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Innovative solutions for sustainability

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Abengoa Solar HCPV Technologies and Projects

Workshop on Concentrator Photovoltaics and Solar Thermal Generation.

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Universidade Federal de Santa Catarina. Florianopolis.
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Outline

Abengoa Solar

PV global market

Concentration PV

Abengoa Solar technology and products

Market for CPV

Outlook

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Business model

Successful strategy based on three activities

1 Engineering and construction

- 70 years of experience
- Proprietary know-how
- 1st international contractor for transmission, 3rd for electricity infrastructures

2 Concession-type infrastructure

- Solar, transmission, desalination and cogeneration
- Very limited market risk
- An average of 27 years of regulated revenues

3 Industrial production

- Biofuels, industrial waste recycling
- High growth markets
- Market leadership

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Engineering and Construction

More than 70 significant projects executed in 2010 (examples)

Examples

	Generation	Transmission	Desalination	Cogeneration
				
Description	▪ Location: Morocco ▪ 450 MW solar-gas hybrid plant (Integrated Solar Combined Cycle, ISCC) ▪ Amount: $522 million	▪ Location: Brazil ▪ 2,375km 220 kV DC ▪ Amount: $1.024 billion	▪ Location: China ▪ 200,000 m^3/day ▪ Amount: $150 million	▪ Location: Mexico ▪ 300 MW cogeneration plant ▪ Amount: $460 million
Milestones	▪ 1st hybrid ISCC plant in the world	▪ Longest transmission project in Latin America ▪ Continuous current	▪ "2009 Desalination Deal of the Year" (Water Intelligence)	▪ 1st cogeneration plant in a Pemex refinery

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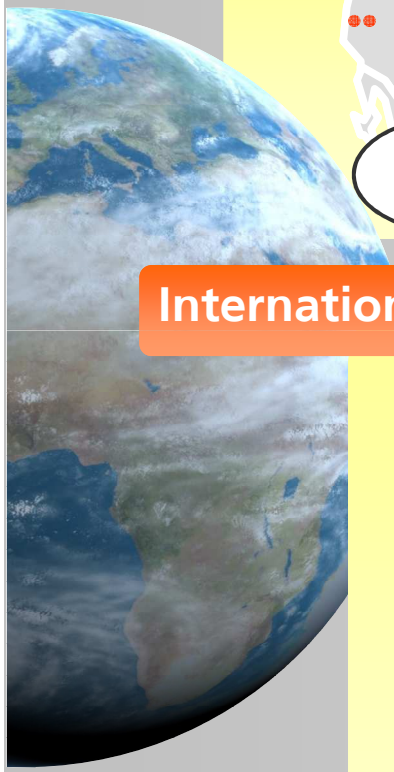
Abengoa Solar Global Presence

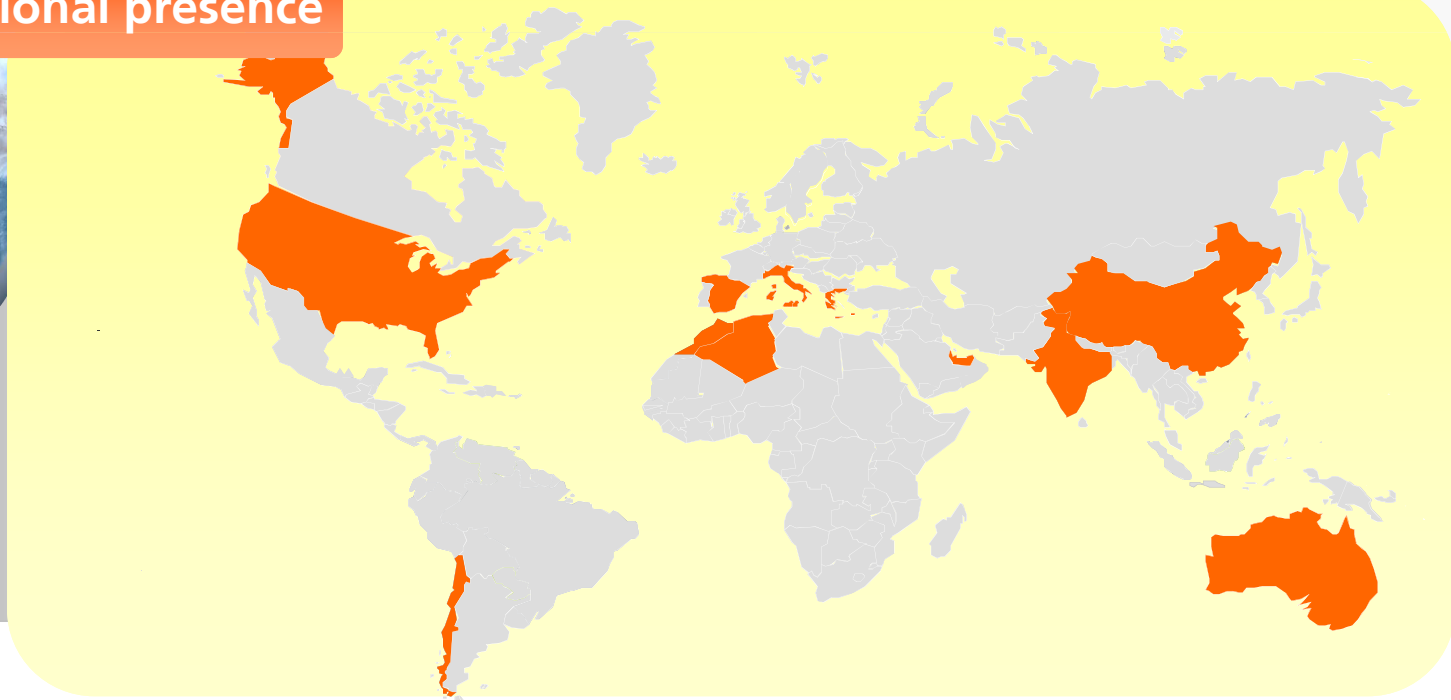
Main geographies



- ✓ **Largest solar plant** in the world in Arizona
- ✓ More than 100 professionals in R&D and project development efforts

