

“¿CSP *made in Chile*?”

Desarrollo de un receptor volumétrico para calor de procesos

Dic. / 2018

José Miguel Cardemil





‘A SOLAR SAUDI ARABIA’

While Trump promotes coal, Chile and others are turning to cheap sun power

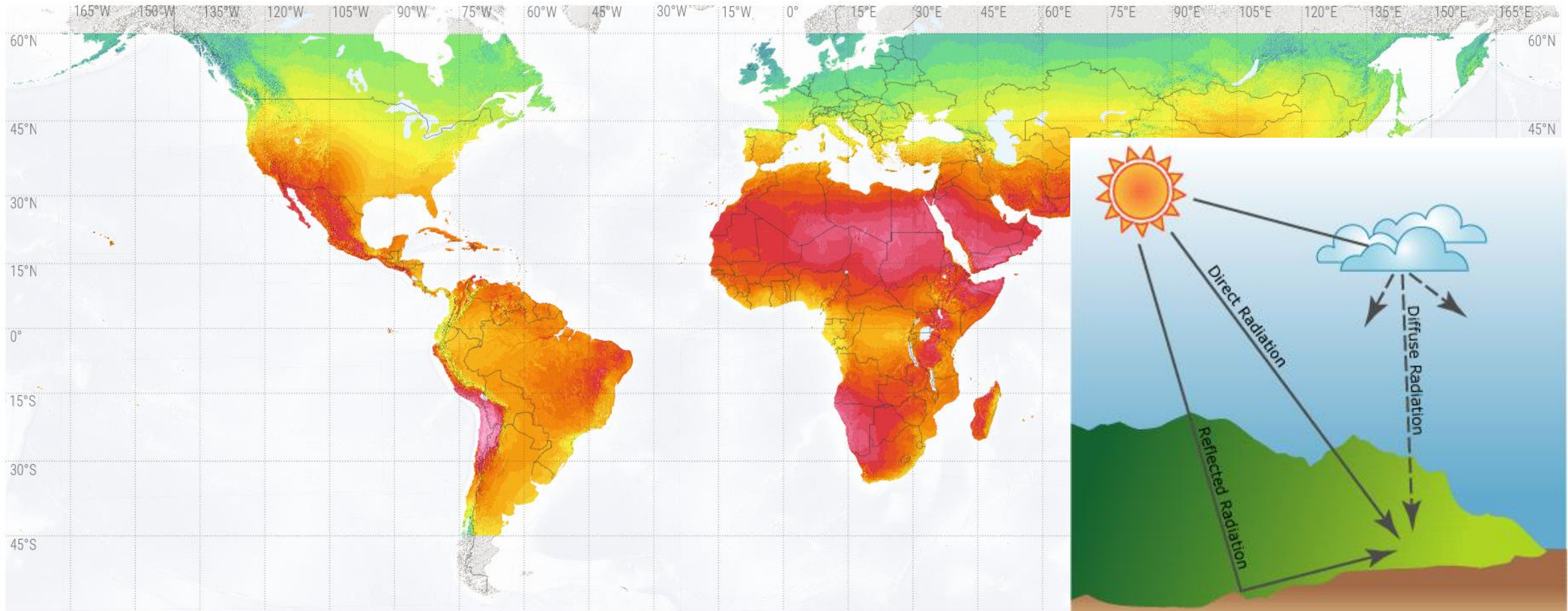


DIMEC
INGENIERÍA MECÁNICA
UNIVERSIDAD DE CHILE

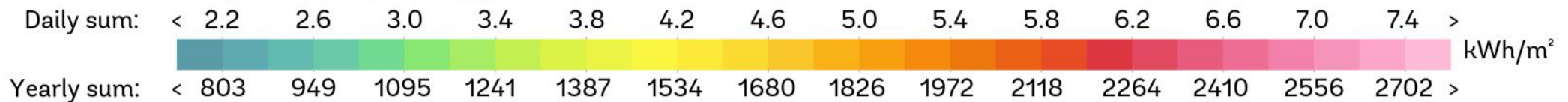
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SOLAR RESOURCE MAP

GLOBAL HORIZONTAL IRRADIATION

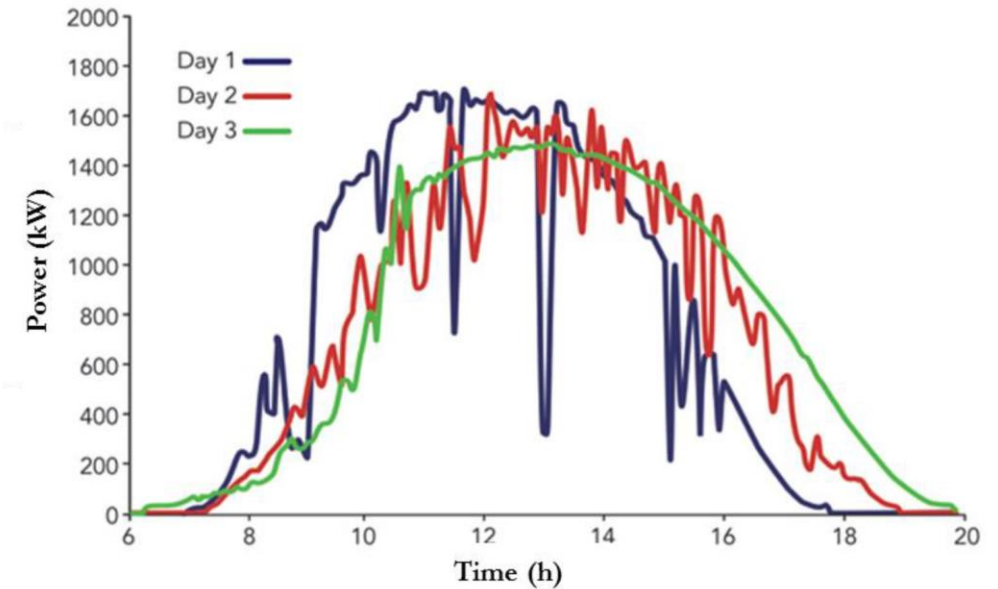
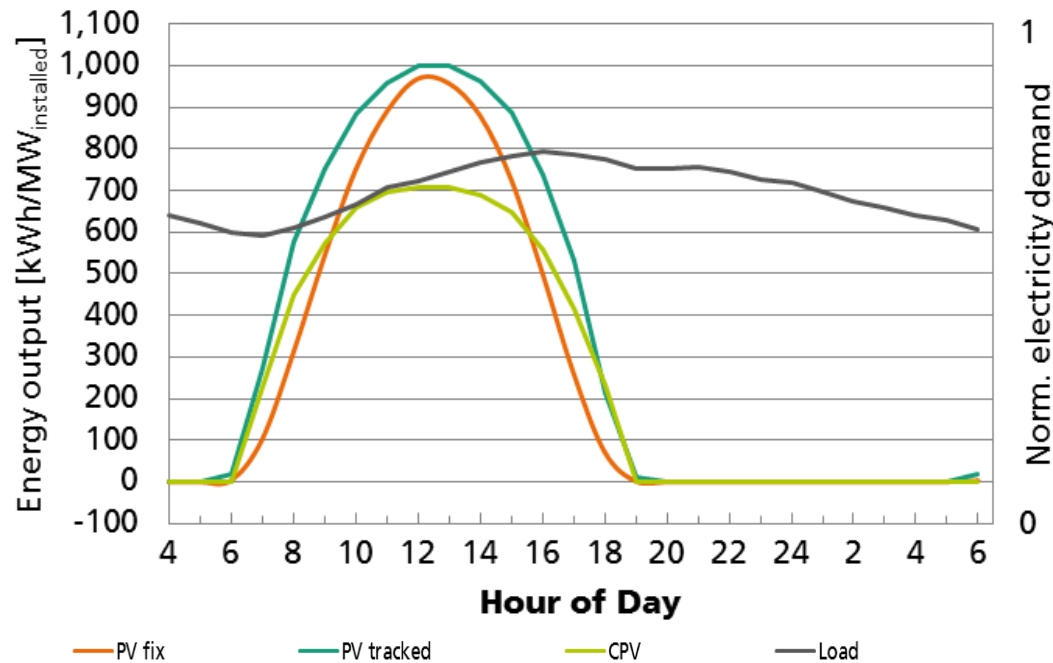


