

# ABENGOA

## ABENGOA SOLAR

Innovative technology solutions for **sustainability**

An Overview of International CSP Developments:

Market, Technology and Policy



## Introduction to Abengoa Solar

Why CSP

International CSP Projects and Developments

Policy Framework. Project Deployment Mechanisms

Abengoa Solar CSP Plants Worldwide

### ABENGOA SOLAR

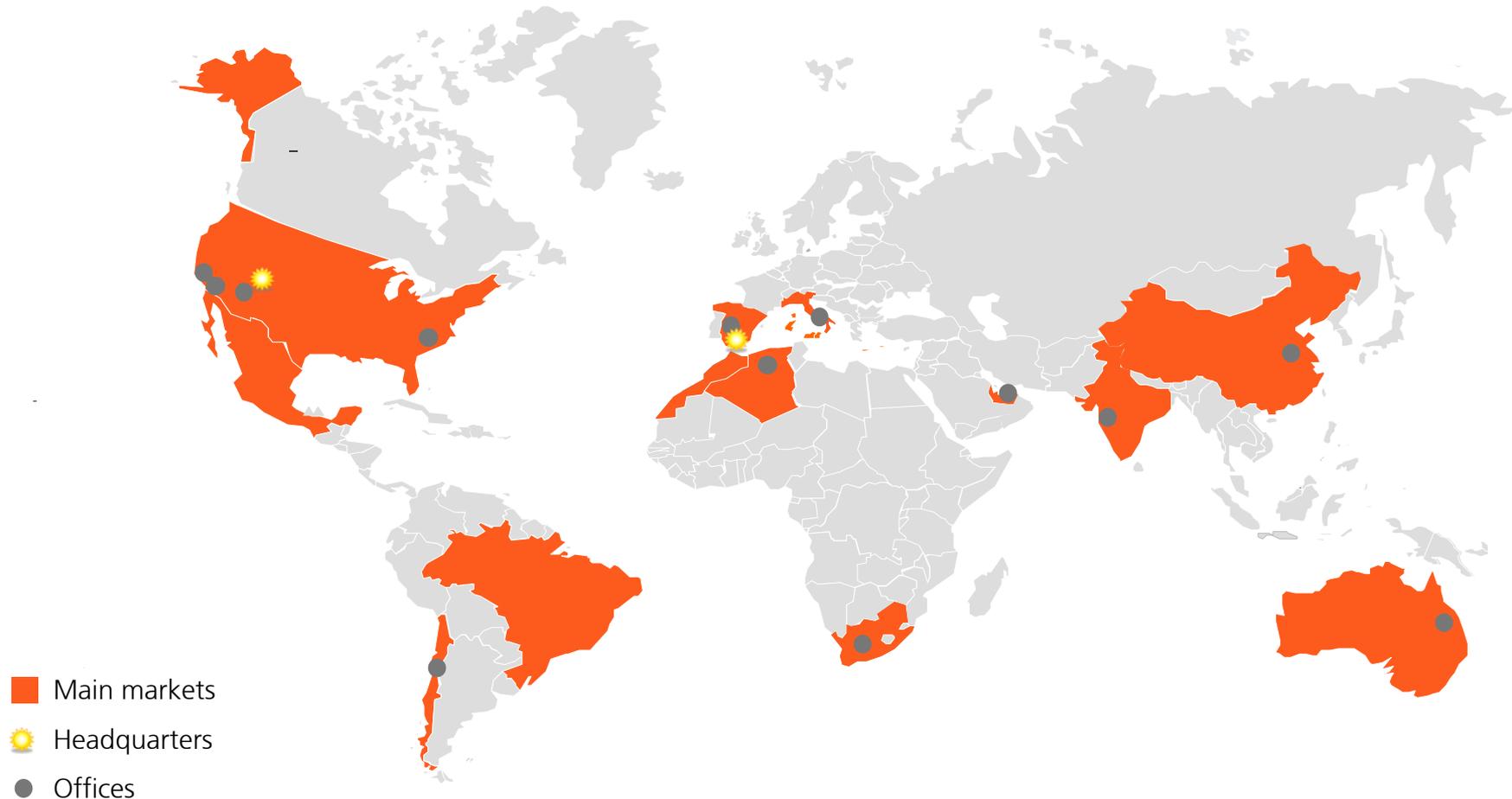
We are a global solar power company that offers proven proprietary technologies and uses them to develop, own and operate power plants.