- ✓ **Hundreds of MW under construction and development** in different technologies
- ✓ Unparalleled **R&D facilities**

International presence



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We are a large international and integrated solar power generation company offering proven technologies and developing new ones, both CSP and PV

- A **twenty year commitment** to both CSP and PV technology development
- **More than 600 professionals worldwide**
- **Two key markets** (Spain and U.S.) and expansion to international markets (i.e. UAE, Italy, India, Algeria, Morocco)
- **Proprietary solar technologies** (trough, tower, thermal storage, other technologies)
- Assembly of a **world class team of solar experts**, with unsurpassed collective experience and skills

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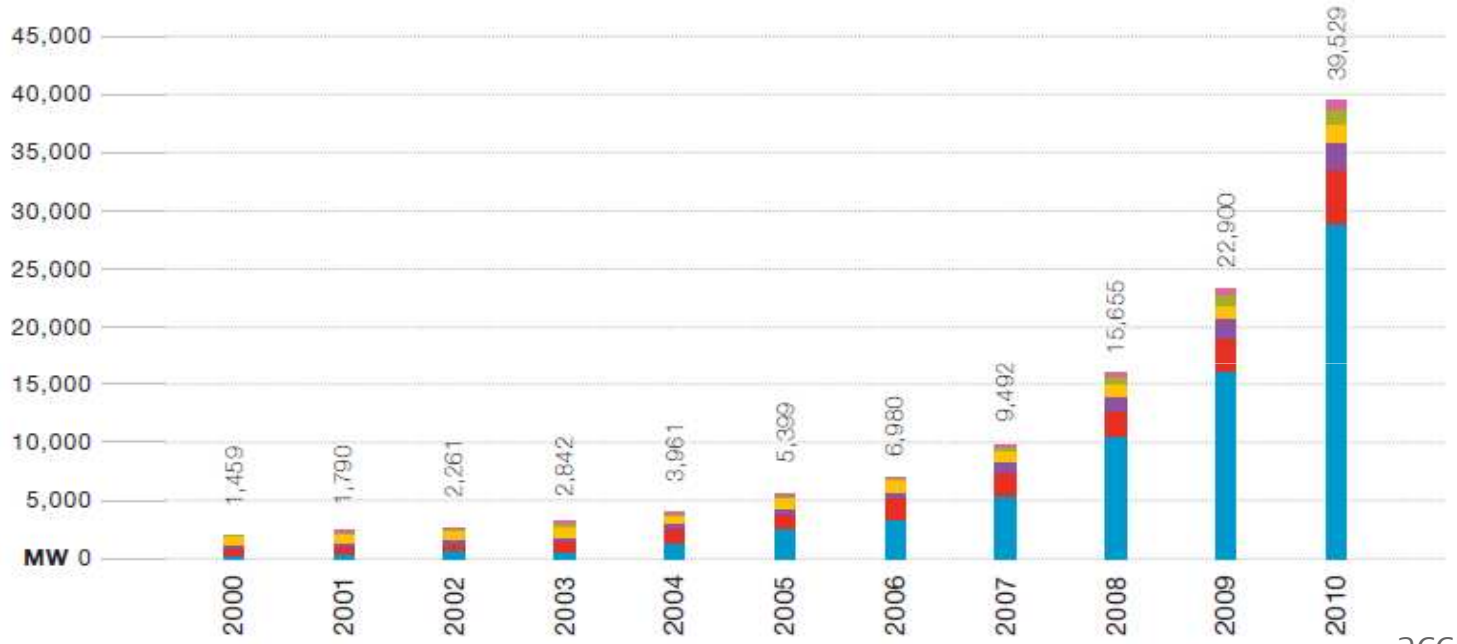
PV Global Market



accumulated

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China	19	30	45	55	64	68	80	100	145	373	893
APEC	38	43	49	57	66	80	112	170	466	718	1,191
Rest of the world	758	814	894	971	1,000	1,010	1,128	1,190	1,303	1,427	1,844
North America	146	177	222	287	379	496	645	856	1,205	1,744	2,727
Japan	318	452	637	860	1,132	1,422	1,708	1,919	2,149	2,632	3,622
EU	181	275	414	613	1,319	2,324	3,307	5,257	10,387	16,006	29,252
Total	**1,459**	**1,790**	**2,261**	**2,842**	**3,961**	**5,399**	**6,980**	**9,492**	**15,655**	**22,900**	**39,529**