Long-term average of daily/yearly sum



Plantas PV: Perfil de generación vs. consumo

4



Source: NREL

Pero, si hay nubes!

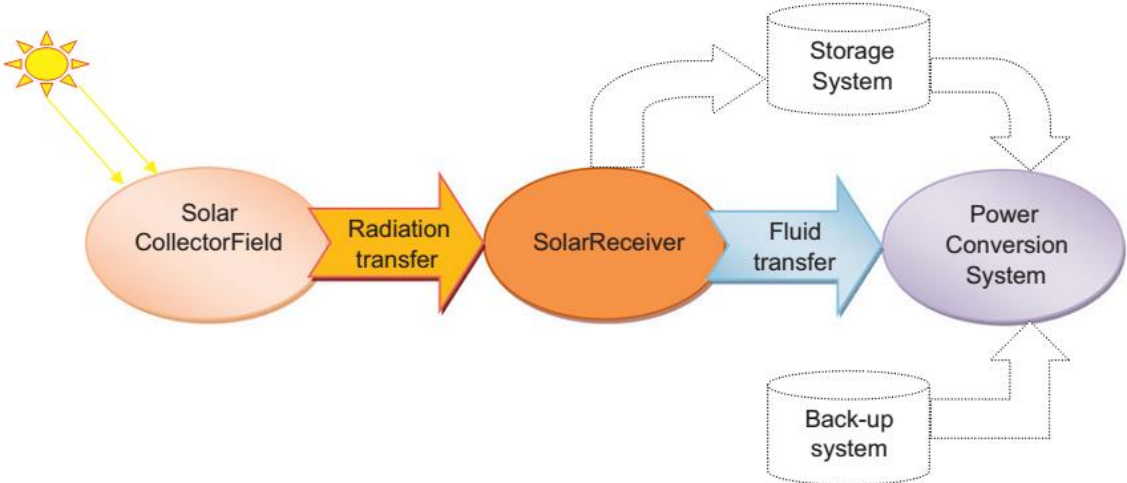
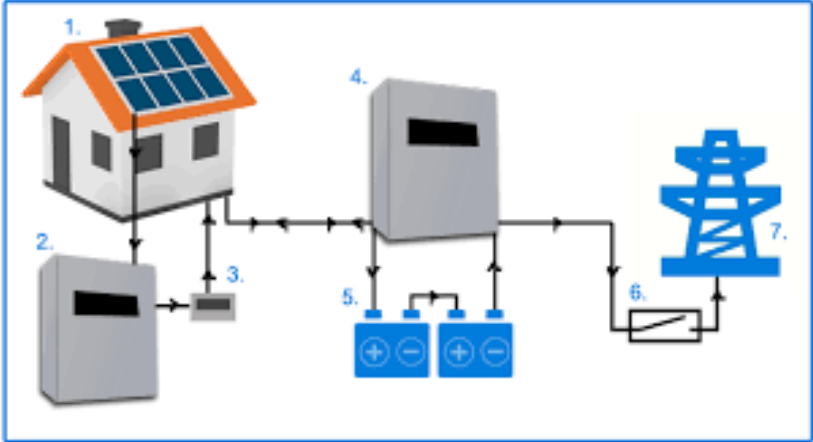
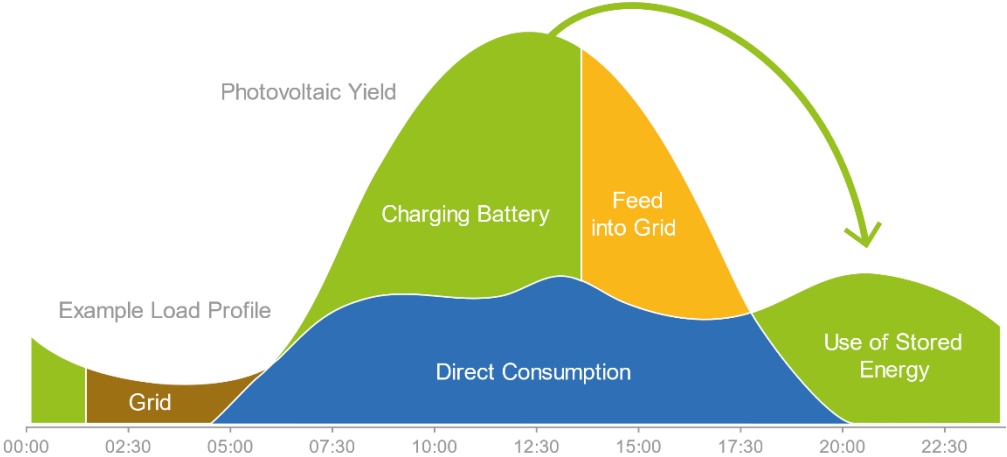


