

# GH2 APPLICATION

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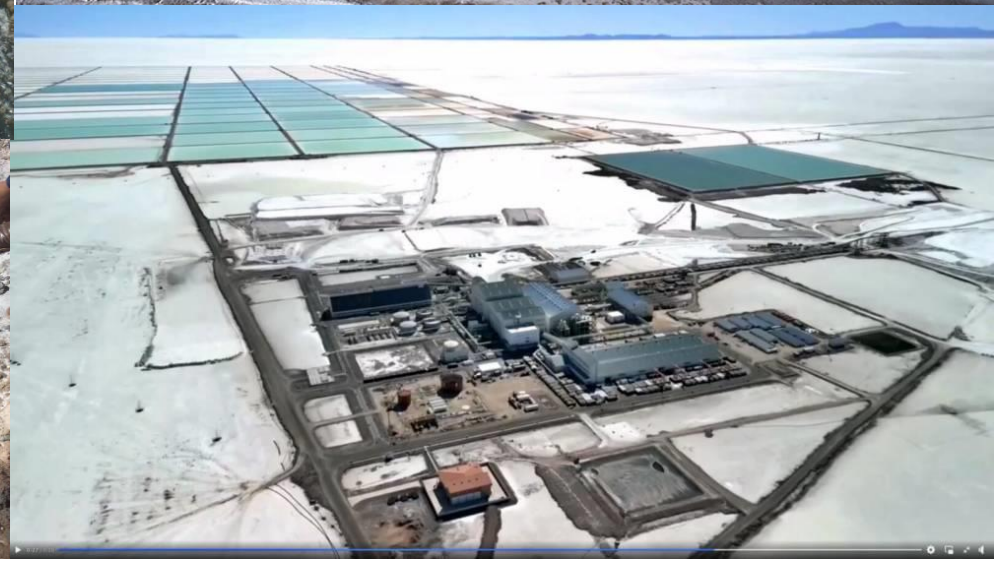
Technically, the hydrogen we propose can be implemented in the internal combustion engines of heavy machinery or turbines. However, challenges remain in improving safety systems. Similarly, it can be used to replace natural gas or diesel with significant advantages due to its combustion properties.

It is important to note that the existing industries in Bolivia's salt flats lack industrial energy security, as there are no industrial gas pipelines and fuels such as diesel and gasoline must be imported. Even current industrial plants lack these inputs, jeopardizing their continuity and permanent operation.



# THANK YOU!!!