- A **twenty year commitment** to the development of both CSP and PV technology
- **More than 800 professionals worldwide**
- **531 MWs in operation and 960 MWs in construction**
- **Proprietary solar technologies** (tower, parabolic trough, thermal storage, high concentration photovoltaics)
- A **world class team of solar experts**, with unsurpassed collective experience and skills



Abengoa Solar is currently constructing more than 1GW in solar power, applying technology developed in proprietary pilot plants



**Maximize output and improve operation by own O+M**

### Abengoa Solar CSP plants in commercial operation

Spain	MW	Technology
<b>Solucar Complex, Seville</b>		
Solnova 1	50	Trough
Solnova 3	50	Trough
Solnova 4	50	Trough
PS10	11	Tower
PS20	20	Tower
<b>Ecija Complex</b>		
Helioenergy 1	50	Trough
Helioenergy 2	50	Trough
<b>El Carpio Solar Complex</b>		
Solacor 1	50	Trough
Solacor2	50	Trough
<b>Algeria</b>		
ISCC Hassi R'mel	150	ISCCS
<b>Total CSP in operation</b>	<b>531</b>	

### PV Plants in Operation

Spain	MW
Sevilla PV	1,2
Casaquemada PV	1,9
Las Cabezas PV	5,7
Copero PV	1
Linares PV	1,9
<b>Total PV in Operation</b>	<b>11,7</b>



**Develop, build and own largest international CSP project pipeline**

### Abengoa Solar CSP plants in construction

<b>Spain</b>	<b>MW</b>
Extremadura Solar Complex	4 x 50
Castilla-La Mancha Solar Complex	2 x 50
<b>United States</b>	
Solana, Arizona	280
Mojave Solar, California	280
<b>United Arab Emirates</b>	
Shams-1, Abu Dhabi	100
<b>Total in construction</b>	<b>960</b>

### Abengoa Solar CSP plants in pre-construction

<b>South Africa</b>	<b>MW</b>	<b>Technology</b>
Kaxu Solar One	100	Trough
Khi Solar One	50	Tower