Source: EPIA global market outlook for PV until 2015

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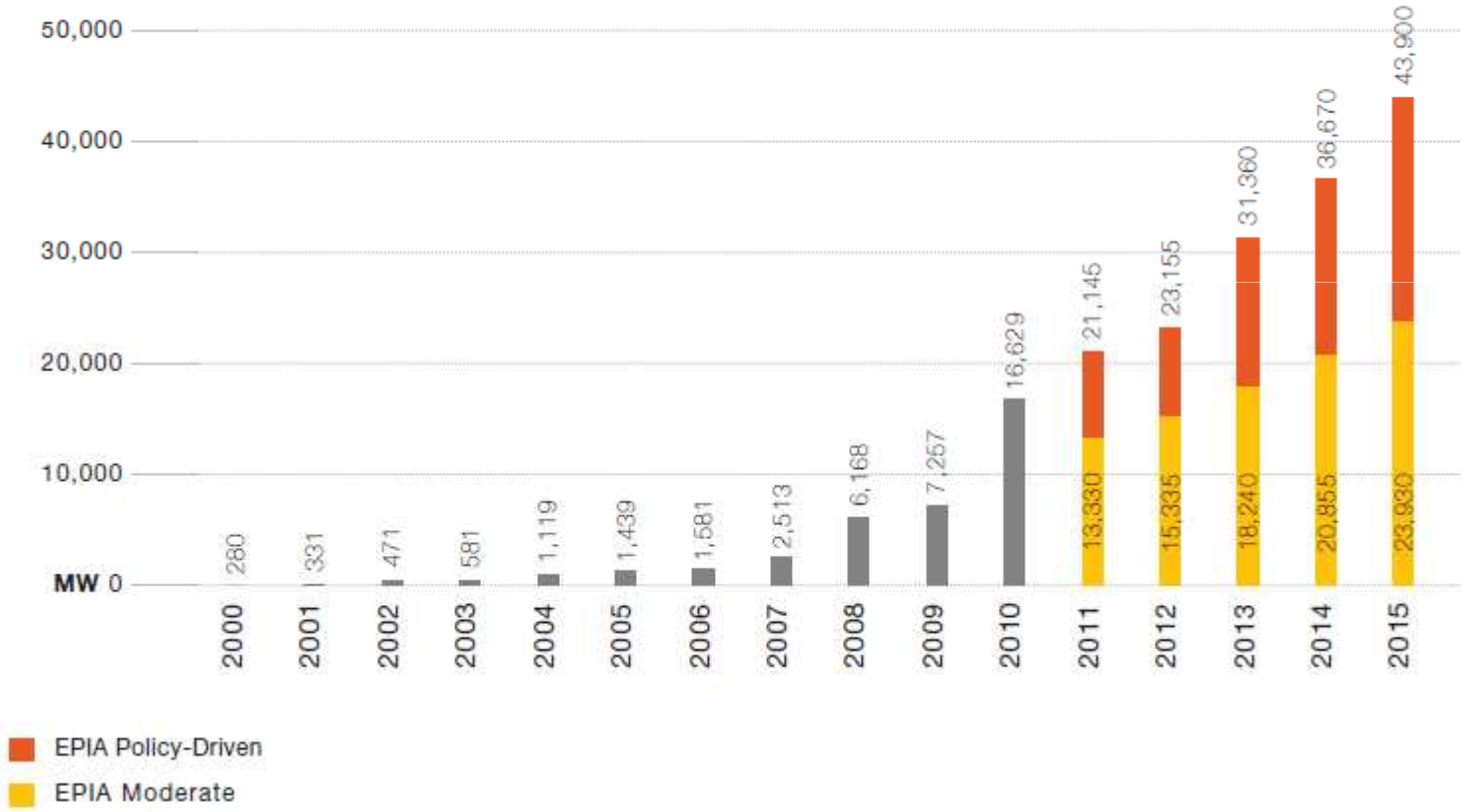
PV Global Market



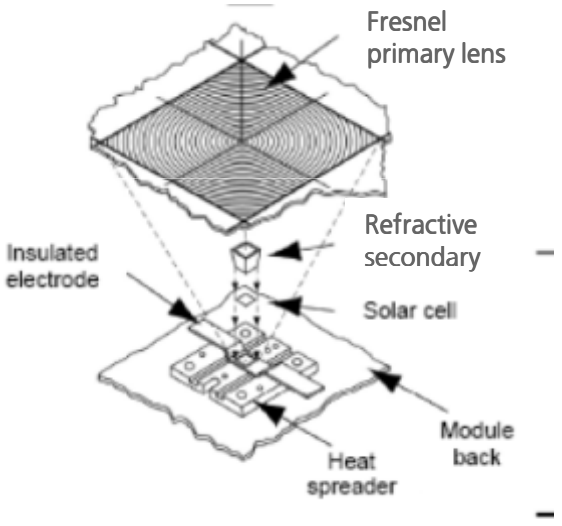
Source: EPIA global market outlook for PV until 2015

CPV produces electricity concentrating the sunlight on a small amount of semiconductor