Source: Bloomberg



Source: Bloomberg

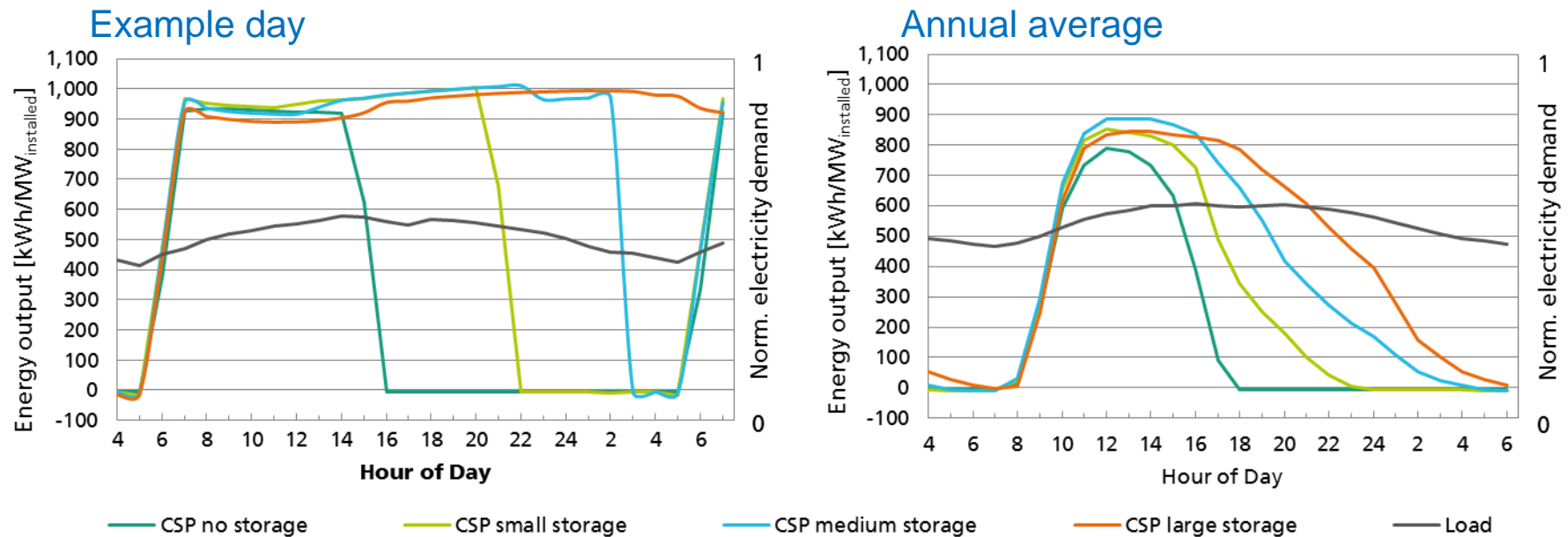
Almacenamiento



CSP + Almacenamiento *Perfil de generación vs. consumo*

8

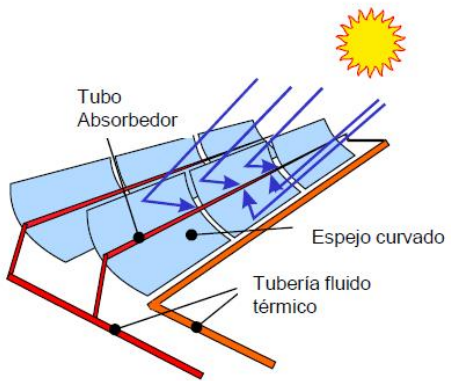
- Usando un dimensionamiento adecuado, generación 24/7 es posible
- Almacenamiento térmico resulta más económico que baterías



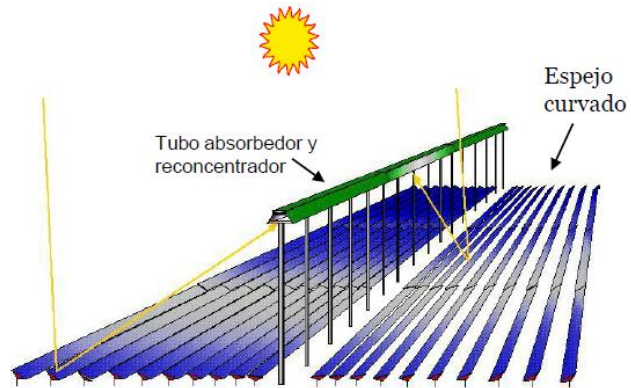
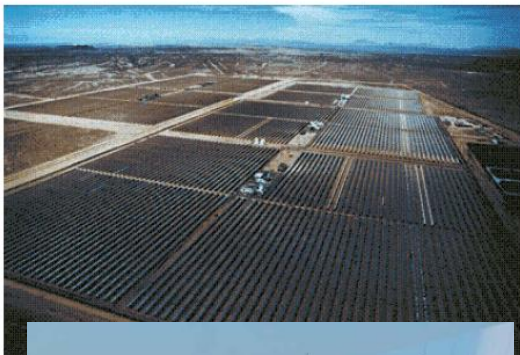
Source: NREL