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**Why CSP**

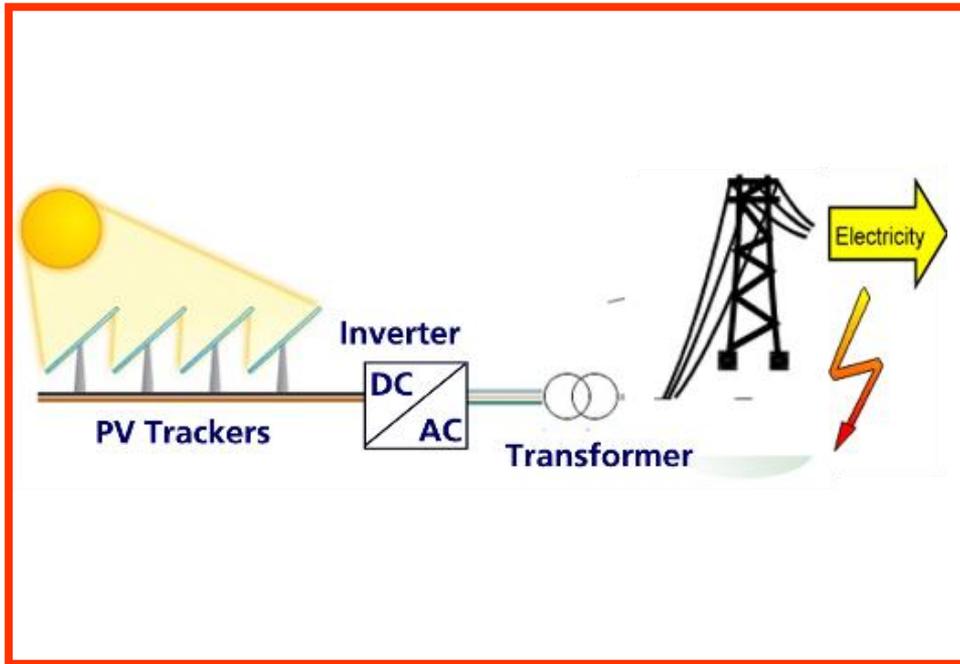
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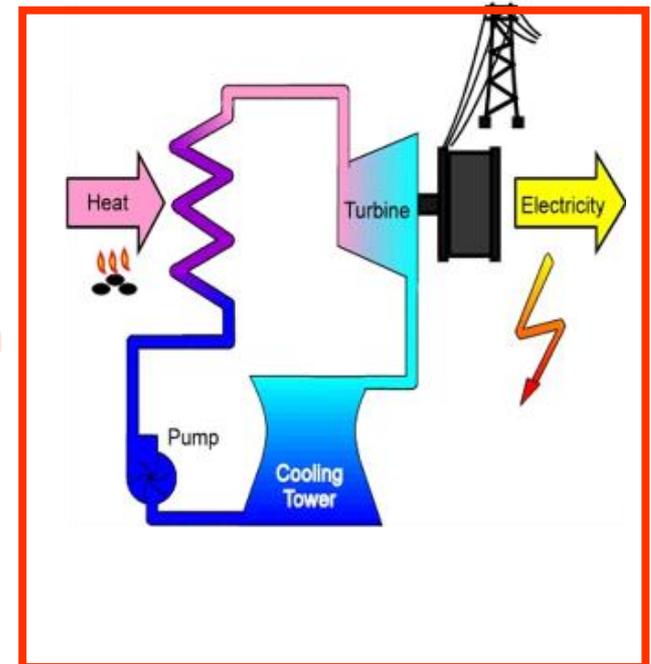
Abengoa Solar CSP Plants Worldwide

