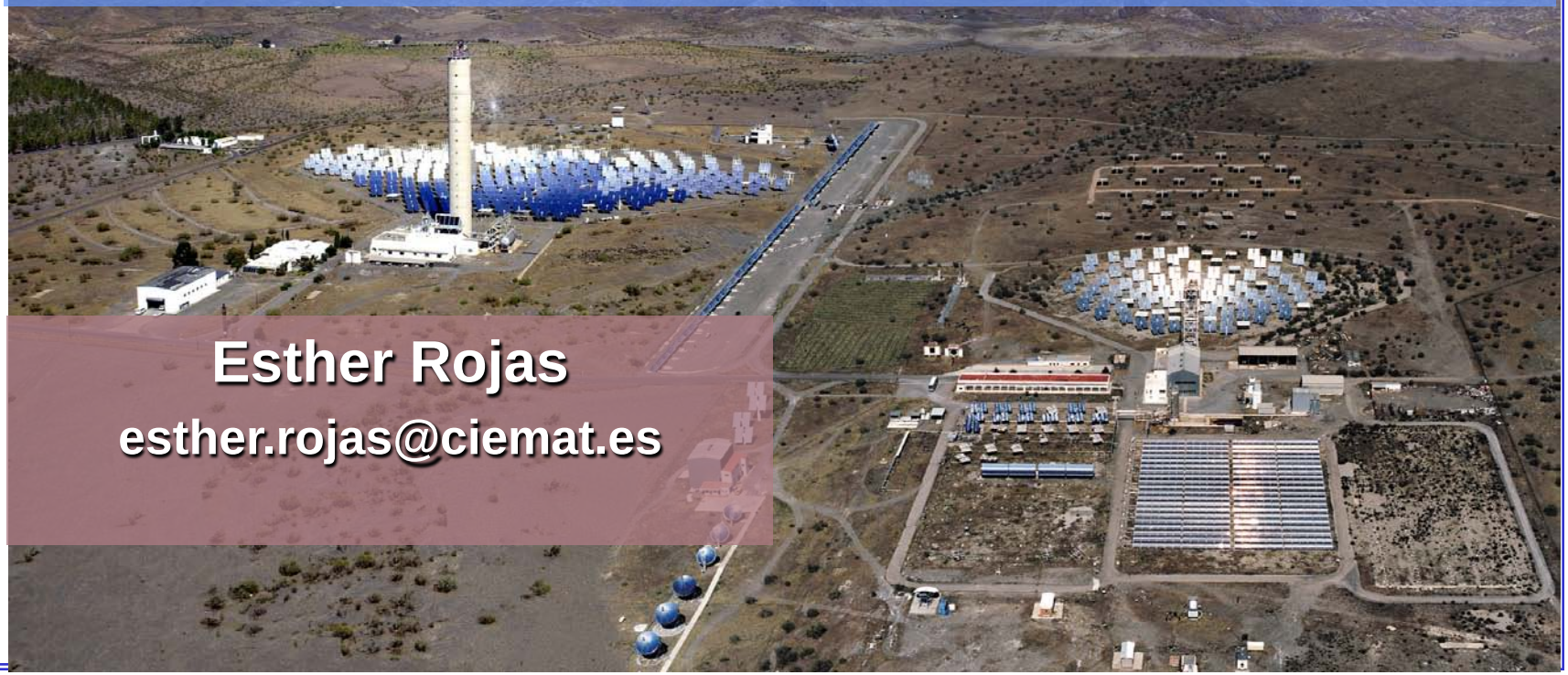
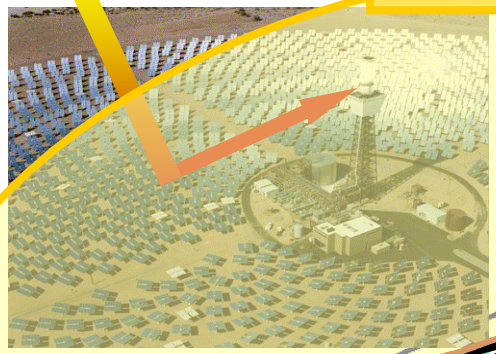
Global Trends in Concentrating Solar Power