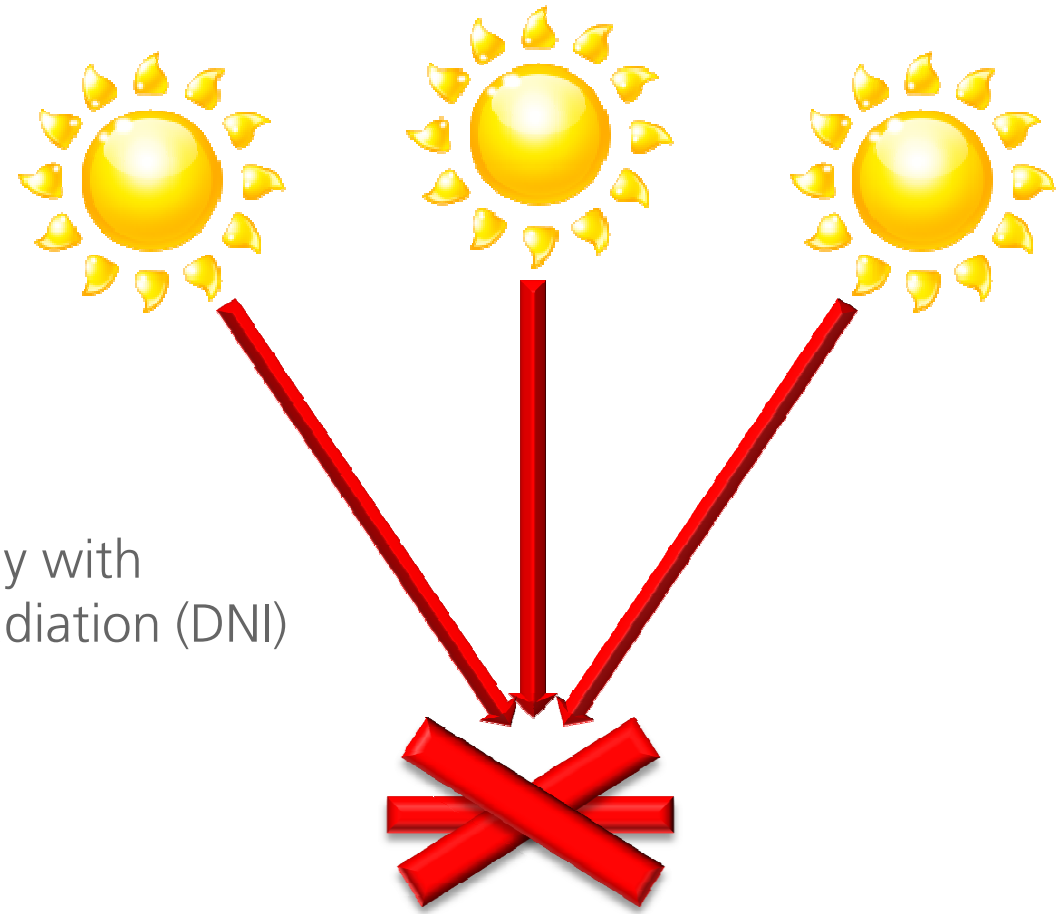
- CPV systems convert light energy into electricity as conventional PV technology does
- It does not use silicon but high efficient III-V cells
- CPV uses concentrating optics
- Efficient technology, area for area, optics in a concentrator system are less expensive that the silicon PV cell.
- Scalable technology by using ordinary materials such as glass and aluminum and low semiconductor volume
- Direct normal Irradiation (DNI): 2 axis tracking is required

CPV concepts

- CPV decouples sunlight collection area and PV conversion area. High concentration ratios are larger than 350
- CPV uses optics that concentrate the sun radiation onto the high efficiency multi-junction cell
- The basic concept is to replace expensive solar cell material with optical elements manufactured from less expensive readily available materials such as glass
- CPV optimizes thermal performance by dissipating heat through large backplane and using cell materials with low temperature coefficient.

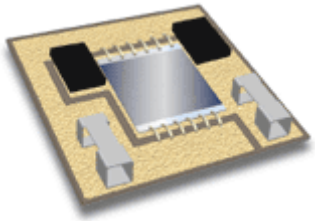


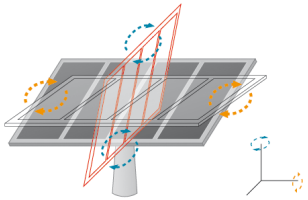
CPV operates only with
direct normal irradiation (DNI)



Conditions the geographical deployment for CPV

CPV Technology





cell	receiver	optics	module	tracking	BOS
Semiconductors Microelectronics LEDs		LEDs Lighting Automotive Assembly / white Goods		Structures Aviation Automotive Control Systems	Electrotechnics Renewables IT

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Our Proposal. CPV Utility Scale Systems

30 kW scalable system

Components:

- M300 modules
- T140 tracker
- Control system

- Proprietary design customized for M300 module
- 144 m^2 array
- > 30 kW per tracker
- High stability and tracking accuracy
- Proven control system for accurate technologies

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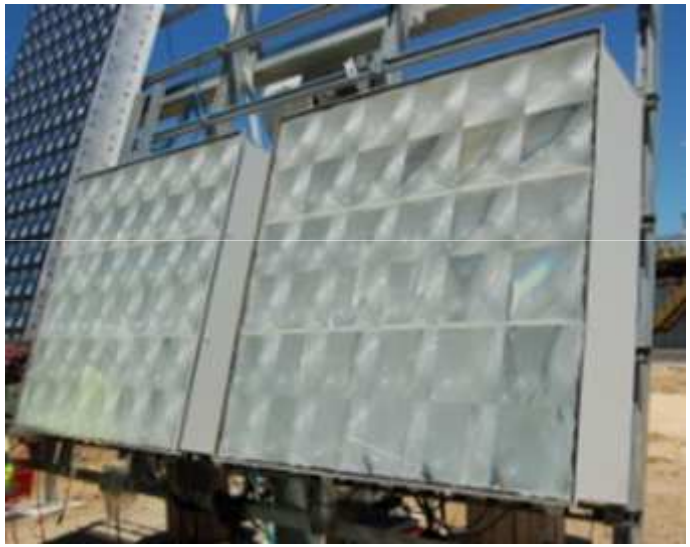
Our Proposal. CPV Module