Other renewables are not dispatchable  
but need reserve capacity in the grid

Non-dispatchable renewable plant



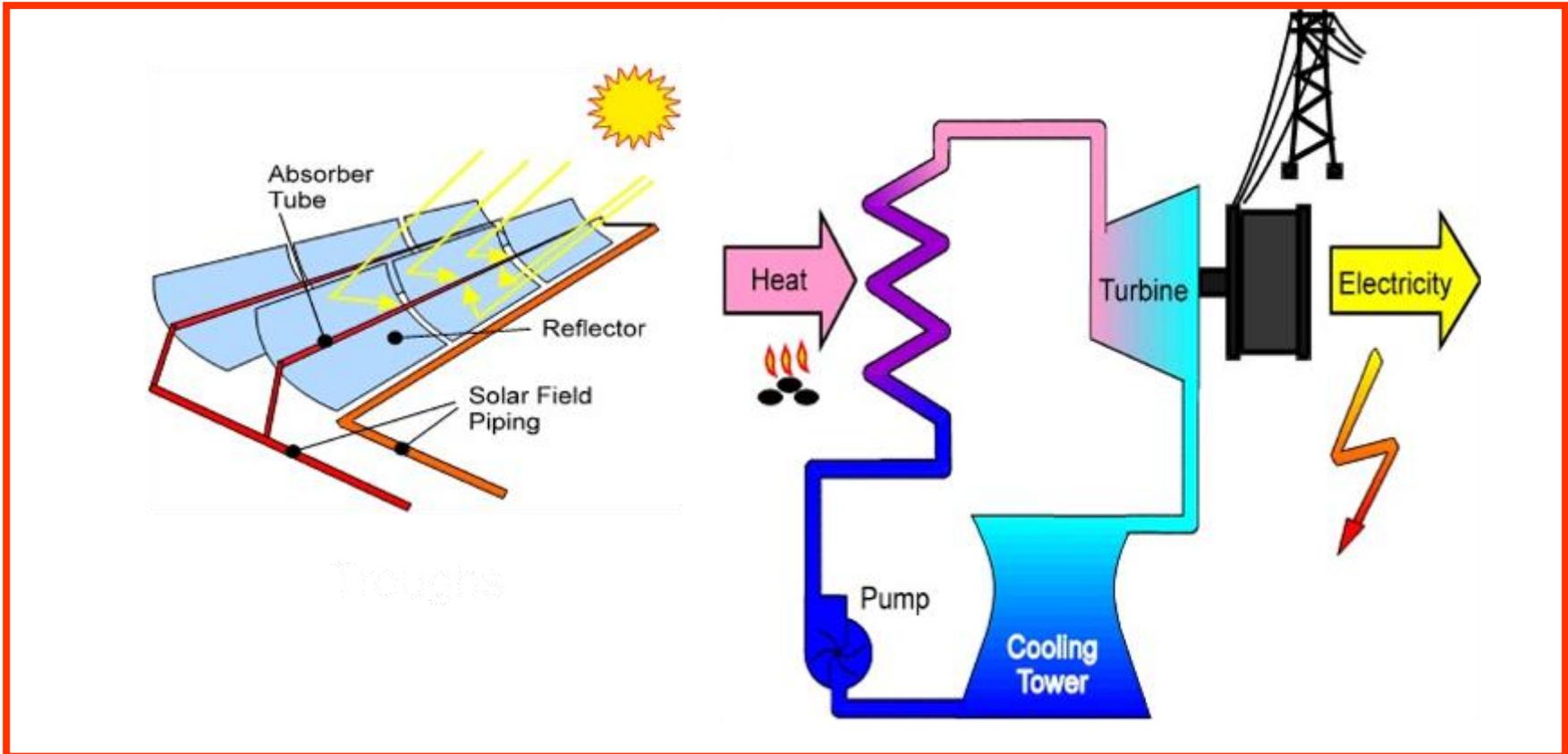
Back-up plant



For a PV or wind plant, the cost of the back-up system to grant firm capacity is not included in the PV system's Capex and Opex

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CSP offers  
dispatchable peak power



For a CSP plant, the cost of required back-up system to grant firm capacity is already included in the CSP system's Capex and Opex

1

### Solar dispatchable

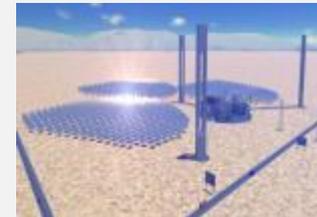
- Superheated tower
- Molten salt tower
- Next generation trough
- Industrial applications



2

### Hybrid solutions

- ISCC
- ISCoal
- Solugas



3

### Solar non-dispatchable

- HCPV

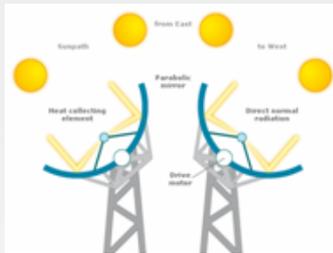


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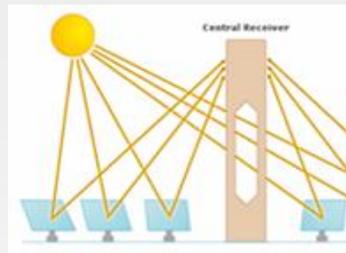
### CSP has four main technologies:



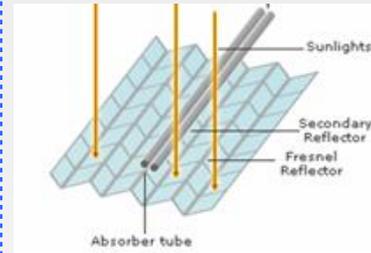
Commercially proven for utility scale power



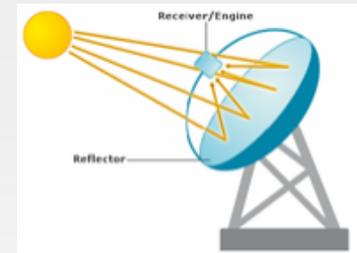
**Parabolic trough**



**Tower**



**Fresnel**



**Dish Stirling**

**Description**

- Parabolic Trough reflector concentrate the sunlight to a receiver tube where the Heat Transfer Fluid (HTF) is circulated

- Heliostats follow the sun to reflect the sunlight to the top of a tower where the heat transfer is heated.