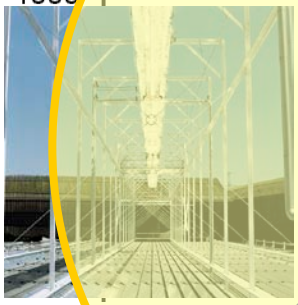
Esther Rojas

esther.rojas@ciemat.es

Power Plants

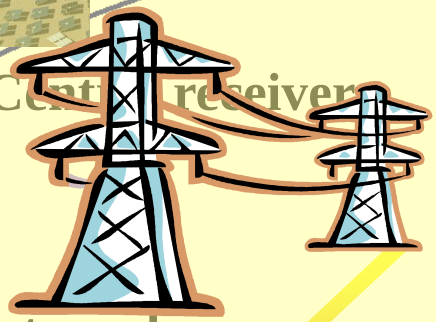


Solar furnace



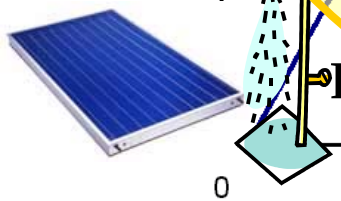
Fresnel

Central receiver



Parabolic trough

Dish



Flat plate

Concentration ratio

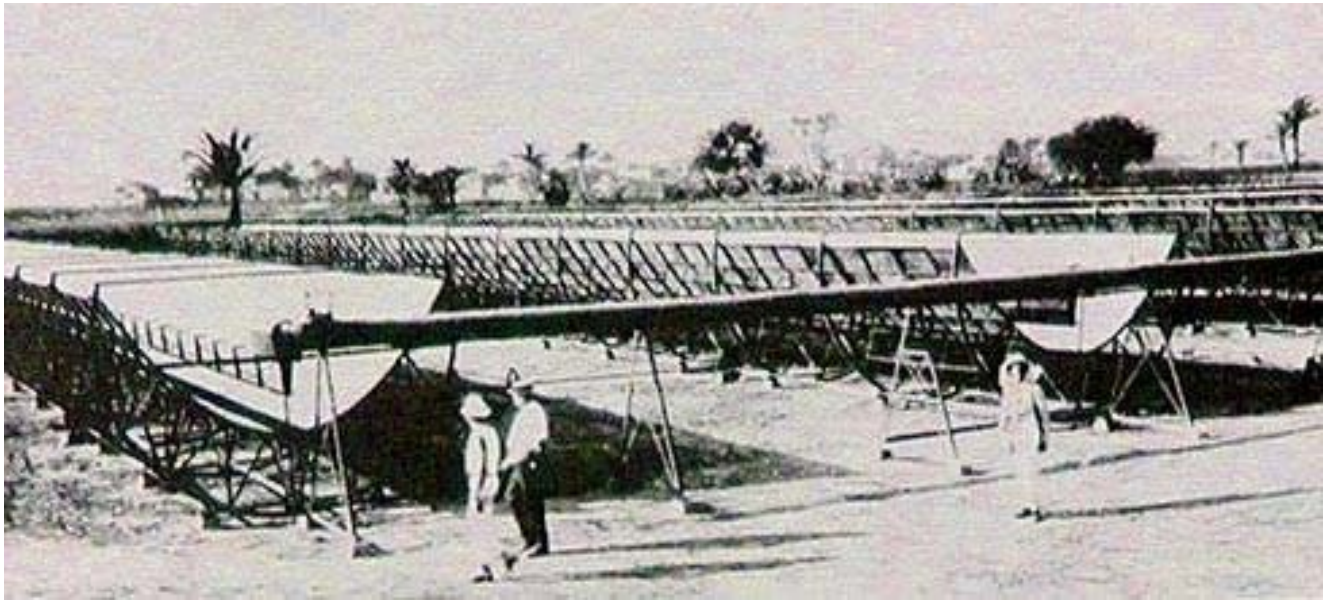
100000
10000
1000
10

0
400
800
1200
1600
2000
2400
2800

Temperature (ºC)

Parabolic Troughs

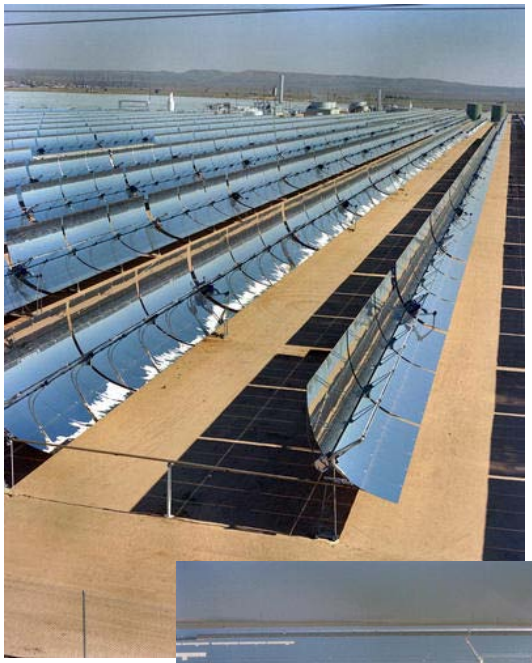
- Proven utility scale technology
- Commercial operation since 1984

