

Centro de Tecnologías  
para Energía Solar



# Comparison between Concentrated Solar Power and Gas-Based Generation in Terms of Economic and Flexibility-Related Aspects in Chile

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19/05/2021

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1 Introduction

2 Results

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QR code



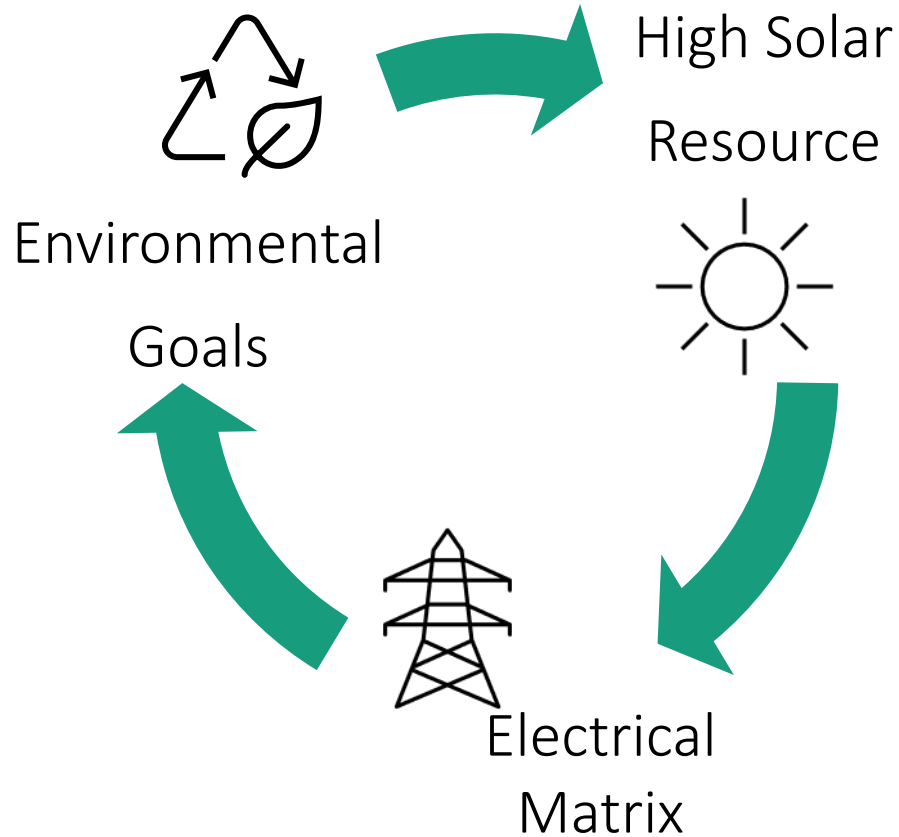
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# Introduction



**Electricidad**  
La revista energética de Chile

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**ENERGÍA**

## El gas natural en la transición energética mundial ?

cuál es... medidas que se impulsan, junto...

# Introduction

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## Economic Comparison according to LCOE

## Systemic attributes

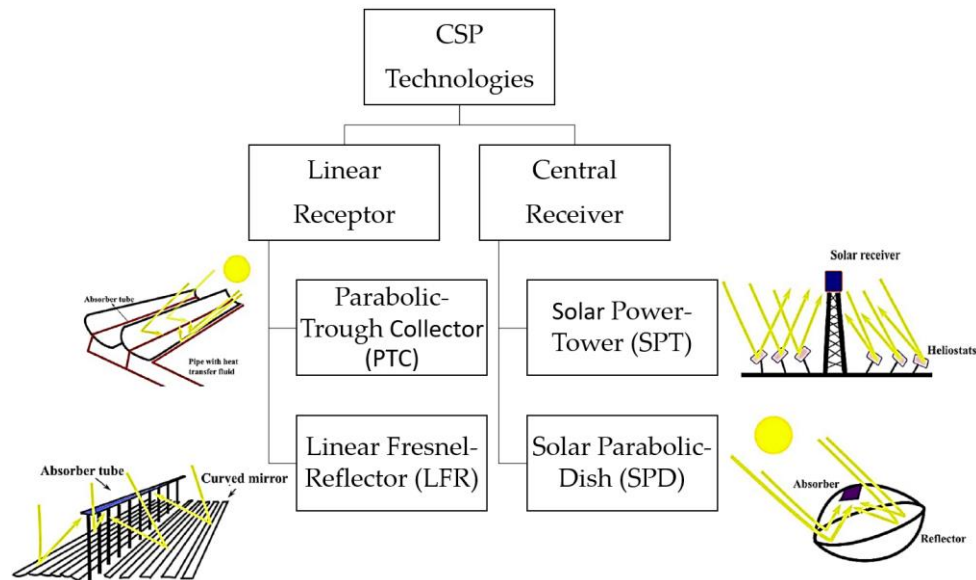
- Hybrid Plant.
  - Solar Tower Power (STP) with 13 hours of storage
  - Photovoltaic (PV)
- Natural gas combined Cycle (CC).
- Solar Tower Power with 6 hours of storage.

