

ABENGOA SOLAR

Solar Power for a Sustainable World

Concentrating Solar Power Generation

CERN Kolloquium






Geneva, October 30th 2008

Dr. Michael Geyer

Director International Project Development

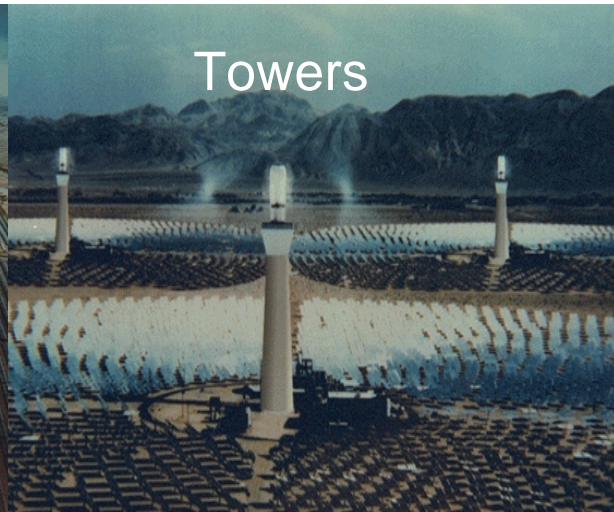
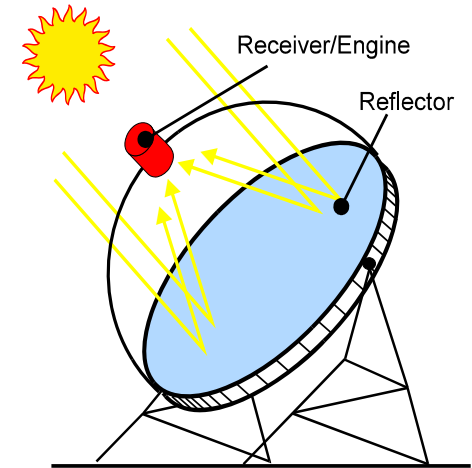
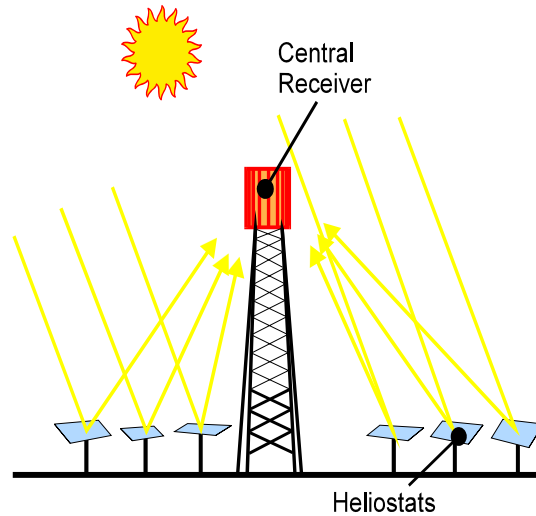
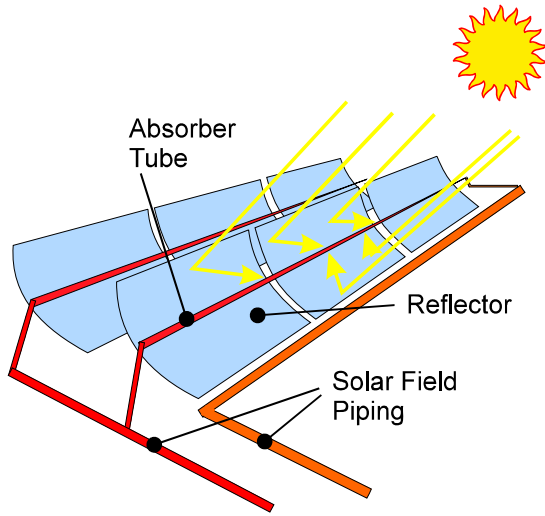
Vice-President European Solar Thermal Electricity Association ESTELA

Five self standing companies, one of which is Abengoa Solar

Abengoa Solar	Abengoa Bioenergy	Befesa	Telvent	Abeinsa
				
Solar energy	Bioenergy	Environmental services	Information technologies	Engineering and construction
<p>International leader on solar power plants solar</p> <ul style="list-style-type: none"> • 12 MWs in operation • 120 MWs under construction • Hundreds of MWs under development 	<p>Only bioethanol producer on the three key geographies</p> <ul style="list-style-type: none"> • First european producer • Fifth largest producer in USA • One of the largest producer in Brazil 	<p>International leader on industrial waste treatment, as well as in the water management field</p>	<p>International leader in IT for the energy, traffic, transport and environmental sectors</p>	<p>Leader in Spain and South America in engineering and construction projects and EPC.</p> <ul style="list-style-type: none"> • Ranked as the third largest international power contractor (ENR)