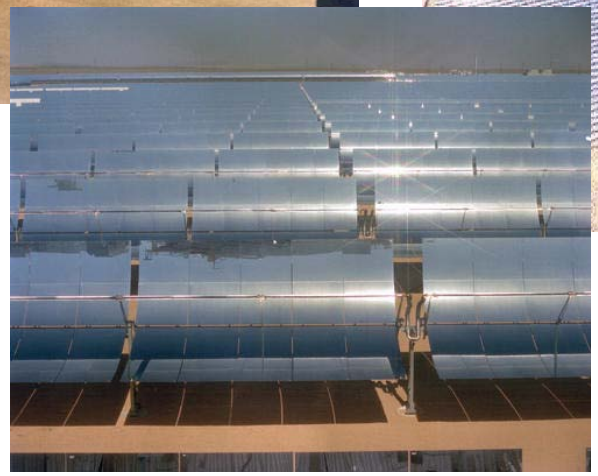


First parabolic trough power plant built in 1912 in Egypt

Sources: *ACCIONA; Brakmann, 2010, 'CSP in the Middle East and North Africa (MENA)',*

9 SEGS Plants (California, USA)





~354MW$_e$ installed

SEGS: Solar Solar Electric Generation Stations

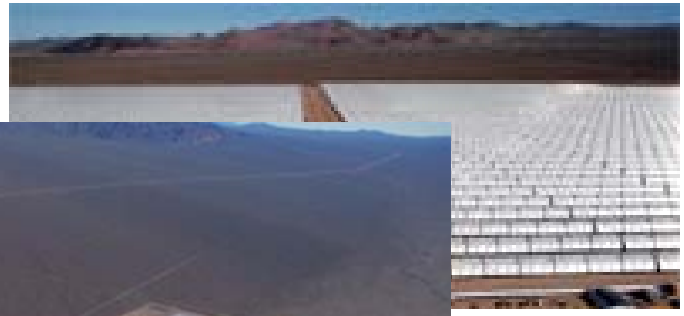
Today running SEGS plants

SEGS Plant	II	III	IV	V	VI	VII	VIII	IX
Location	Dagget	Kramer Junction					Harper Lake	
Working since	12/85	12/86		10/87	12/88		12/89	9/90
Power	30						80	
Annual solar fraction (%)	64	71	72	75	76	76	76	76
Collector type	LS1/LS2	LS2		LS2/LS3	LS3			
Temp. Max. Oil (ºC)	349					395		

Developments in

- Integration with the power block
- Heat transfer fluid in the solar field
- Collector size and structure

Nevada Solar One (64MW; 2008)