- Flexibility
- Reliability
- Economic Risks
- Decarbonization Scenario

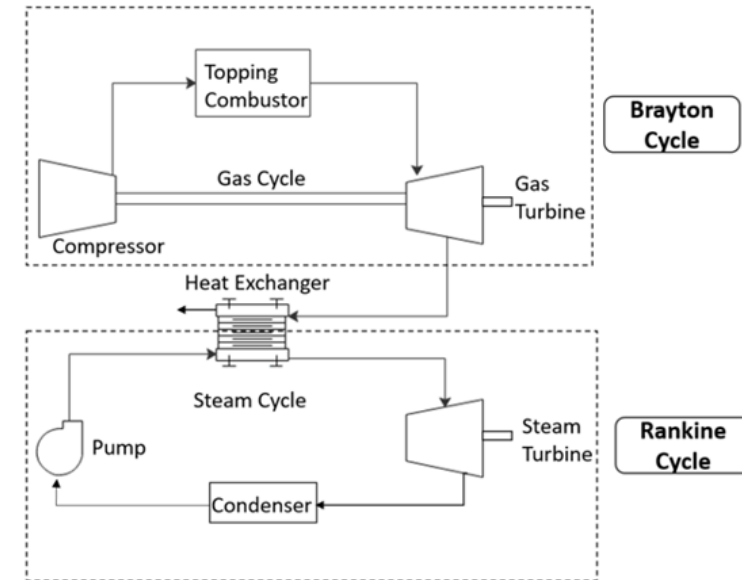
What do we want to do?

# Technologies

## Concentrated Solar Plants



## Natural gas a combined Cycle



Description – environmental impact / Benefit – Operation

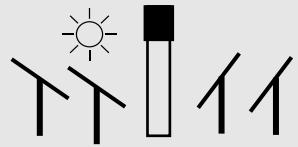
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# Hybrid Plant



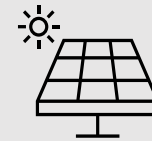
## Design Parameters STP

- Design Power - 130 MWe
- Tower height - 165 meters
- Reflective Surface 1.15 km<sup>2</sup>
- Site: Tierra Amarilla



## STP Cases

- Without Restriction
- Night STP
- Night STP in winter
- SPT supplement PV in summer and without restriction in winter.



## Design Parameters PV

- Design Power - 150 MWe
- Arrangement type – Tracking on an axis (W-E)
- Investor Efficiency 96%
- Global loss 14%

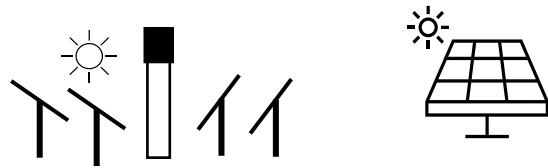
$$\frac{CAPEX_o + \sum_{i=1}^N \frac{OPEX_i}{(1+t)^i}}{\sum_{i=1}^N \frac{Producción_i}{(1+t)^i}}$$

## LCOE Comparison

- Comparison metric for electricity generation technologies.
- Represents the cost of generating a unit of electrical energy.



# Economic Parameters



Parameters	Value
Lifetime of STP systems	40 years
Lifetime of PV systems	25 years
CSP degradation rate	0.2%/year
PV degradation rate	0.6%/year
CAPEX CSP	3.25 MMUSD/MWe
CAPEX PV	0.71 MMUSD/MWe
OPEX PV + SPT	14.32 MMUSD/year

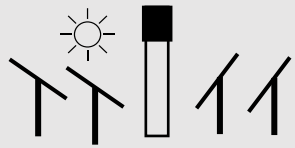


Parameters	Value
Lifetime of CC systems	30 years
CAPEX	0.898 MMUSD/MWe
Non-fuel Variable Cost	3.5 USD/MWh
Fixed Cost	1% CAPEX

Cost structure for a 225 MW CC Power Plant – Source: CNE

Annual interest rate	7%
Inflation rate	0%

# Economics Results



## LCOE Comparison

Configuration	LCOE 6 hrs, USD/MWh	LCOE 13 hrs, USD/MWh	$\Delta LCOE = \frac{SAM_{6hr} - SAM_{13hr}}{SAM_{13hr}}$
Without Restriction	83.3	88.3	-6%
Night SPT in winter	112.7	92.2	+22%
SPT supplement PV in summer and without restriction in winter.	153.7	118.1	+30%
Night SPT	225.5	132.8	+70%

First Results: Comparison of LCOE between STP of 6 hours and 13 hours of storage.