CSP: Concentrated Solar Power

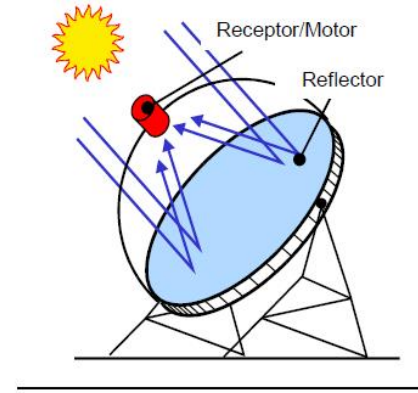
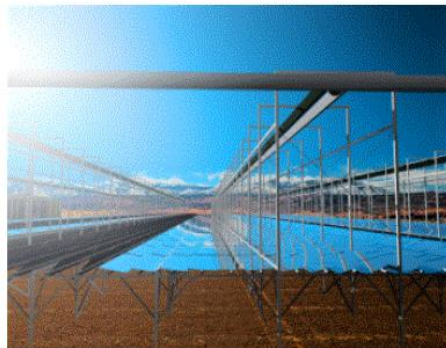
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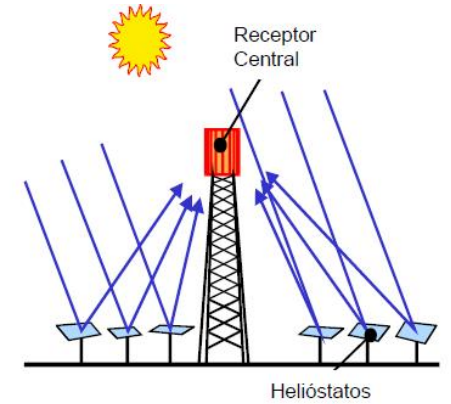
Cilindro-parabólicos