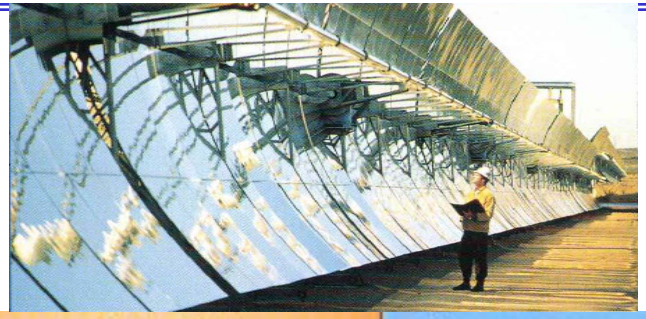
ANDASOL I and II

~50MWe

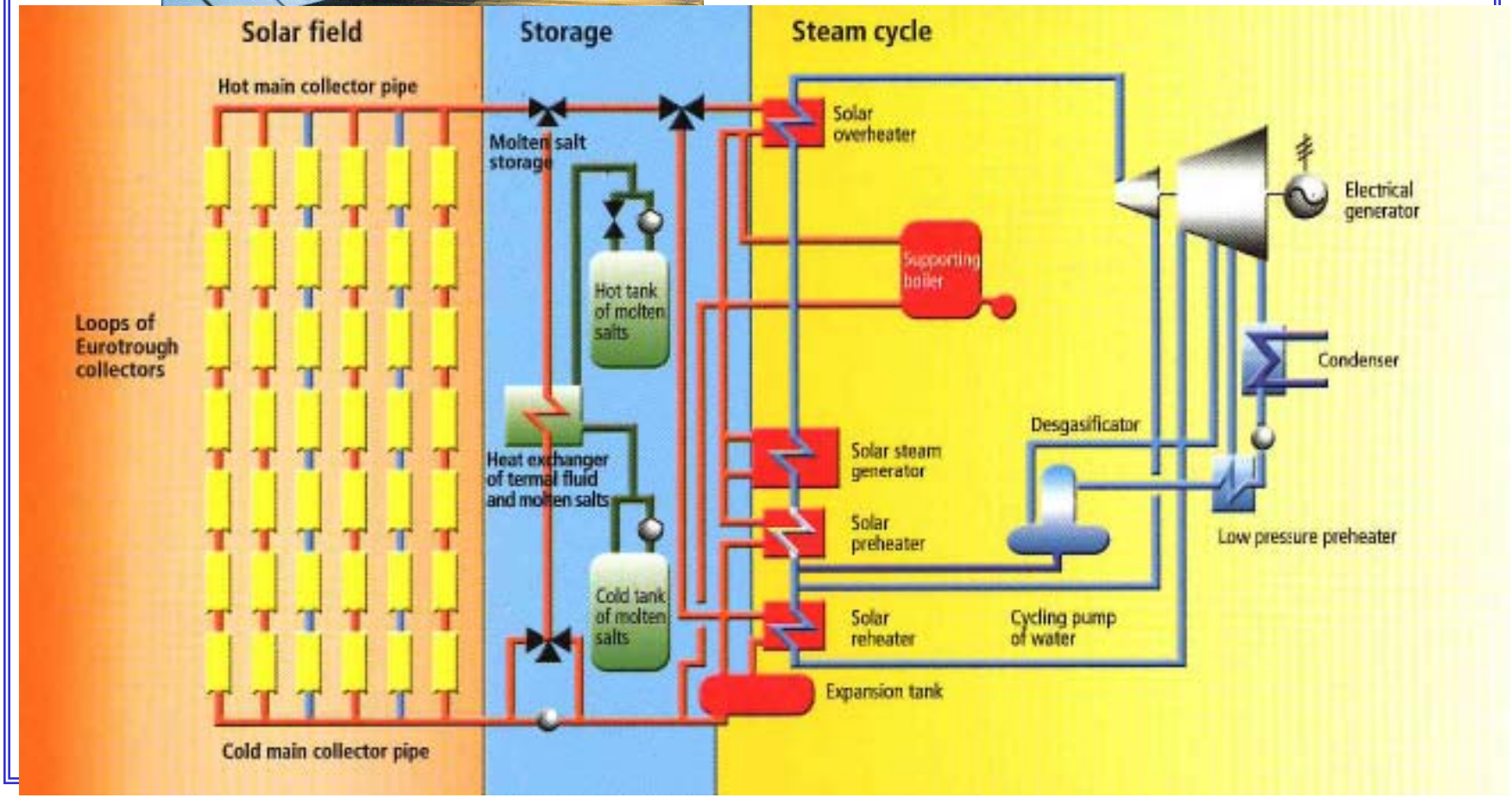
Storage for 7,5 h nominal power

~3600 annual operating hours

182 000MWh/year



Andasol I and II scheme



EXTRESOL I

1

SOLNOVA 1, 3 and 4

CTS Puertollano

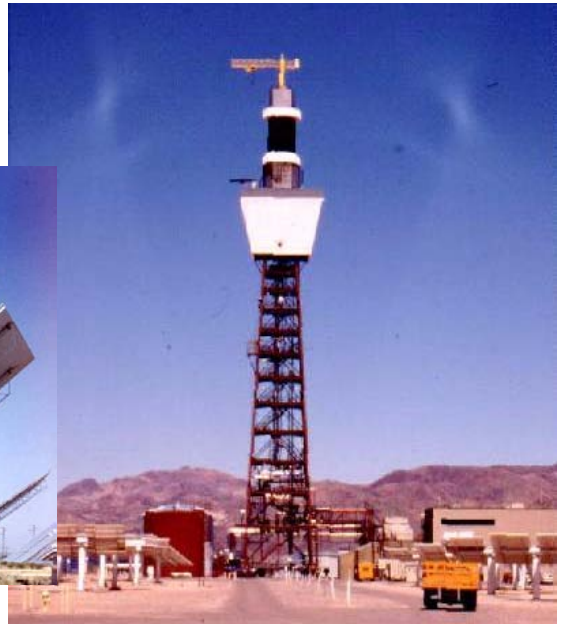
LA RISCA, Alvarado

Tower Technology

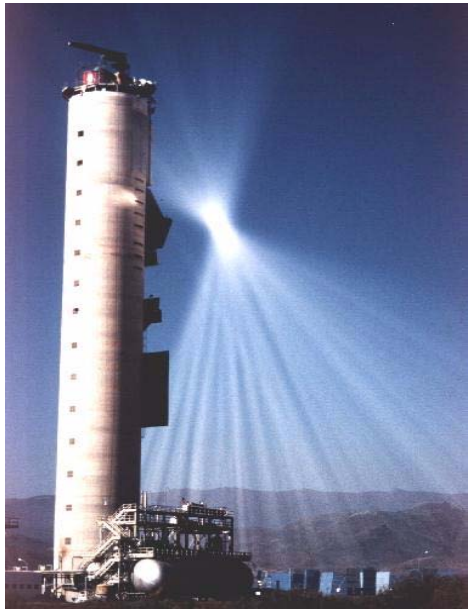
- Proven utility scale technology
- Commercial operation since 2007

(demo plants in 80's)

CRS-SSPS (1981)