- Rows of mirrors concentrate the sunrays onto a receiver tube where the HTF is pumped

- A group of mirrors with a parabolic shape reflect the sun to an engine located in the focus point

**Track record**

✓ 30 years

✓ 4 years

✓

✓

**Application**

✓ Utility scale power

✓ Utility scale power

✓ Heat applications

✓ Distributed power

**Key feature**

✓ Modular

✓ High temperatures

✓ Low cost

✓ High power conversion

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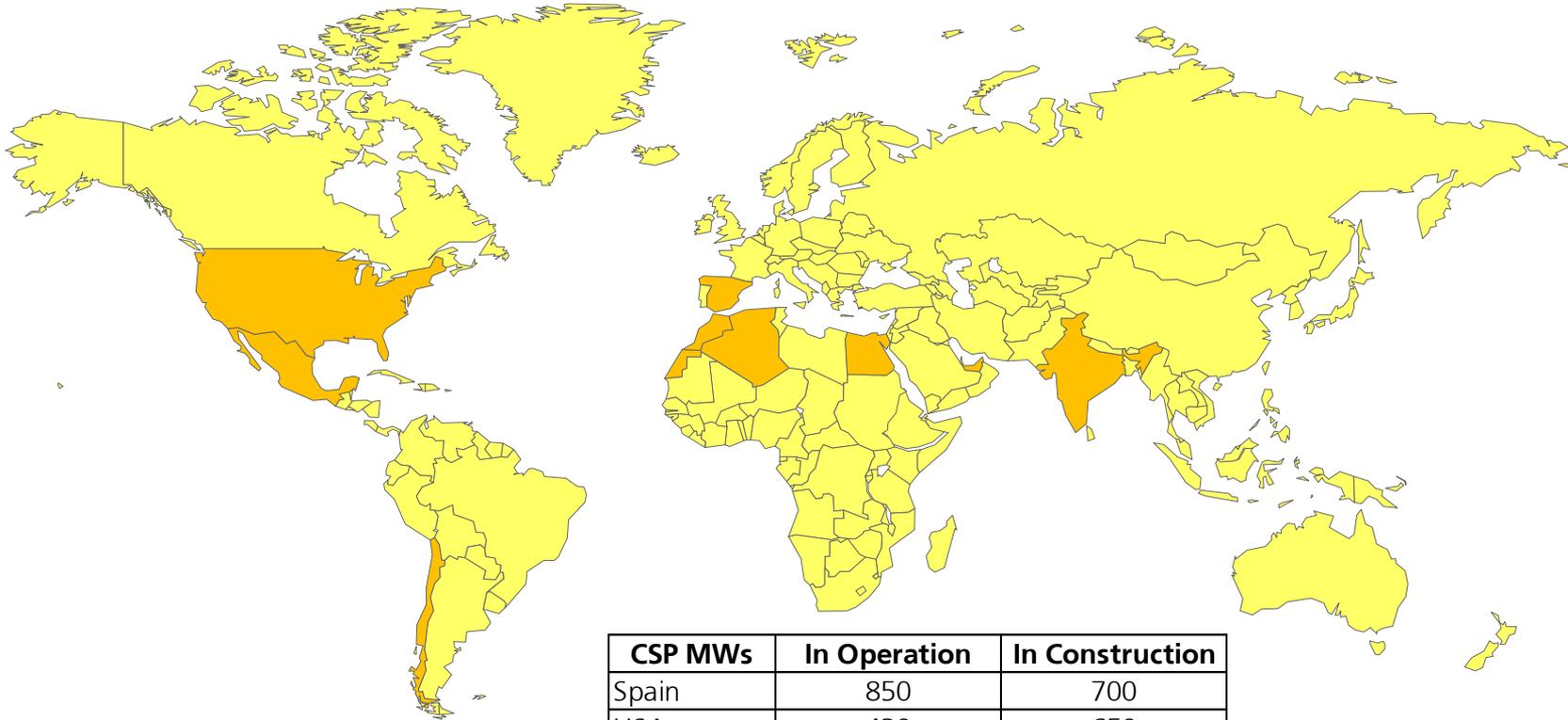
**International CSP Projects and Developments**