	Unit	Operation
Add-on Projects and Engine Plants	MW	1.234
Combined Cycles	MW	2.923
Cogeneration and District Heating	MW	643
Solar and Thermal Power Plants	MW	31
Ethanol	M3/year	611.000
D.D.G.S.	t/year	558.000
Biodiesel	t/year	200.000





We apply the best technology for each solar power need...

CSP



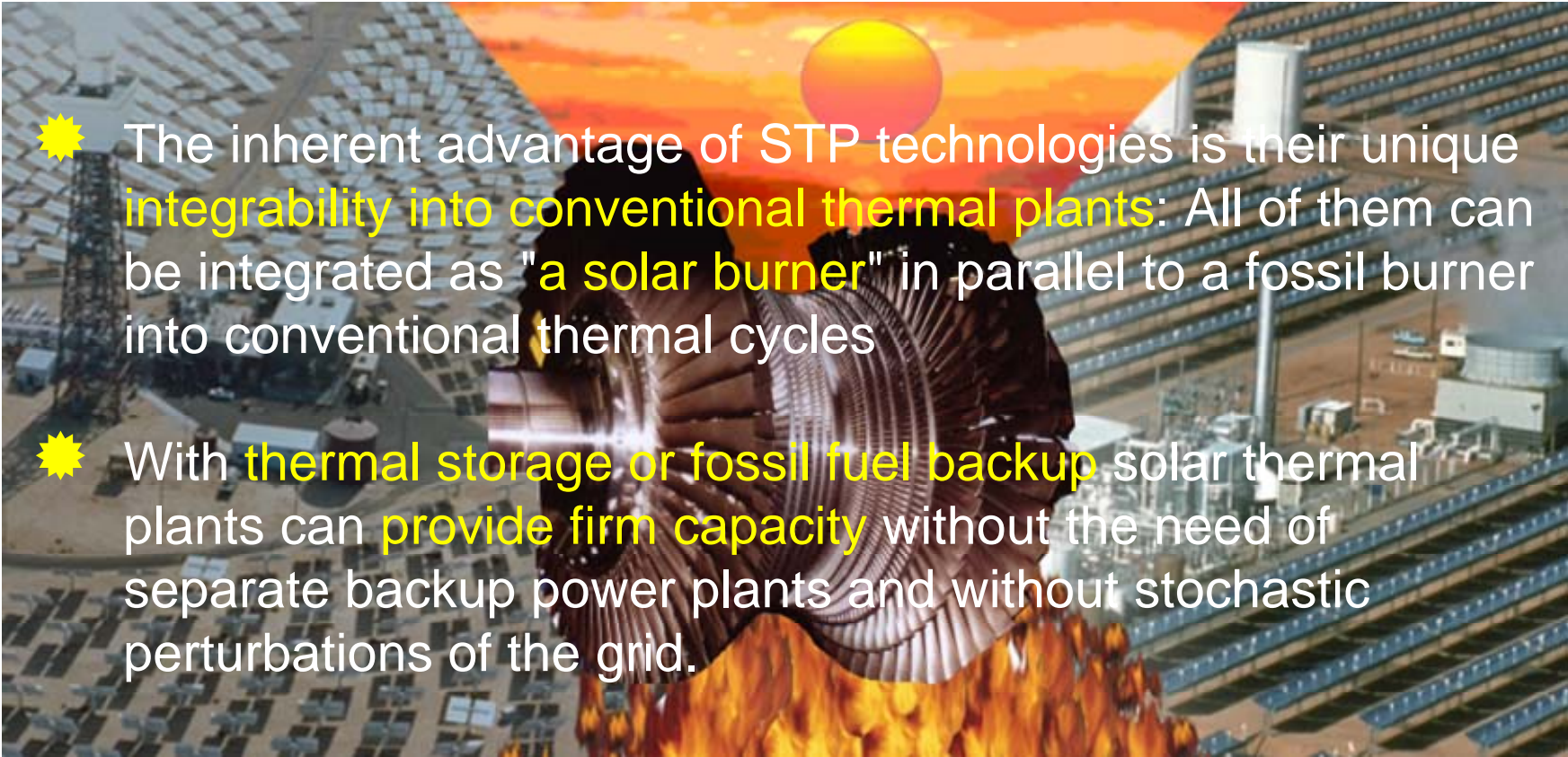
- ✓ Technology neutral and focused on power generation and industrial applications. Troughs is the only proven, commercially ready solution
- ✓ Development of our own CSP technology to reduce the cost and improve the efficiency