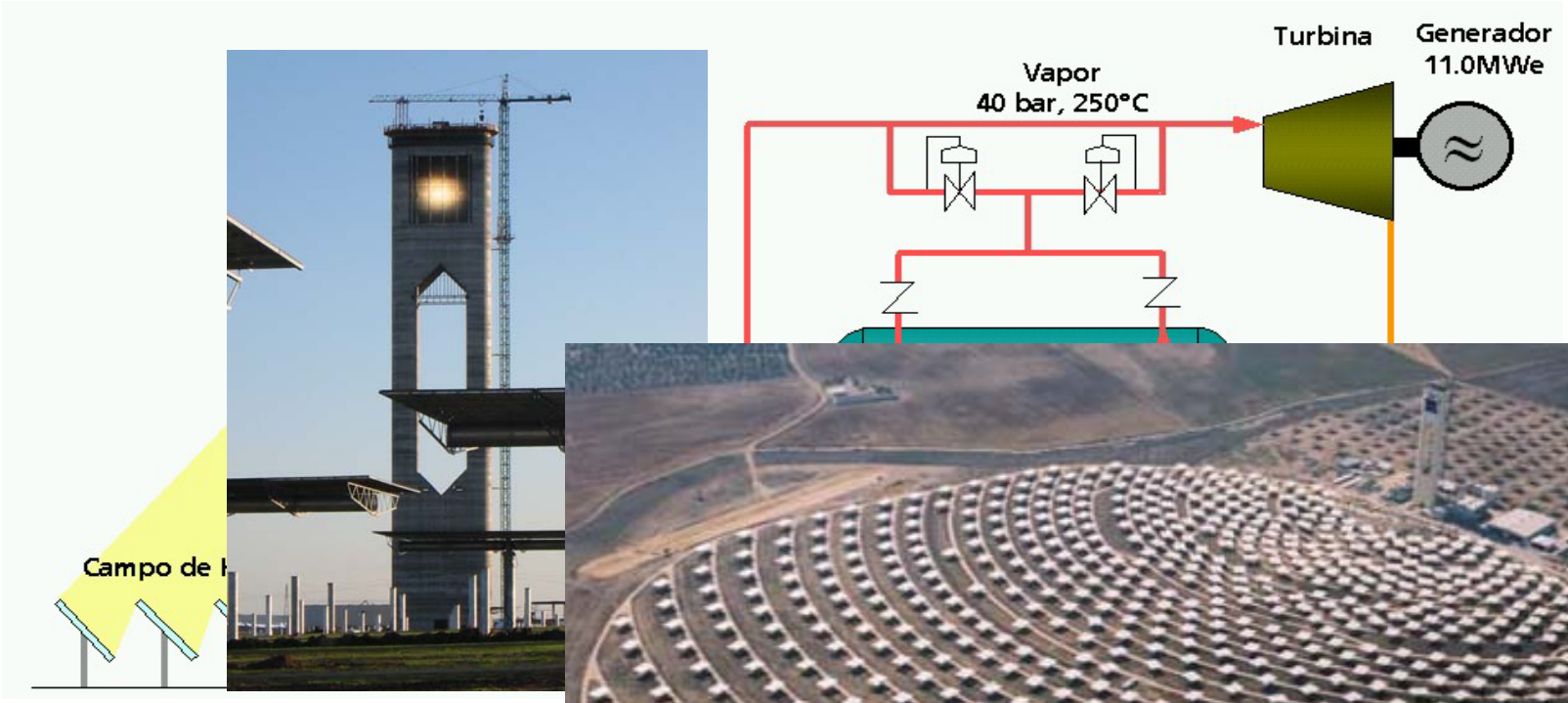


SOLAR-ONE (1982)