Policy Framework. Project Deployment Mechanisms

Abengoa Solar CSP Plants Worldwide

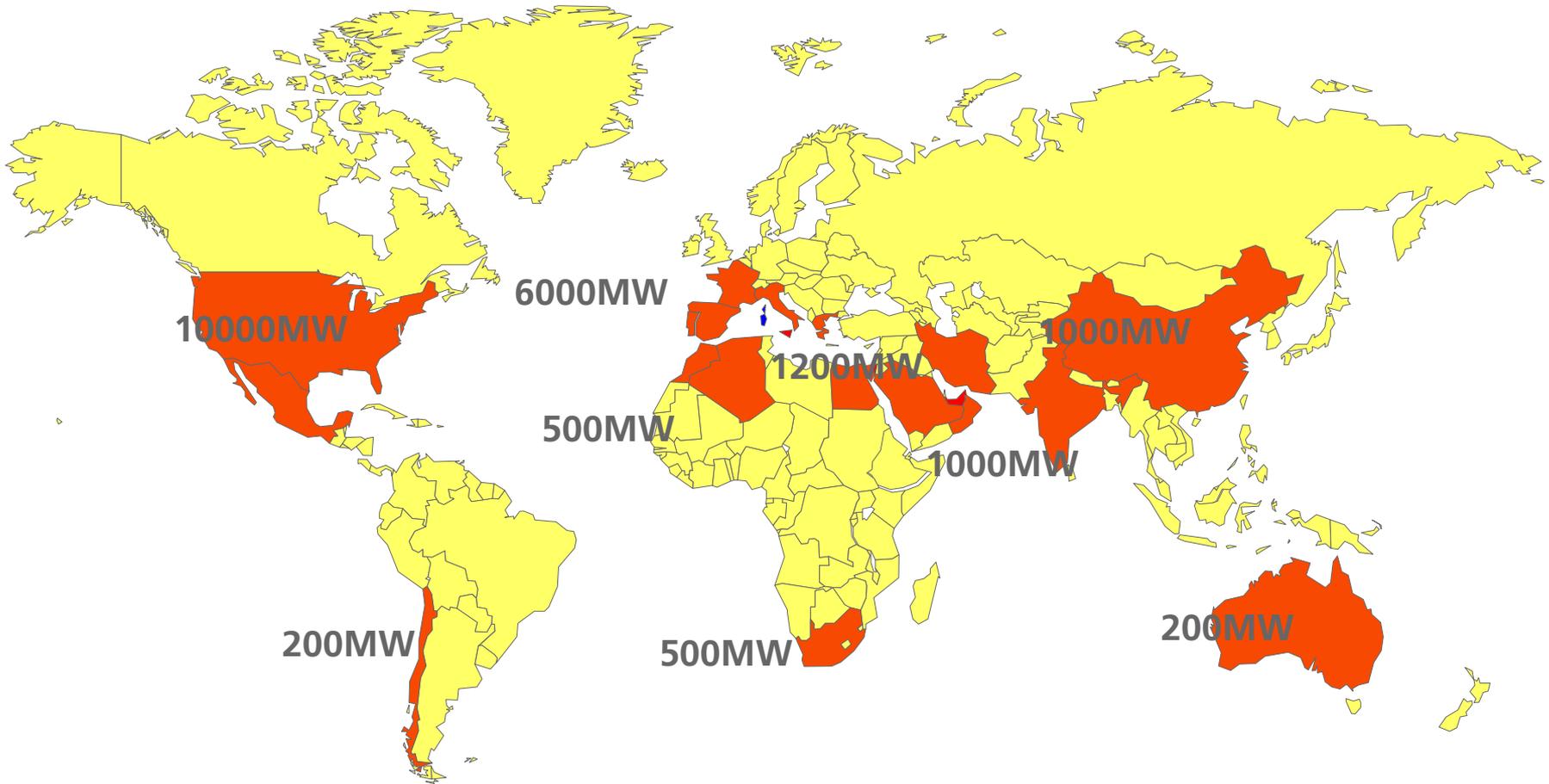
### Worldwide capacity:

- Operation: over 1300 MW CSP
- Construction: over 1450MW CSP



CSP MWs	In Operation	In Construction
Spain	850	700
USA	430	650
Abu Dhabi		100
Algeria	20	
Egypt	20	
Morocco	20	
Mexico		12
India		10

Currently over 20 GW CSP under development



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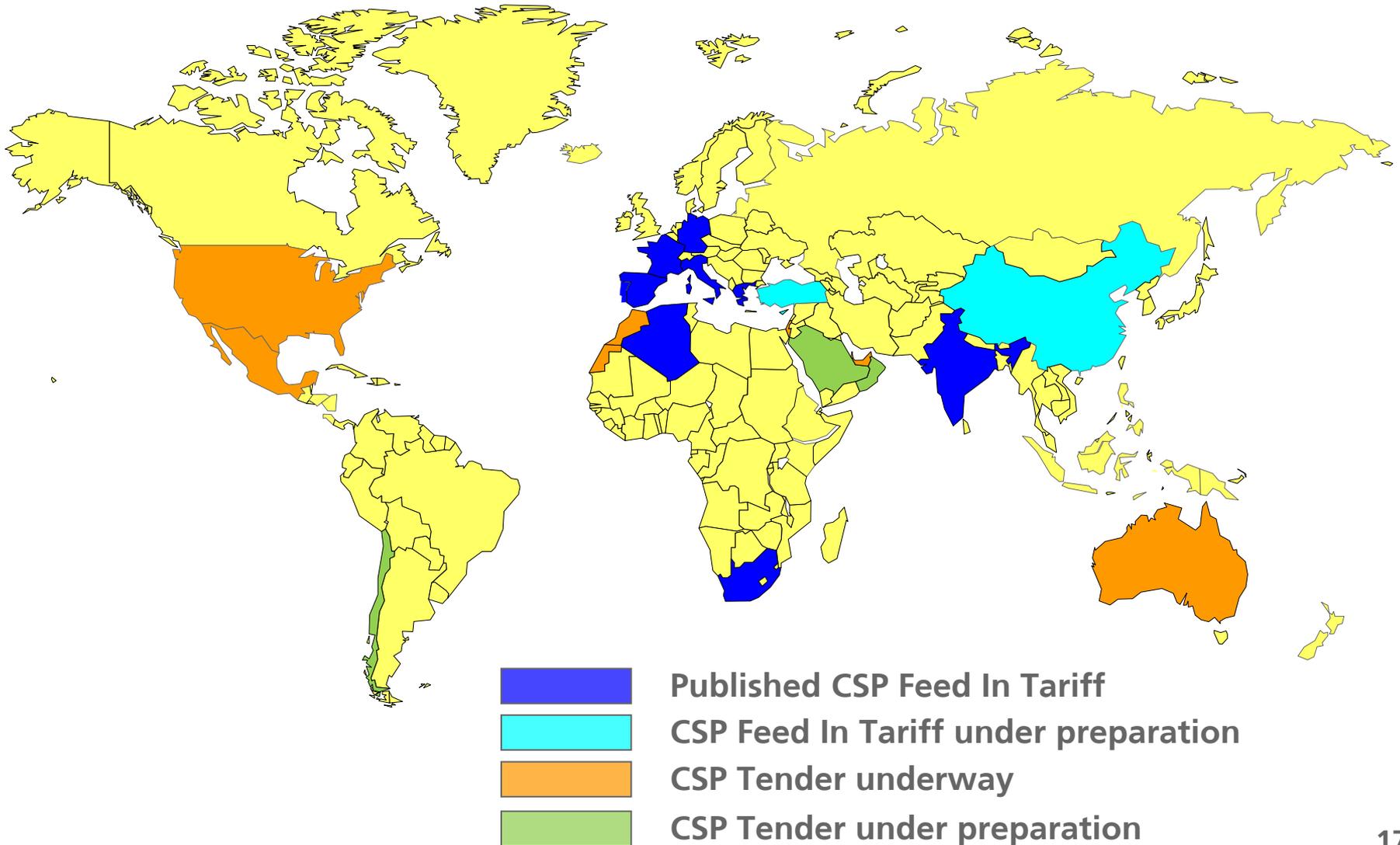
International CSP Projects and Developments