CPV is a system: individual components must be optimal fitted to each other



M300 module

CPV systems

- Proprietary technology based on primary fresnel lens + secondary optics
- Very high performance
  - 1000x concentration
  - 365W modules (STC: @1000W/m2; 25ºC)
  - ±1.2º acceptance angle
  - > 29 % efficiency
- Monitoring system performance in southern Spain
- Designed for utility scale CPV power plants with a view to achieve the lowest possible levelized cost of energy (LCOE)

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Our Proposal. Flat CPV Systems

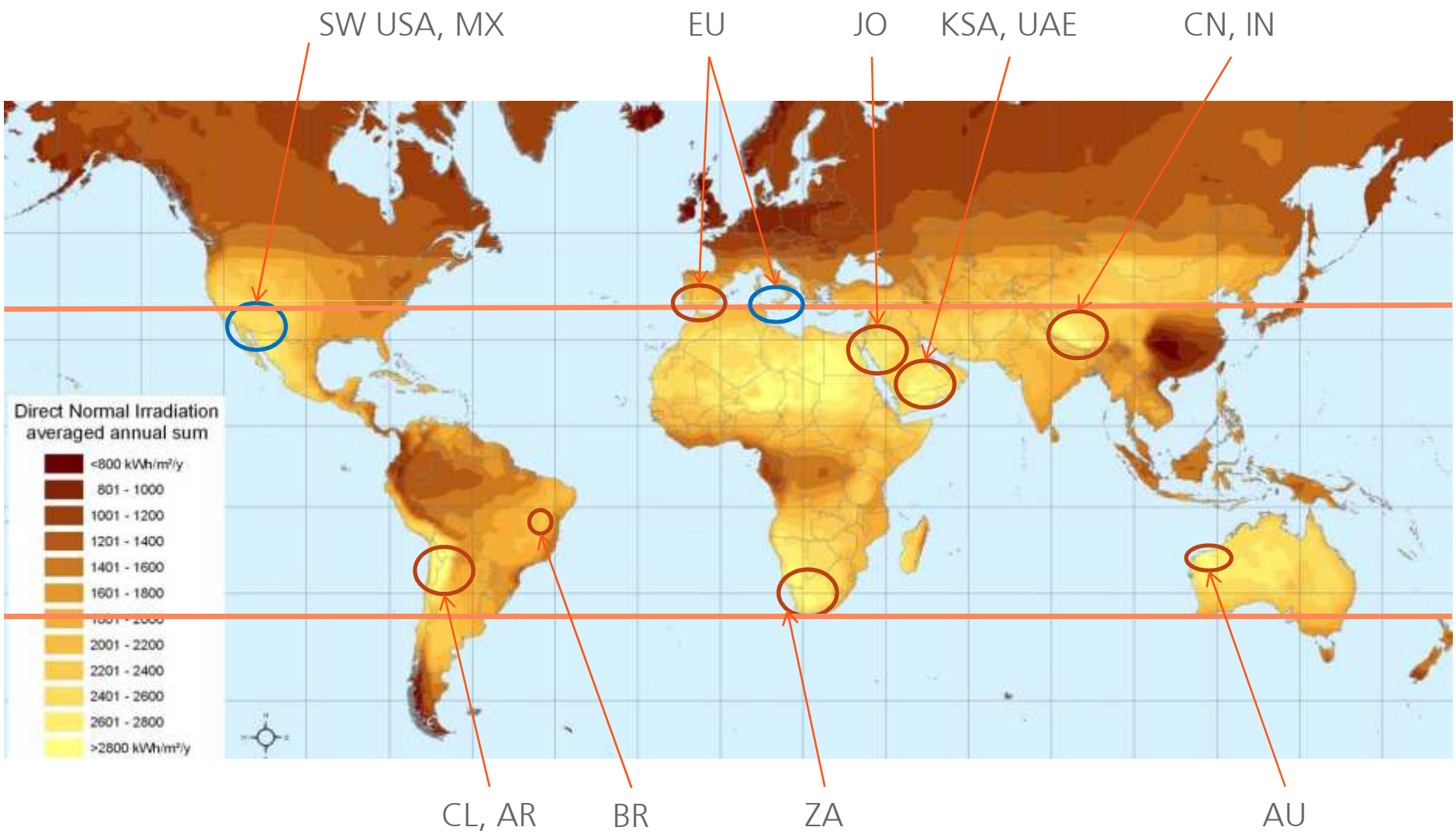
Scalable modular system

Components:

- M35 modules
- Tornasol tracker
- Control system

- Proprietary design customized for M35 module
- The pre-serial system is currently under validation

Optimum solar resource (DNI). Where to deploy CPV technology?