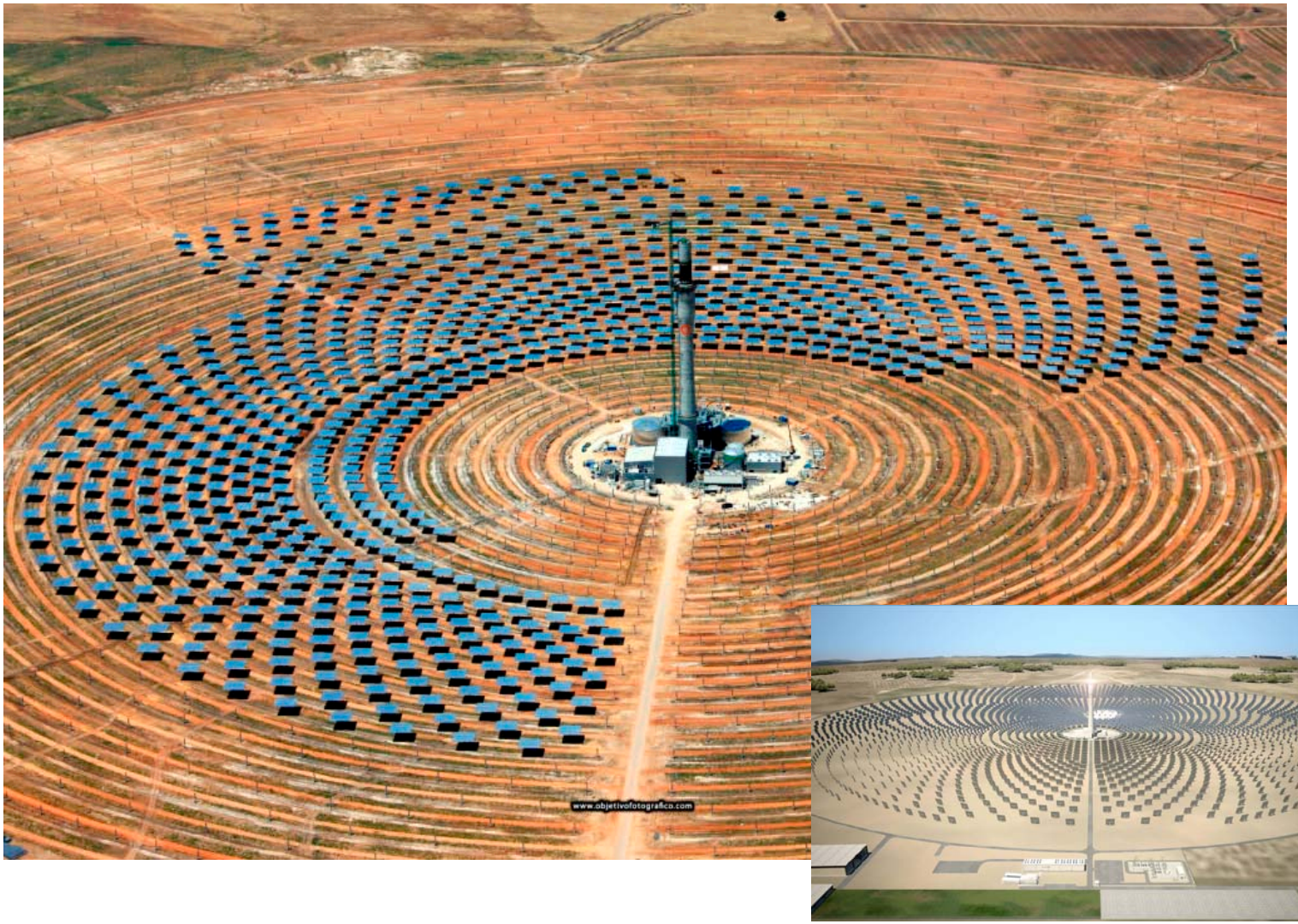


CESA-1, (1982)

PS10 (2007)