Fresnel Lineal



Discos parabólicos



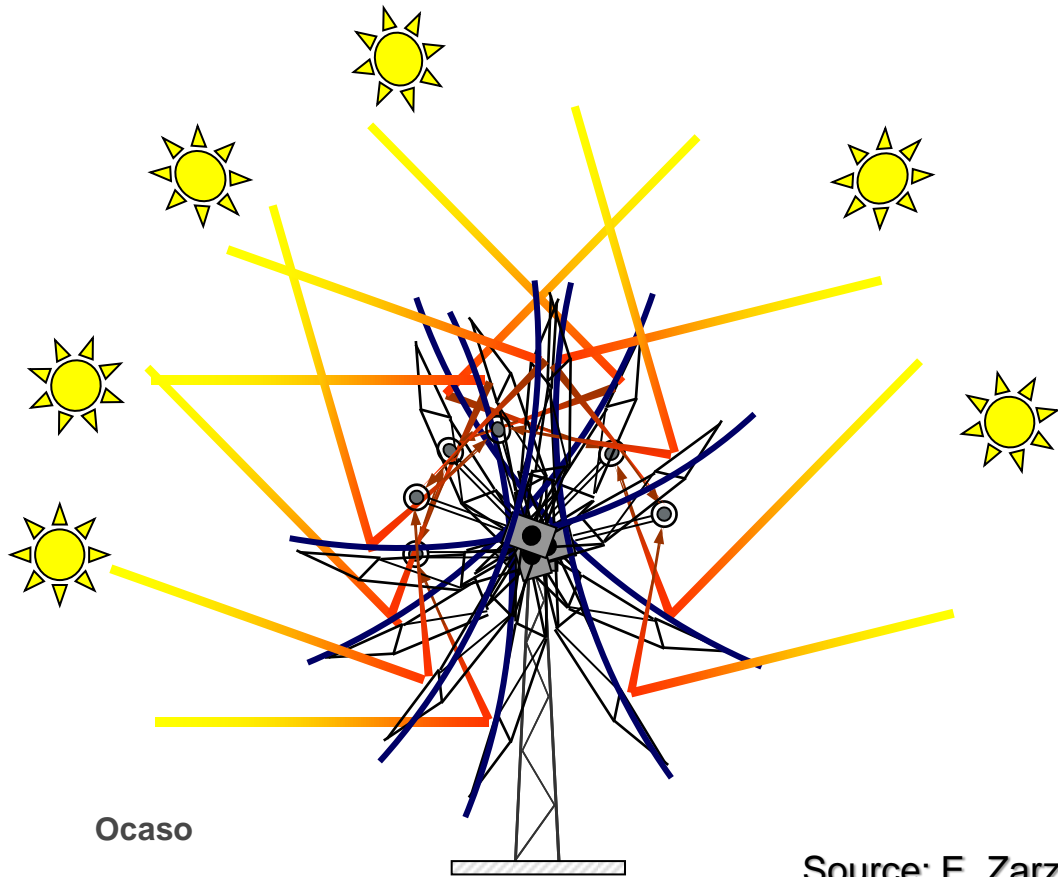
Receptor Central



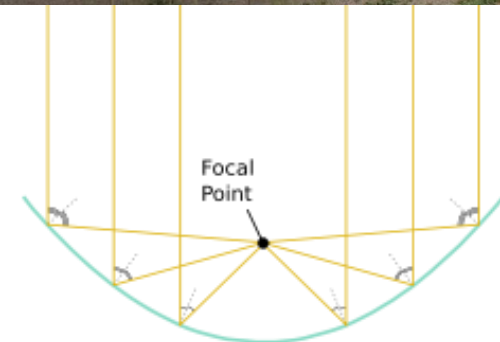
Source: NREL

Parabolic Trough

10

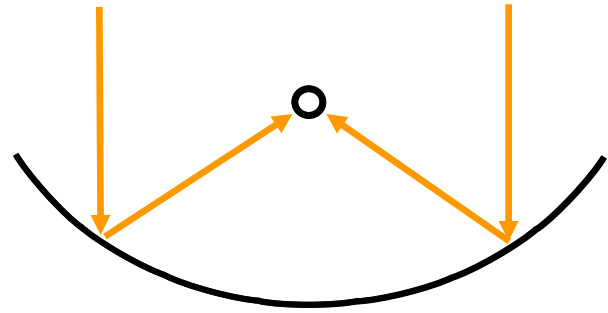


Source: E. Zarza
CYTED

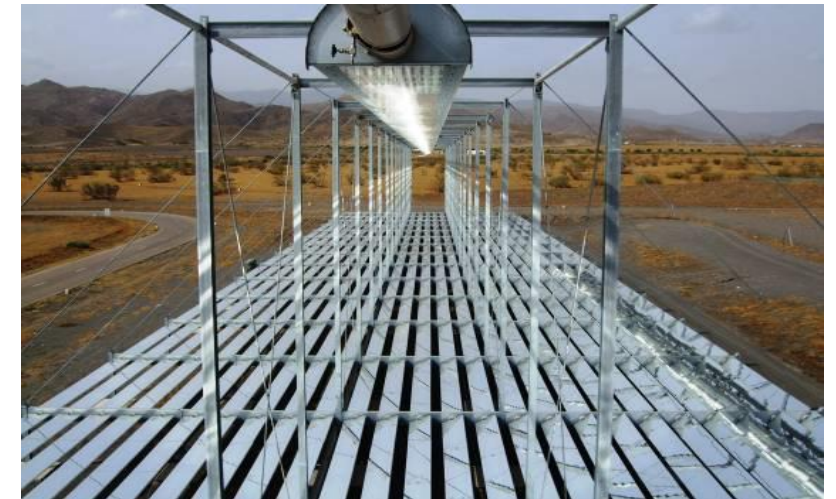
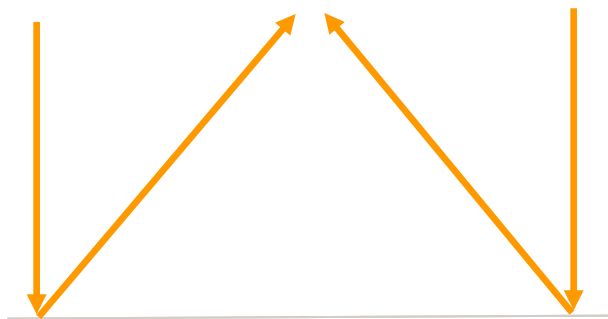