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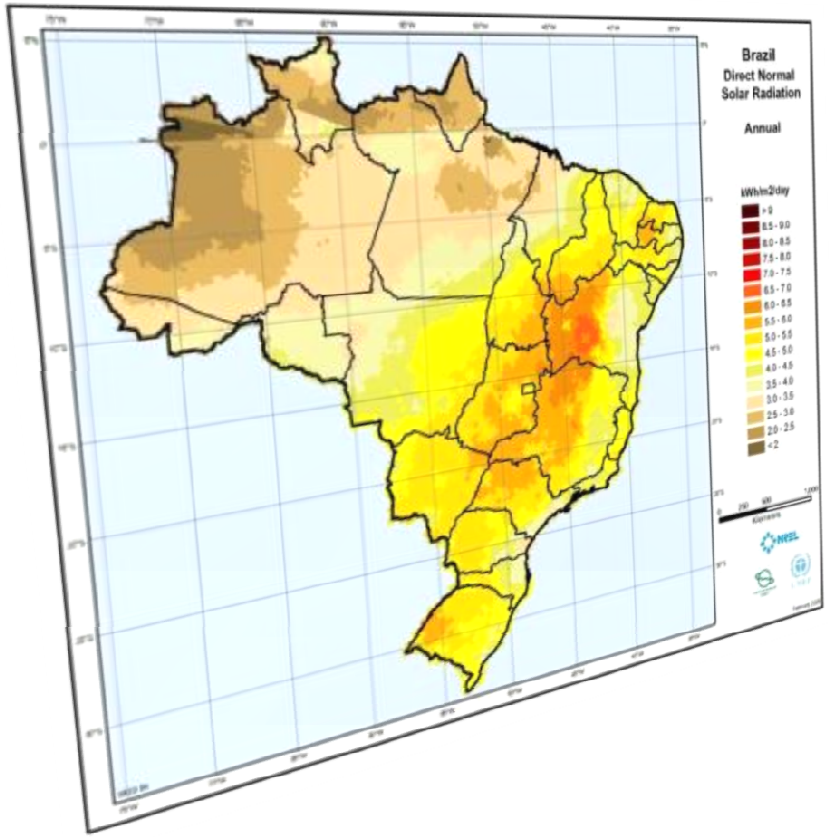
RE Country Attractiveness Indices



Rank1	Country	Solar index	Solar PV	Solar CSP
1 (1)	USA2	74	73	77
2 (2)	India	65	70	53
3 (5)	China	62	67	48
3 (4)	**Spain**	**62**	**61**	**65 (2)**
5 (3)	Italy	58	64	45
6 (6)	Greece	54	59	40
7 (6)	Japan	52	61	26
8 (9)	Australia	51	51	52
9 (10)	France	50	58	31
9 (na)	Morocco	50	50	51
9 (11)	Portugal	50	54	39
12 (6)	Germany	48	66	0
13 (12)	South Korea	46	53	29
14 (13)	Mexico	45	46	40
15 (13)	Egypt	44	43	46
16 (15)	**Brazil**	**42**	**46**	**32 (13)**
17 (18)	Turkey	39	43	30
17 (16)	Austria	39	54	0
19 (19)	South Africa	38	35	46
20 (16)	UK	37	51	0

Source: Ernst & Young. Renewable energy country attractiveness indices, Issue29, May 2011