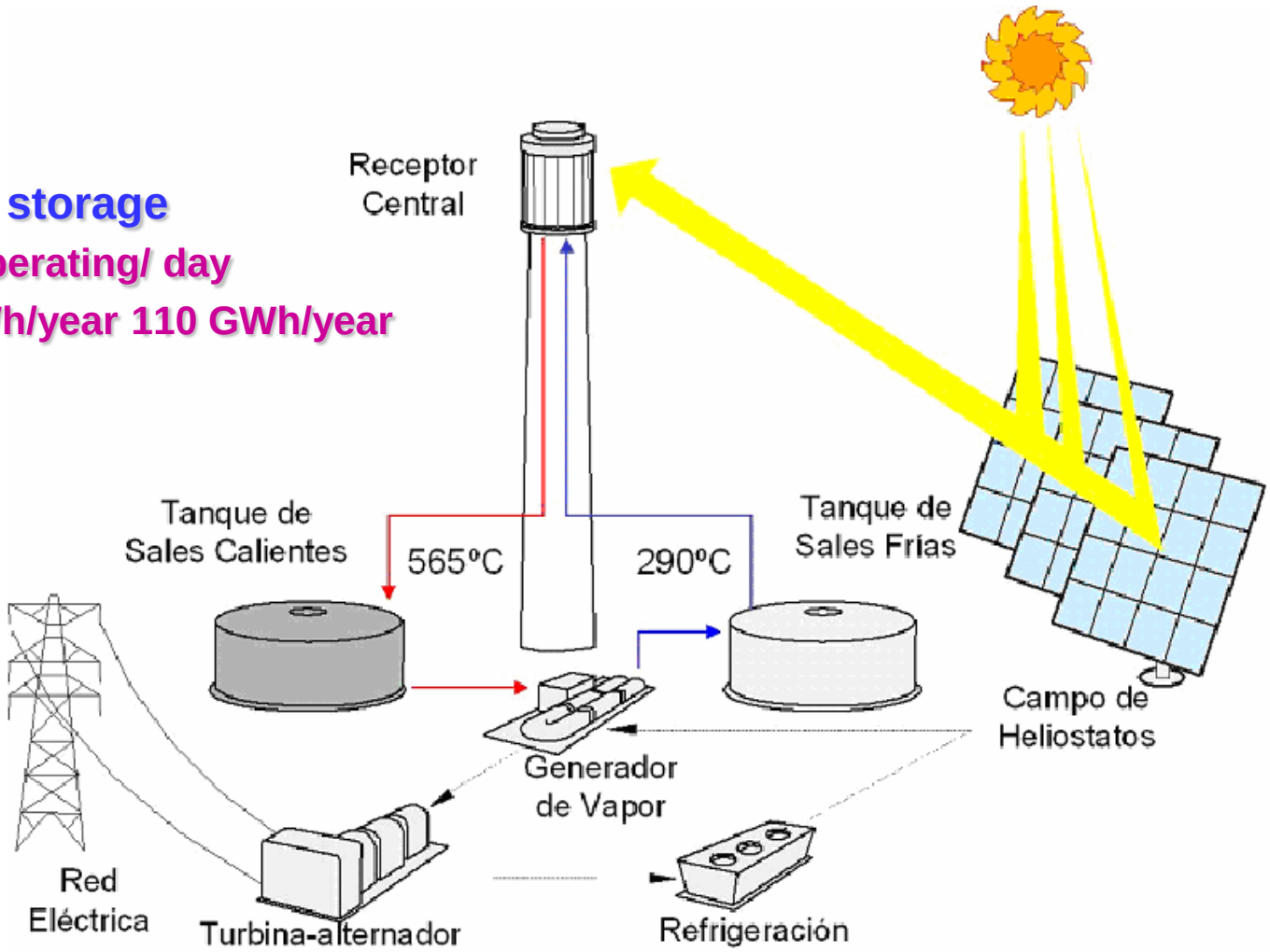


GEMASOLAR, Fuentes de Andalucía



Gemasolar

- 19 MW
- 15 hour of storage
  - ~24h operating/ day
  - 110 GWh/year 110 GWh/year



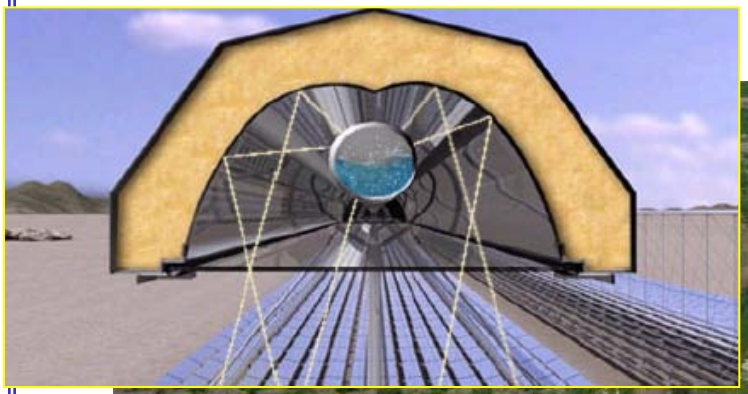
Fresnel Technology

- Demostration plants

Solarmundo (Belgium, 1999)

Ausra
(Kimberlina, 2008)

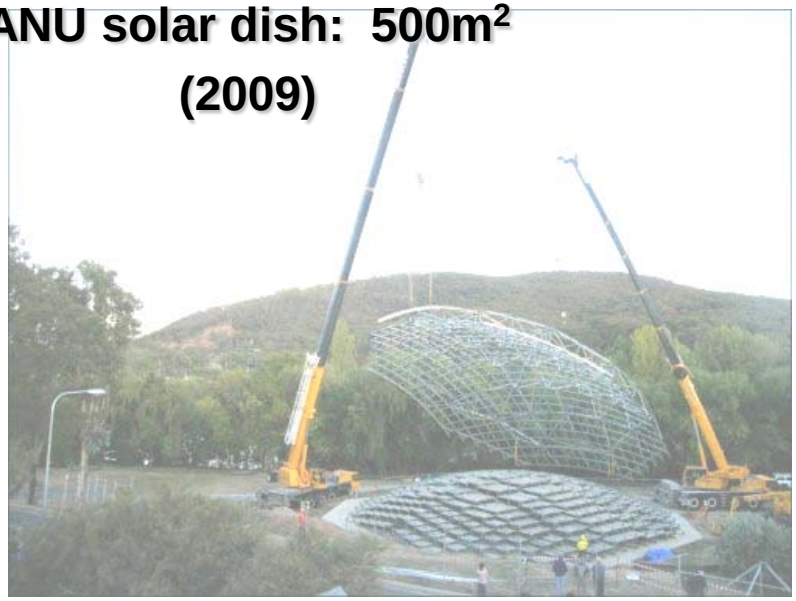
Puerto Errado I



Dish- Stirling

- Small scale installations

ANU solar dish: 500m²
(2009)