Linear Fresnel

11



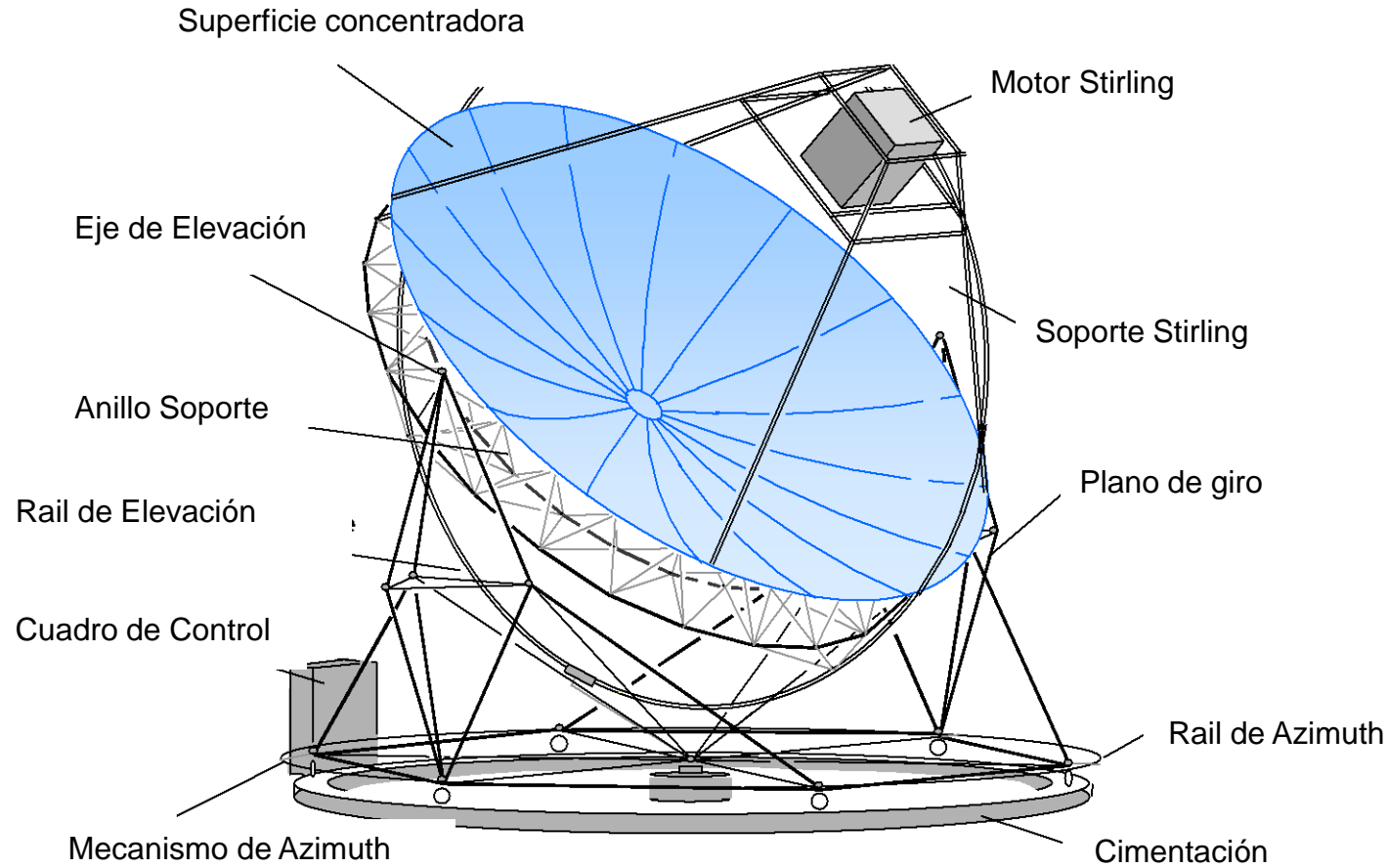
Parabolic Trough Collector



Source : PSE &
SolarPACES

Dish-Stirling

12



Source: E. Zarza
CYTED

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Solar Tower

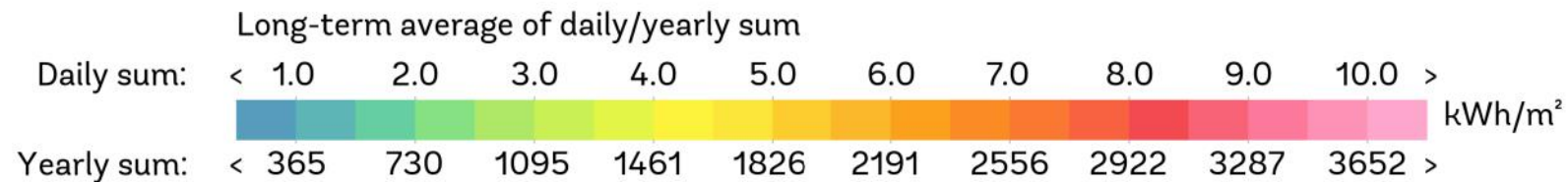
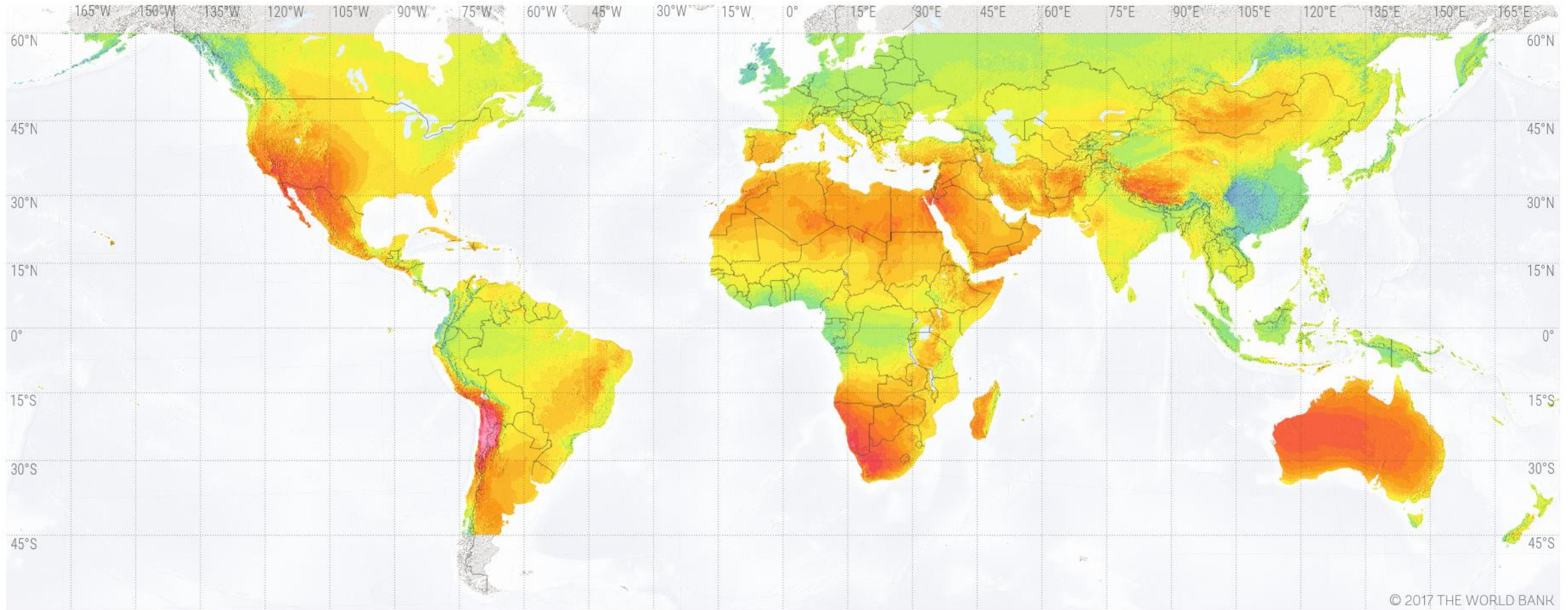
13



Source: E. Zarza
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SOLAR RESOURCE MAP

DIRECT NORMAL IRRADIATION

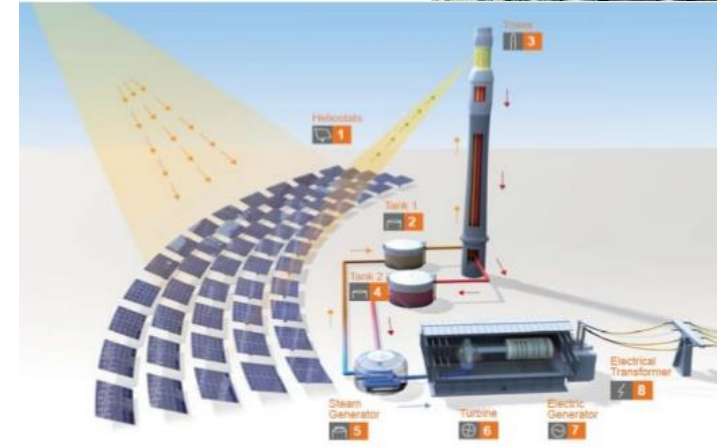


CSP Technologies - Tower

15

- 1ª Generación
 - ▣ Vapor Saturado
- 2nd Generación
 - Sales Fundidas (KNO_3 (40%) + NaNO_3 (60%))

- Desafíos
 - ▣ Reducción de costos
 - ▣ Aumentar eficiencia de conversión
 - Aumentar temperaturas de operación



Source: Behar et. al. (2013)

Gas como Fluido de Trabajo: Receptor volumétrico

16

- El gas absorbe calor directamente en el absorbedor
 - ▣ Absorbedor → Medio Poroso
 - ▣ CO₂, Helium o Aire como HTF
 - ▣ **BAJO** costo e impacto ambiental

- Desafíos
 - ▣ Transferencia de calor limitada
 - ▣ Integración a almacenamiento
 - ▣ Elevada potencia por circulación de fluido
→ Complex Flow patterns



Source: NREL (2017)

Current Operational Plants

17

□ Jülich Solar Tower:

- Germany, 1500 kW - 2000 heliostats
Atmospheric air - 902 kWh/m² year.

□ Daesung Solar Power Tower:

- Korea, 200 kW - 400 heliostats
Atmospheric air – 803 kWh/m²·year.

□ Solar Resource in Chile:

- Santiago - DNI 2300 kW·h/m²· year.
- Calama - DNI 3390 kW·h/m²· year.