# Economics Results

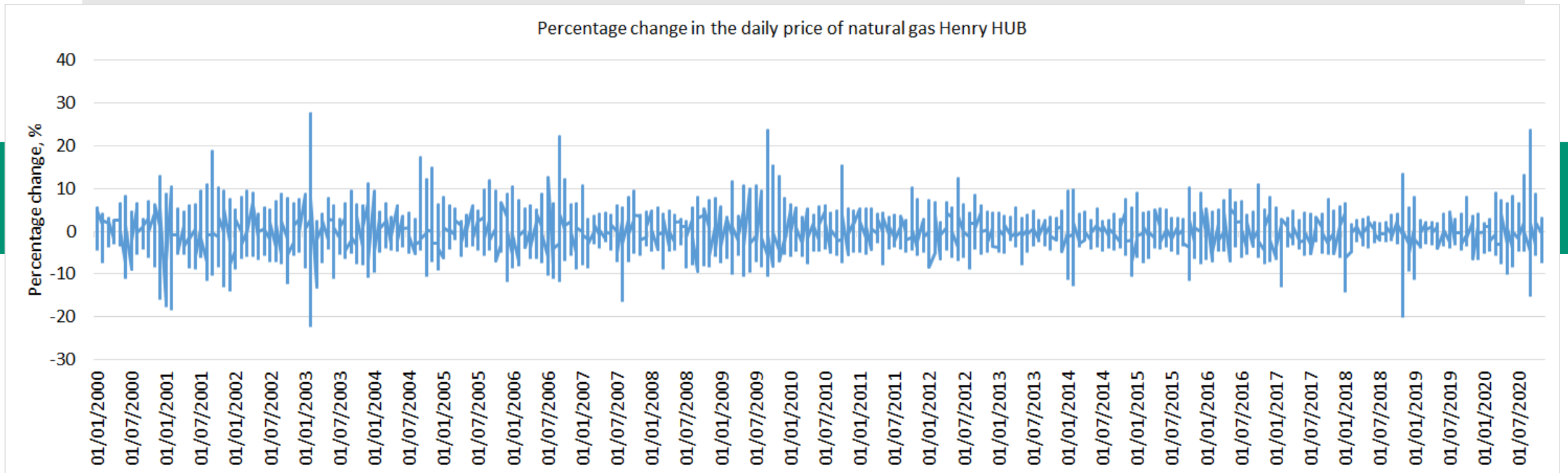


LCOE  
Comparison

Configuration	Solar Multiple	LCOE, USD/MWh		
		Hybrid	CSP	PV
PV + STP Without Restriction	2.0	52.6	62.7	30.5
PV + Night STP	1.5	70.6	98.0	30.5
PV + Night STP Winter	2.0	55.6	68.1	30.5
PV + SPT supplement PV in summer and without restriction in winter.	1.7	63.5	83.6	30.5

Economic results for the CSP plant with 13 h of storage.

# Economics Results



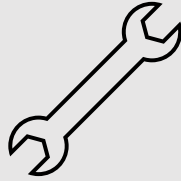
LCOE of a gas plant according to plant factor and variable fuel cost (CVC).

# Systemic Attributes



## Flexibility

- Both technologies are very flexible.
- Synchronous generation technology, with the ability to adjust your generation profile.



## Reliability

- SPT technology is a proven (reliable) technology
- CCs have a much higher failure rate than hydroelectric ones.
- Input availability.



## Economic Risks

- Price of the primary input.
- Possible taxes
- Correction to the green tax.



## Decarbonization Scenario

- Technologies that provide inertia in the energy network, flexibility and SSCC to guarantee the safety and quality of the service.

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# Conclusions

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According to the LCOE calculations, the minimum value was found for the solar hybrid technology with 13 h of storage without generation restrictions (53 USD/MWh), while the natural gas technology has an LCOE of 86 USD / MWh.



Chile faces the challenge of determining the best strategy taking advantage of the benefits of each existing technology in the generation matrix.

CSP technology provides very similar systemic benefits, while avoiding significant negative externalities.

# Thanks for your attention



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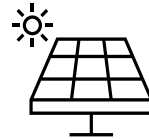
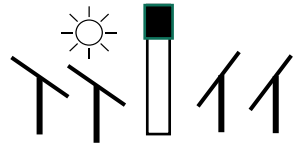


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# Economic Parameters



Parameter	Value
CAPEX CSP Plant (130 MWe)	3.25 MMUSD/MWe
CAPEX PV Plant (150 MWe)	0.713 MMUSD/MWe
CAPEX Substation 110 kV	4.9 MMUSD
CAPEX Transmission 110 kV	1.8 MMUSD
OPEX Substation 110 kV	0.079 MMUSD/year
OPEX Transmission 110 kV	0.016 MMUSD/year
OPEX CSP	5 MMUSD/year
Variable Cost Operational CSP	3.5 USD/MWe
Fixed OPEX CSP	7.72 MMUSD/year
Fixed OPEX PV	1.6 MMUSD/year

Items	Value
CAPEX	0.898 MMUSD/MWe
Non-fuel Variable Cost	3.5 USD/MWh
Fixed Cost	1% CAPEX

Fuente: Comisión Nacional de Energía. Informe de Costos de Tecnologías de Generación-Informe Anual; Comisión Nacional de Energía: Santiago de Chile, 2020