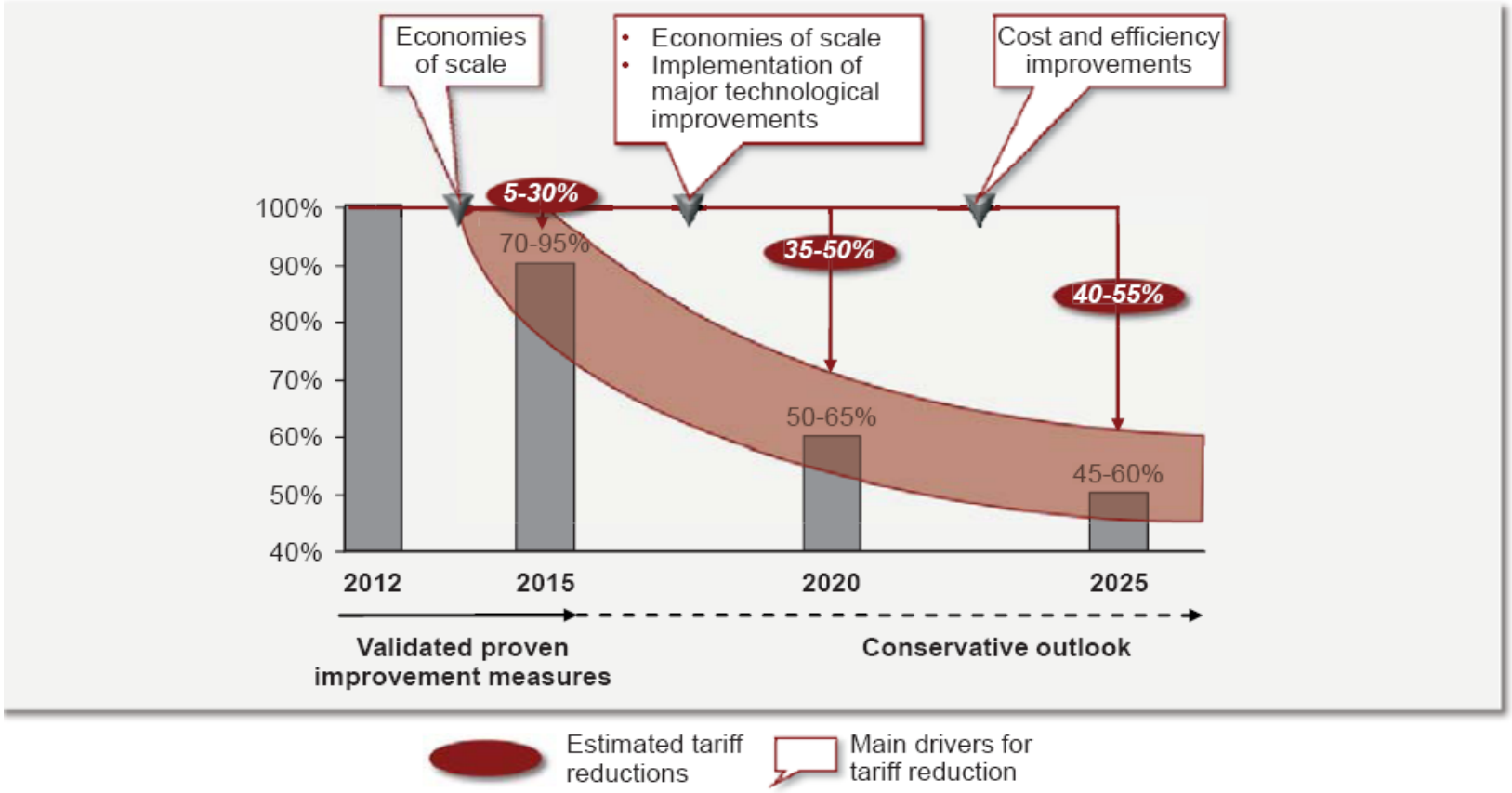


Villarrobledo

CSP Status

- **Reliable commertial technology**
  - → **~2 GW in operation/construction in Spain and USA**
- **Dispatchable energy production**
  - → **by thermal storage**
  - → **hybridation with other sources of energy (biomass)**
- **Water demand for refrigeration should be reduced**
- **Cost reduction is foreseen**

Expected cost reductions from 2012 to 2025



Notes: Tariffs equal the minimum required tariff, and are compared to 2012 tariffs
Source: A.T. Kearney analysis

Overview of main technological and efficiency improvement measures

Functionalities / Technology	Solar collection	Thermal generation	Storage	Electrical generation
Parabolic trough	• Mirror size and accuracy • Optimized support structure design	• Receiver characteristics • Alternative working fluid • Higher operating temperature	• Alternative storage reservoir designs and storage medium compositions	• Turbine efficiency
Solar tower	• Field configuration and heliostat size optimization • Optimized tracking system costs	• Alternative working fluid • Higher operating temperature • Improved cycle technology	• Alternative storage reservoir designs and storage medium compositions	• Turbine efficiency
Dish Stirling	• Optimized support structure design • Optimized mirror sizes for various solar resources		• Storage development	• Engine efficiency and capacity
Linear Fresnel	• Automatic mirror assembly • Optimized mirrors	• Receiver characteristics • Higher operating temperature	• Storage development	• Turbine efficiency

Initiative improvement potential: High Medium Low

Source: A.T. Kearney analysis


Thank you
for your attention
esther.rojas@ciemat.es