Nuevas Iniciativas:

- AZELIO
- 247Solar



SolarBosch: Planta Prototipo CSP



Torre Almacenamiento

Receptor

Planta de Galvanizado

Heliostatos

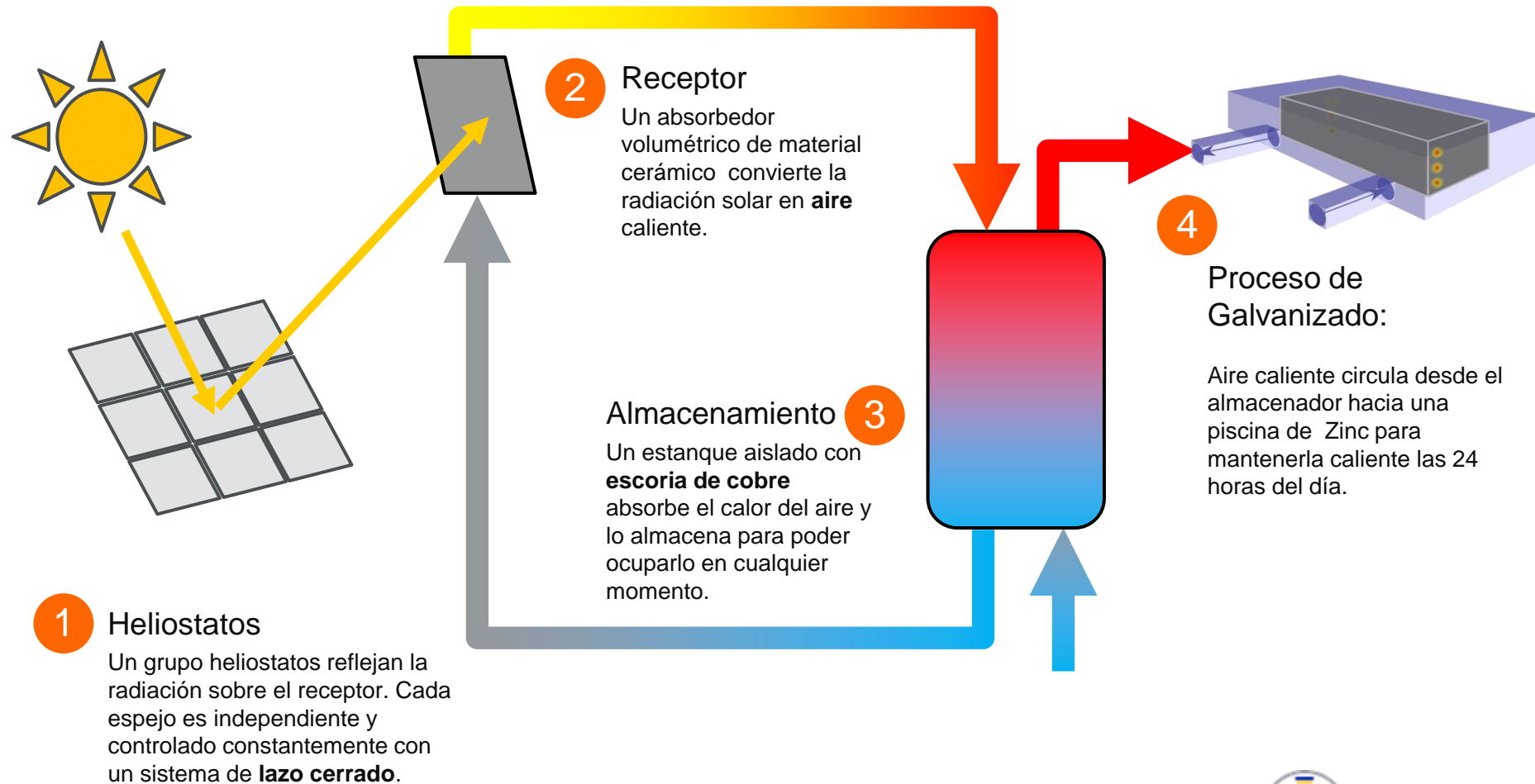


CORFO

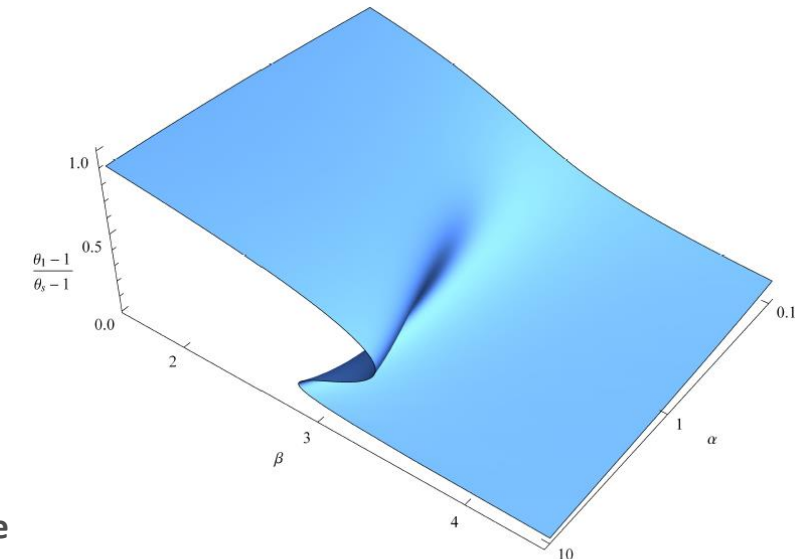
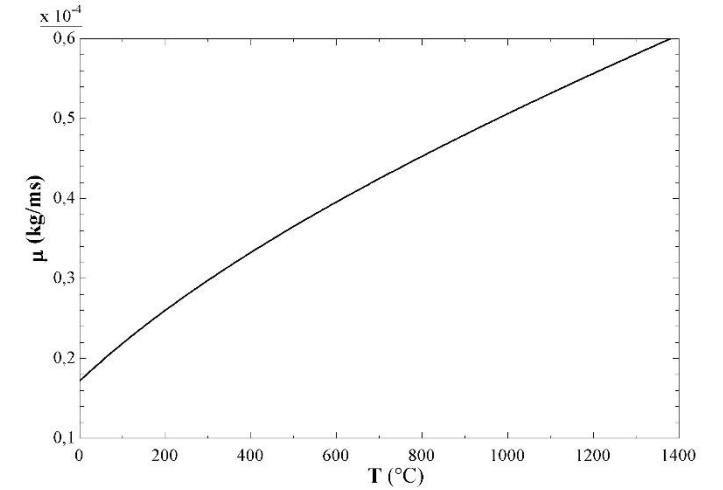
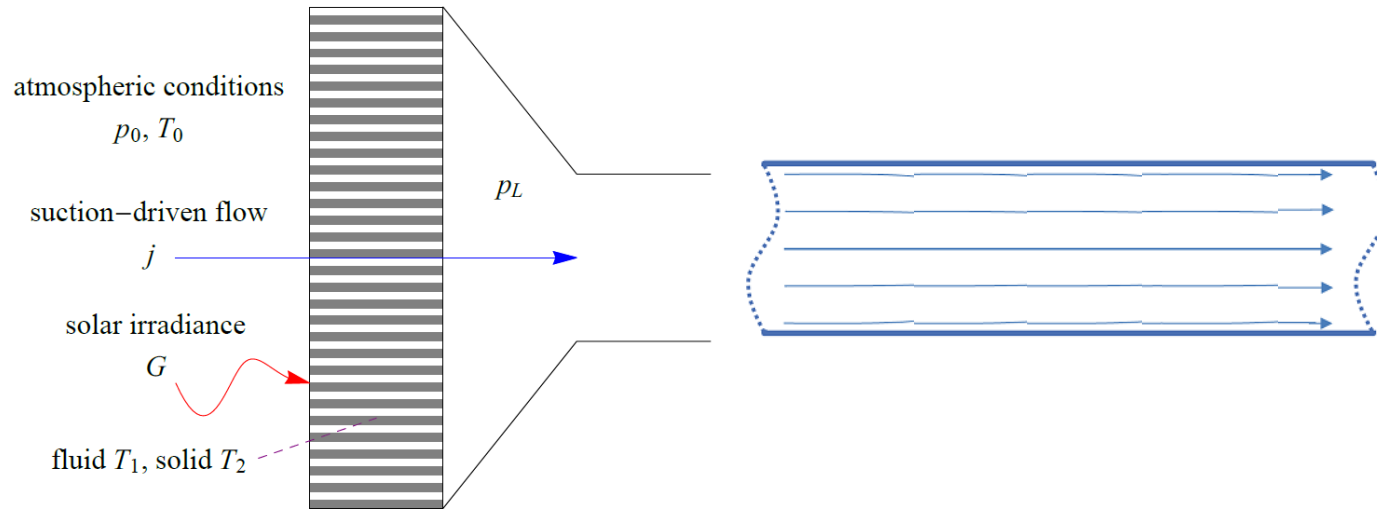
- Validación y empaquetamiento
- Contratos Tecnológicos (UChile)