PV



- ✓ Develop, build and operate PV plants
- ✓ Investing in R&D to develop lower cost solutions (i.e. CPV)

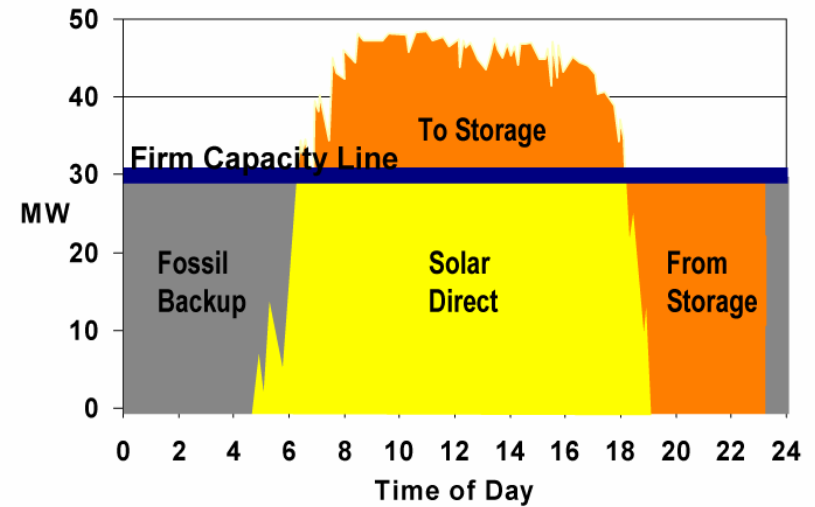
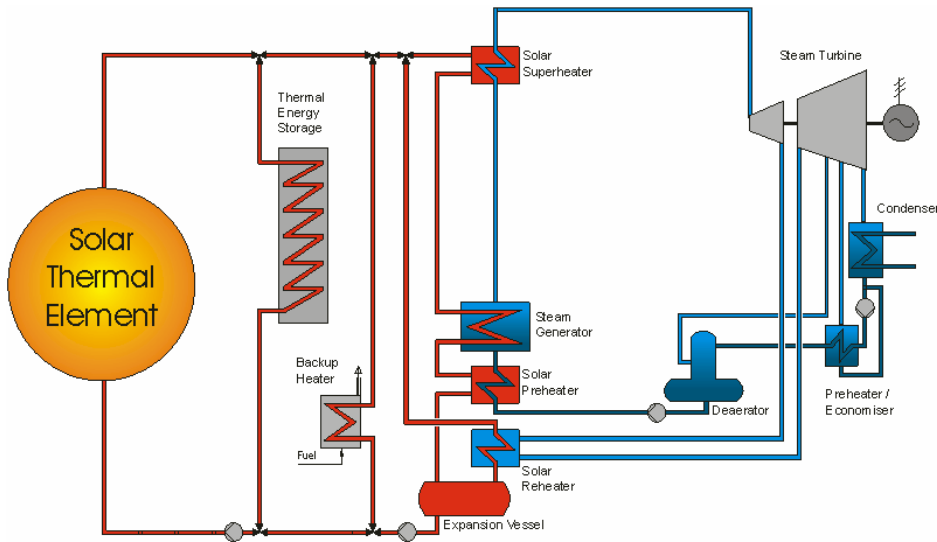
Why do we need CSP?

- 
- ☀ The inherent advantage of STP technologies is their unique **integrability into conventional thermal plants**: All of them can be integrated as "**a solar burner**" in parallel to a fossil burner into conventional thermal cycles
 - ☀ With **thermal storage or fossil fuel backup** solar thermal plants can **provide firm capacity** without the need of separate backup power plants and without stochastic perturbations of the grid.