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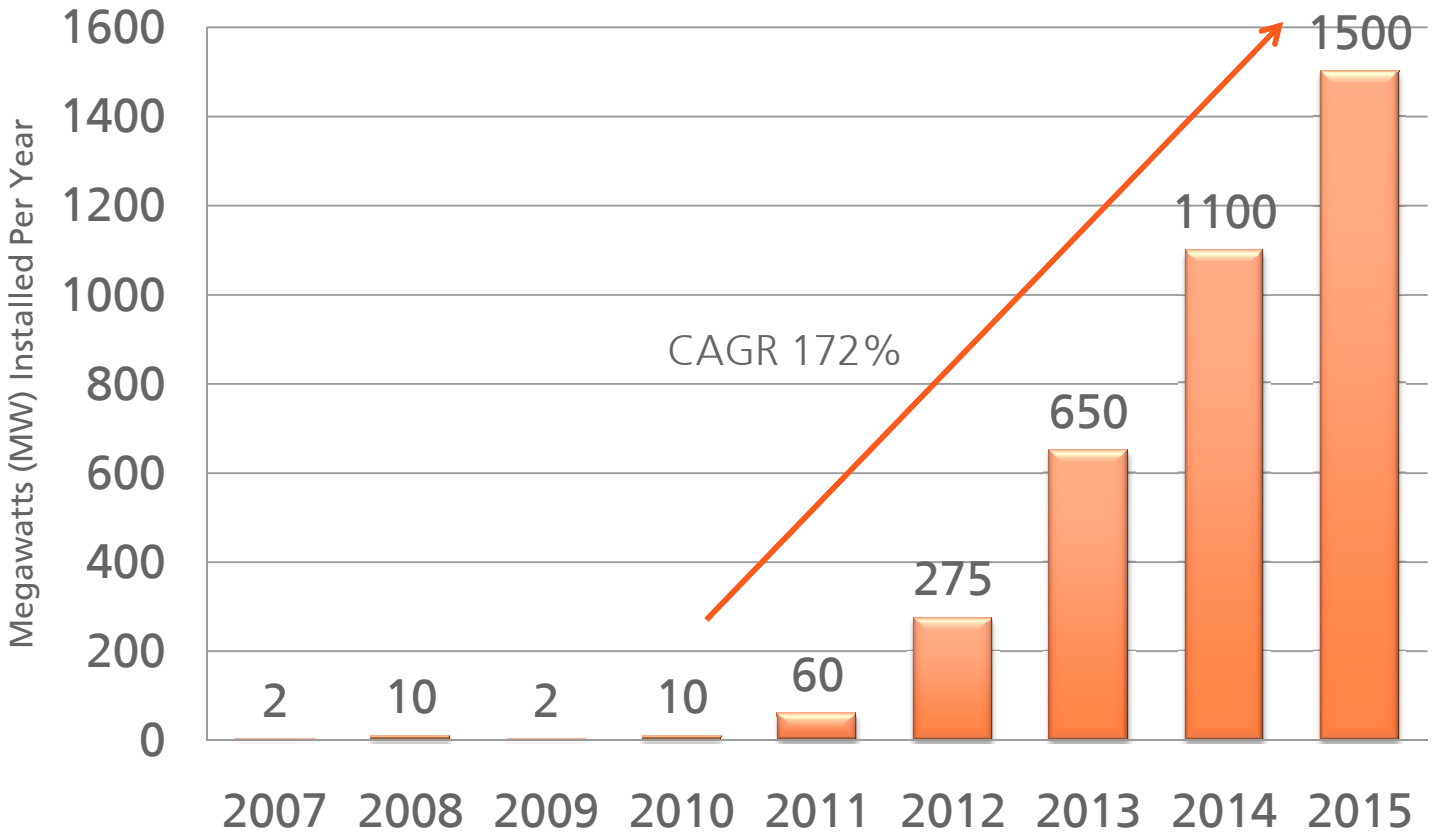
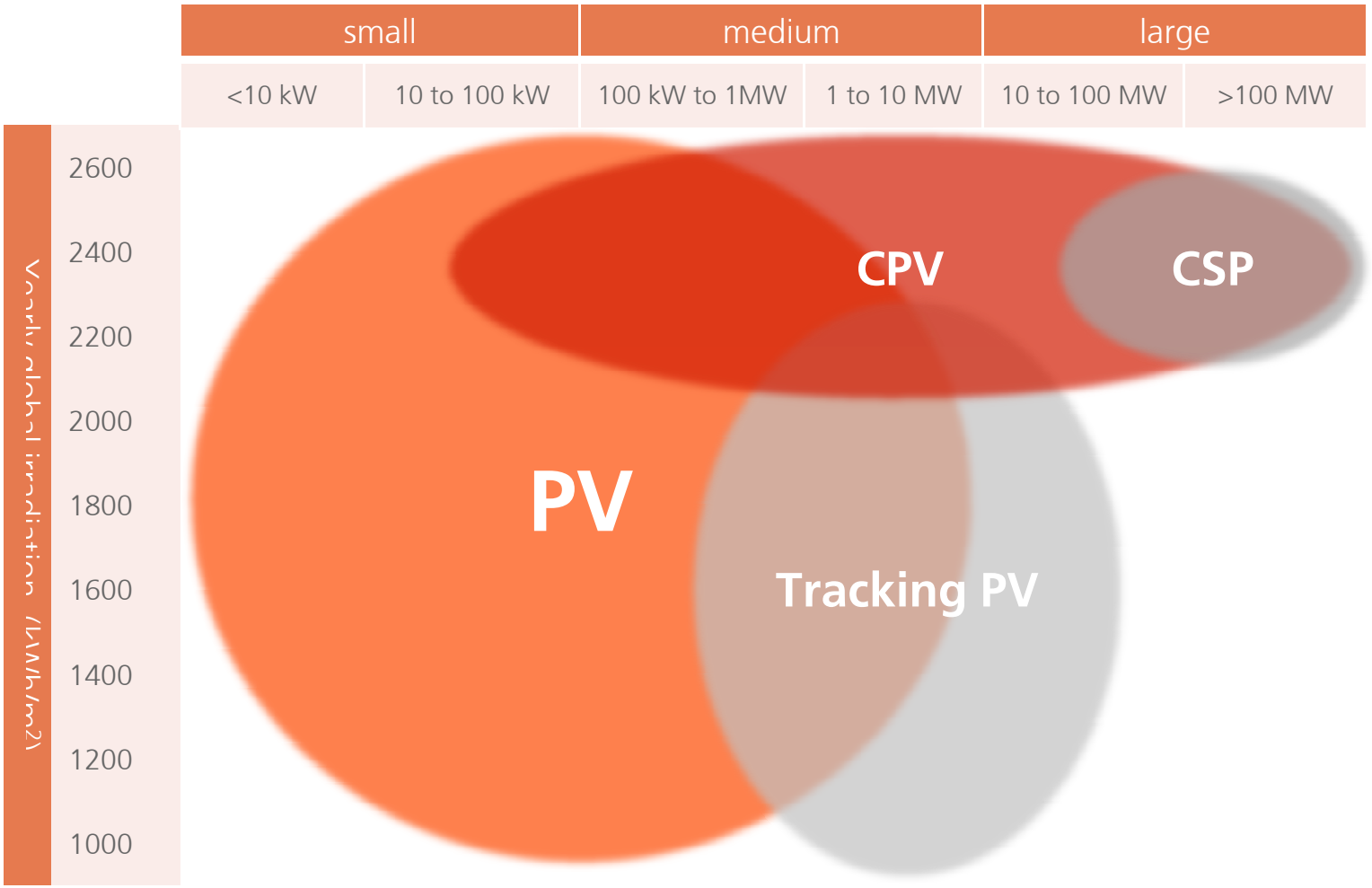
CPV Market Estimates