**Policy Framework. Project Deployment Mechanisms**

Abengoa Solar CSP Plants Worldwide

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## Countries with Published CSP Tariff and Tenders



### ❖ Feed-in Tariff Market

- Policy mechanism that enables IPP to sell electricity at a fixed price.
- Guarantees grid access
- Long term contracts for electricity produced
- Deadline for preregistration

Examples: Spain (indexation), Germany (tariff digression), ...

### ❖ “Ad Hoc” Tenders

- Public or private tenders
- Specifications defined by client
- Price is tendered by bidders
- Specific grants, tax credits, etc.

Examples: Abu Dhabi, Morocco, Mexico, USA....

### ❖ Cap Price tender

- Allocated MW to specific technologies are published.
- Electric price is capped.

Examples: South Africa, India

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**Abengoa Solar CSP Plants Worldwide**

**PS20, the second commercial tower in the world (Solúcar Complex, Spain). In operation since 2009**



- Provides energy to around 11,000 households
- 12,200 t of CO<sub>2</sub> saved
- 1,255 heliostats of 120 m<sup>2</sup> each
- Tower height: 160 m. Total land use: 90 ha
- Proprietary technology
- Excellent performance track record
- Financial Close: Q4 2006



### Solnova parabolic trough (Solúcar Complex, Spain) 3 x 50 MW trough plants. In operation since 2010



- Each 50 MW plant supplies energy to 25 700 households
- 31,200 t of CO<sub>2</sub> saved per year
- Total reflective area 300,000 m<sup>2</sup>
- Proprietary technology
- Excellent performance track record
- Financial Close Solnova 1: Q4 2007



Solúcar Complex, Spain

50 MW Solnova 1

50 MW Solnova 4

50 MW Solnova 3

### Helioenergy parabolic trough (Écija Solar Complex, Spain) 2 x 50 MW trough plants. Helioenergy 1. In operation since 2011



- Each 50 MW plant supplies energy to 25 700 households
- 31,400 t of CO<sub>2</sub> saved per year
- Total reflective area 300,000 m<sup>2</sup> (74 acres)
- Proprietary technology
- Financial Close Helioenergy 1: Q2 2010
- Financial Close Helioenergy 2: Q2 2010
- Both plants in operation.



**Solana, the largest solar plant in the world with 280 MW (Arizona, USA).  
Under construction. Expected to operate in 2013**



- Will produce electricity for 70,000 households
- 450,000 t of CO<sub>2</sub> avoided yearly
- Financed by Federal Financial Bank in December 2010
- 6 hours molten salt heat storage
- Creating a national supply chain that already spans 23 states,
- Proprietary technology
- Operation scheduled to begin 2013

Solana, Arizona



**Mojave Solar Project. 280MW, gross. Parabolic trough plant.  
Under construction.**

- Federal Loan Guarantee (Sept 2011)
- Construction has recently begun.
- Proprietary technology



Artistic rendering of Mojave Solar Project

### Solar integrated combined cycle (Ain Beni Matar, Morocco). In operation since 2011



- Combined cycle with solar parabolic trough field
- 470 MW (25 MW from solar field)
- 33,000 t of CO<sub>2</sub> avoided yearly
- 183,000 m<sup>2</sup> of reflective surface
- Proprietary technology

### Solar integrated combined cycle (Hassi R'mel, Algeria). In operation since 2011



- Combined cycle with solar parabolic trough field
- 150 MW (25 MW from solar field)
- 33,000 t of CO<sub>2</sub> avoided yearly
- 180,000 m<sup>2</sup> of reflective surface
- Proprietary technology



ISCCS Hassi R'Mel, Algeria  
Aerial View



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**Thank you!**

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