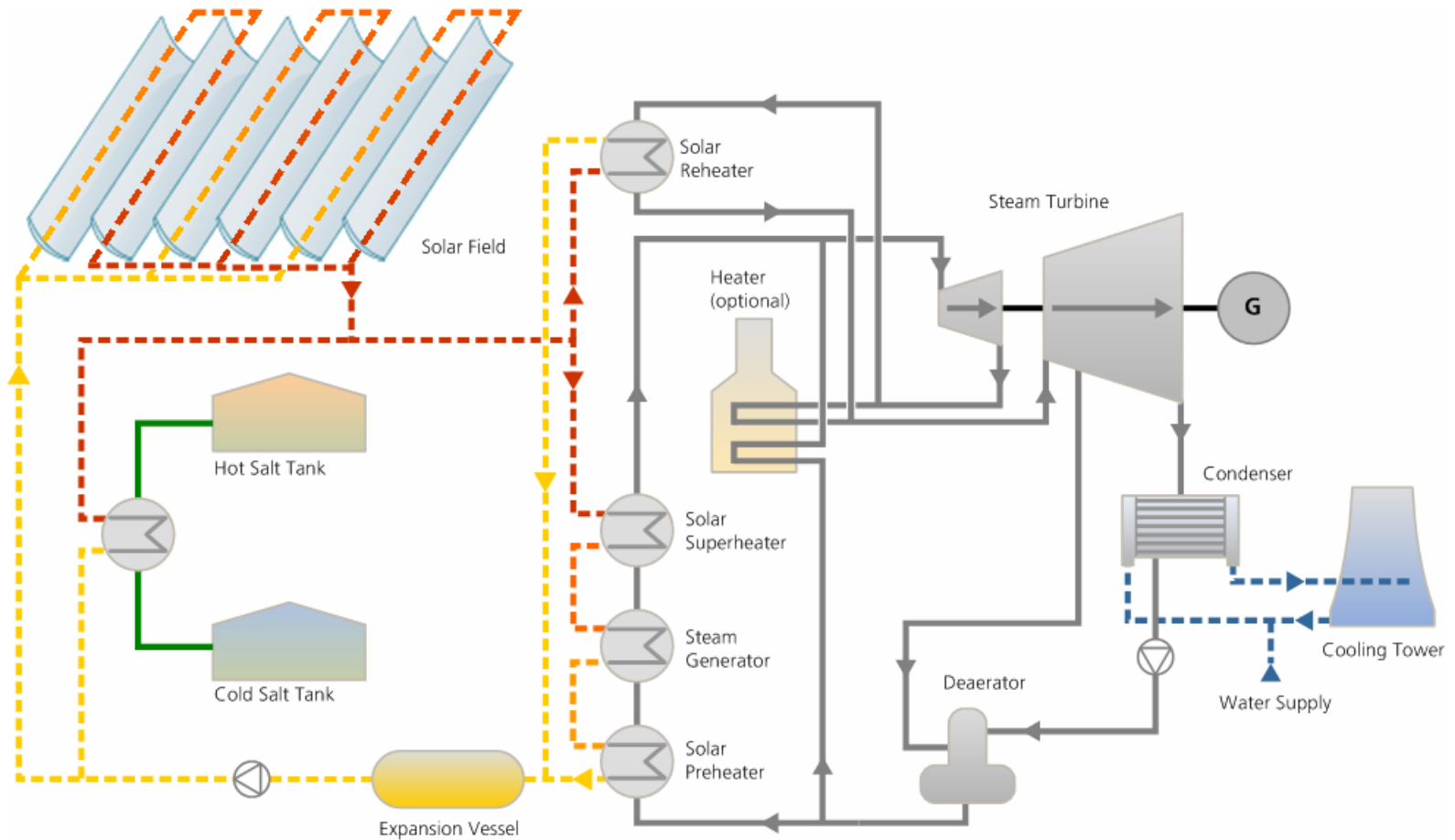
ESTELA

Renewable Energy House
Rue d'Arion 63-67 - B-1040 Brussels - Belgium
Tel.: +32 (0)2 400 10 90 - Fax: +32 (0)2 400 10 91
estela@estelasolar.eu - www.estelasolar.eu