Sources: 2007-2009 EPRI; 2010-2015 CPV Consortium 2011 report

3.5% PV market share in 2015

CPV Outlook


small
medium
large
<10 kW
10 to 100 kW
100 kW to 1MW
1 to 10 MW
10 to 100 MW
>100 MW
Annual direct insolation (kWh/m2)
2600
2400
2200
2000
1800
1600
1400
1200
1000
CPV
CSP
PV
Tracking PV

CPV Outlook

Efficiency%	2009	2015
Cell	30-41	42-50
Optics	75-85	80-90
Module	20-30	30-40
System	18-25	26-32

source: EUPV platform, CPV Consortium

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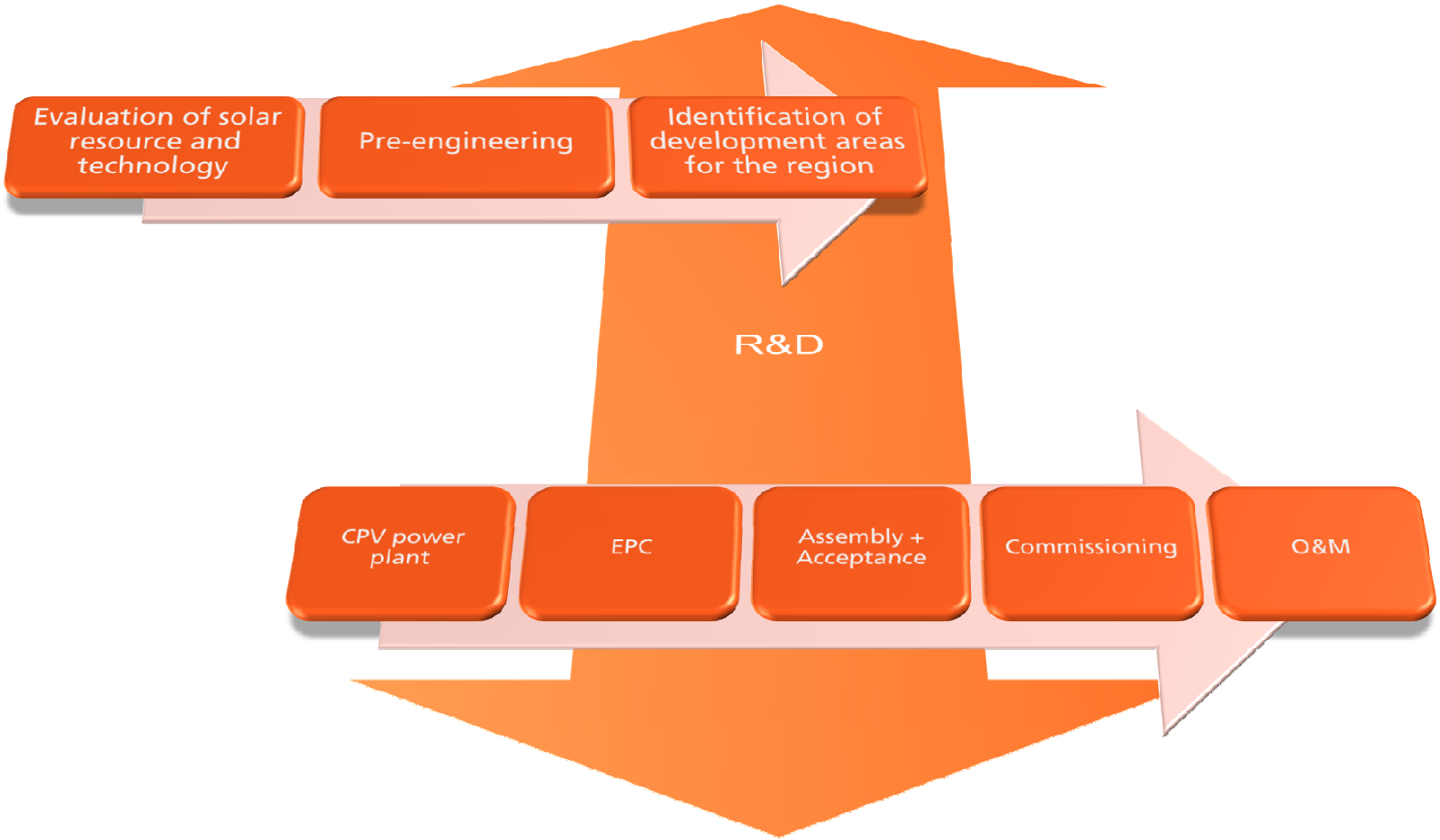
HCPV Project in Brazil



CPV Technology - Summary

Abengoa Solar - CPV outlook

- CPV is the highest solar efficiency technology to be deployed in the high solar resource regions of the world
- CPV is the highest growth technology within solar PV business
- Abengoa Solar module efficiencies > 30%
- Financing of CPV plants is taking place
- Abengoa Solar technology: large acceptance angle leading to lower cost and higher efficiencies
- Abengoa Solar technology: scalable product, ground mounting and rooftop
- Abengoa Solar capable of delivering full system: logistics, installation, startup, operation and maintenance
- Abengoa Solar global presence and renewable energy projects in regions of interest for CPV