SolarBosch: Planta prototipo

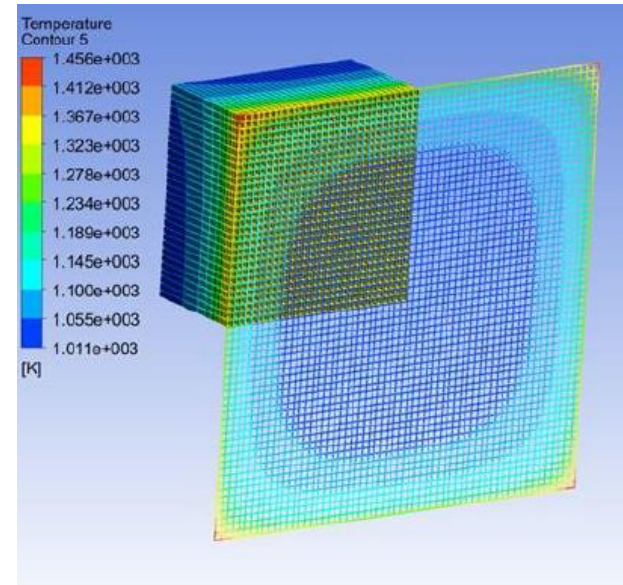
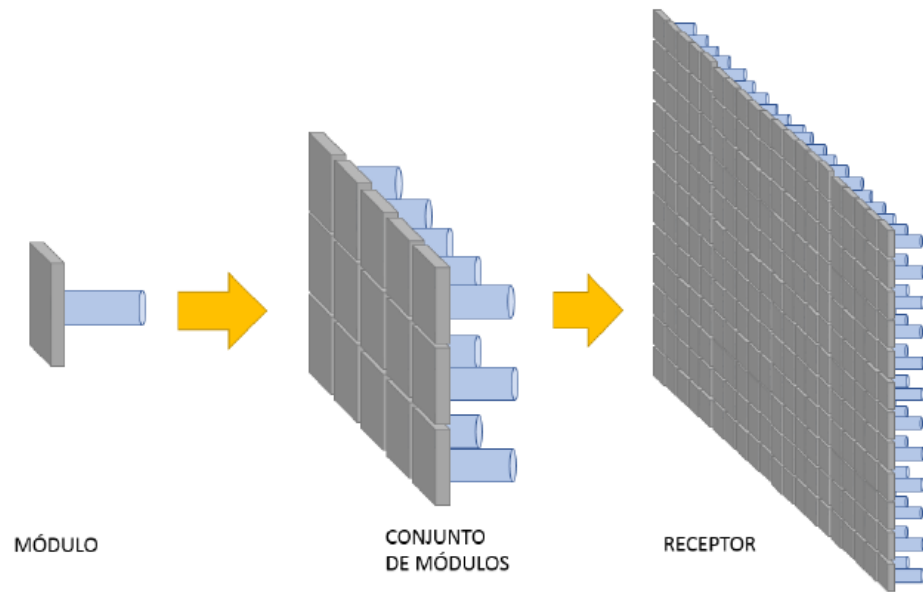


Desarrollo de un Receptor Volumétrico



Desarrollo de un Receptor Volumétrico

21



- Material del absorbedor SiC/SiSiC; material del manifold alúmina.
- Modelación 1d y CFD 3D.
- Temperatura objetivo de salida 750°C

Desafío: Almacenamiento térmico

22

- **Sistemas comunes en ciclos de aire**
 - Packed bed
 - Comúnmente rocas sedimentarias

- **Propuesta**
 - Copper Slag

 - **Caracterización termofísica: DIMEC**
 - Elevada capacidad calórica
 - **Diseño: SolarBosch**



23

Muchas Gracias

Equipo:

- JM Cardemil
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- R. Barraza
- A. Urrutia

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