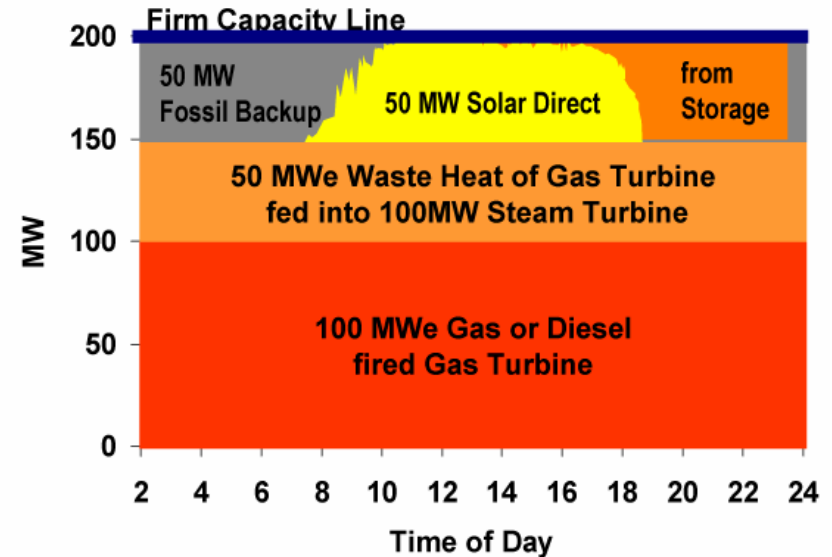
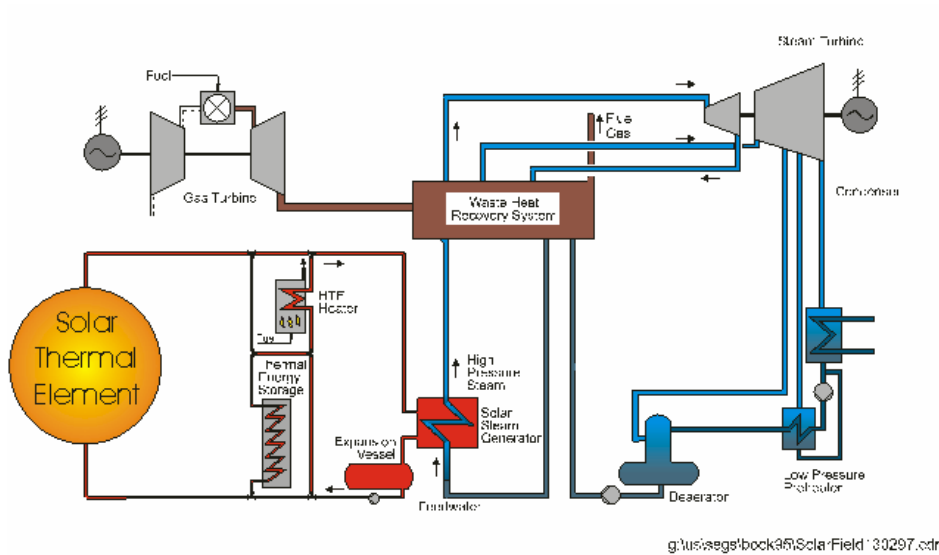
Firm Capacity with Storage and/or Fossil Backup



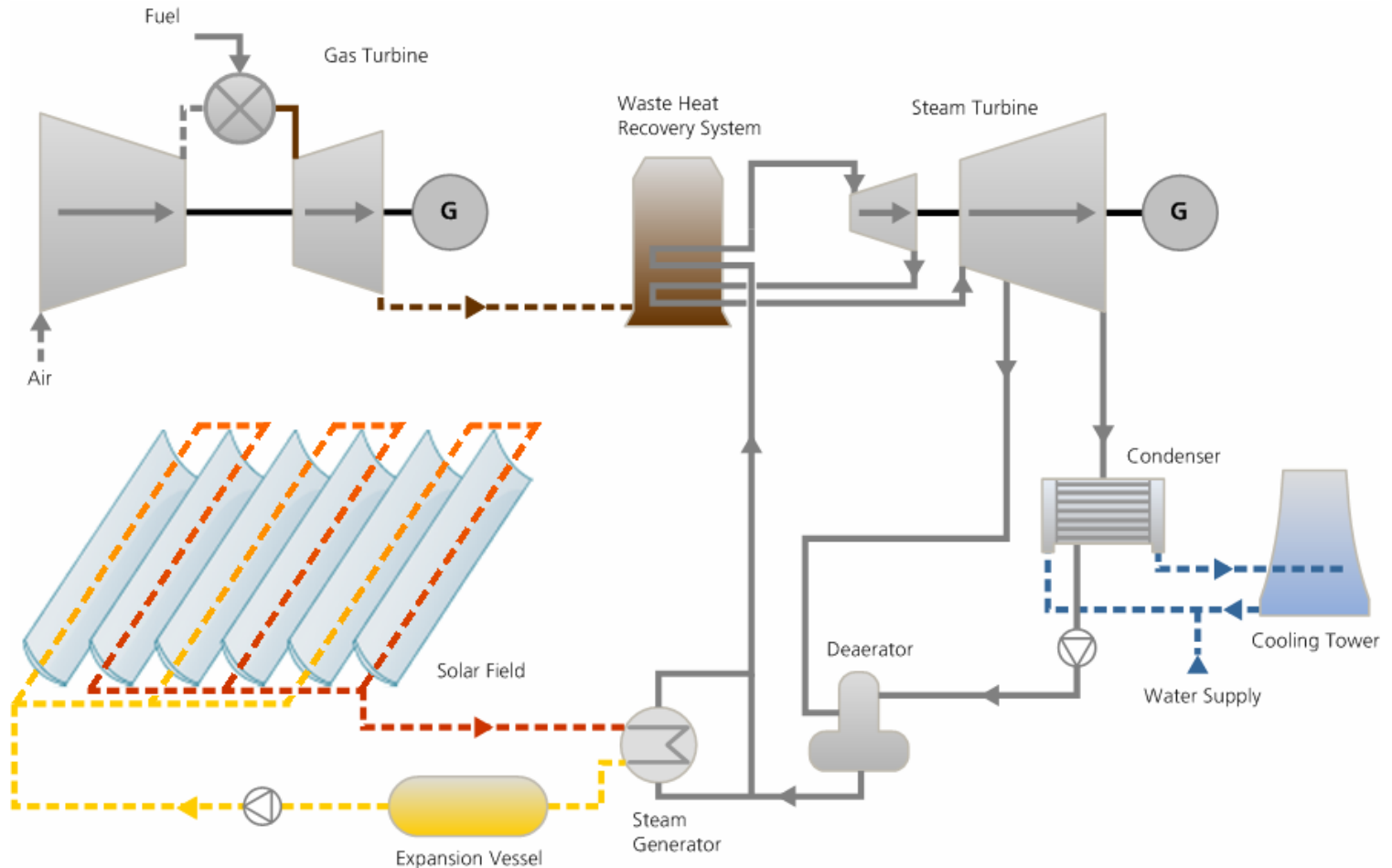
Steam Cycle Parabolic Trough Plant with Storage



Integration into Combined Cycles



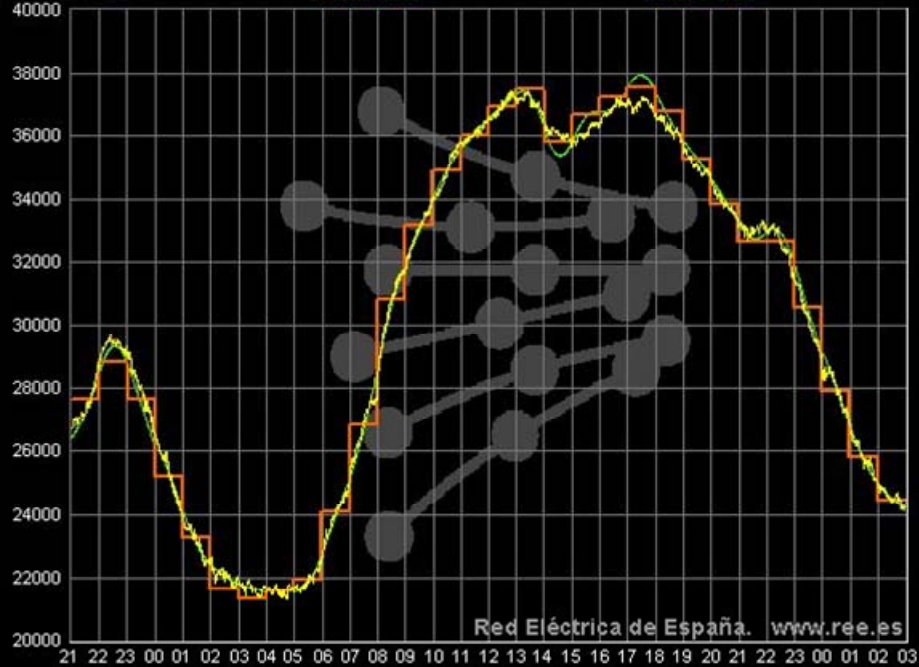
Integrated Solar Combined Cycle (ISCC)



Record Summer Peak in Spain 2005

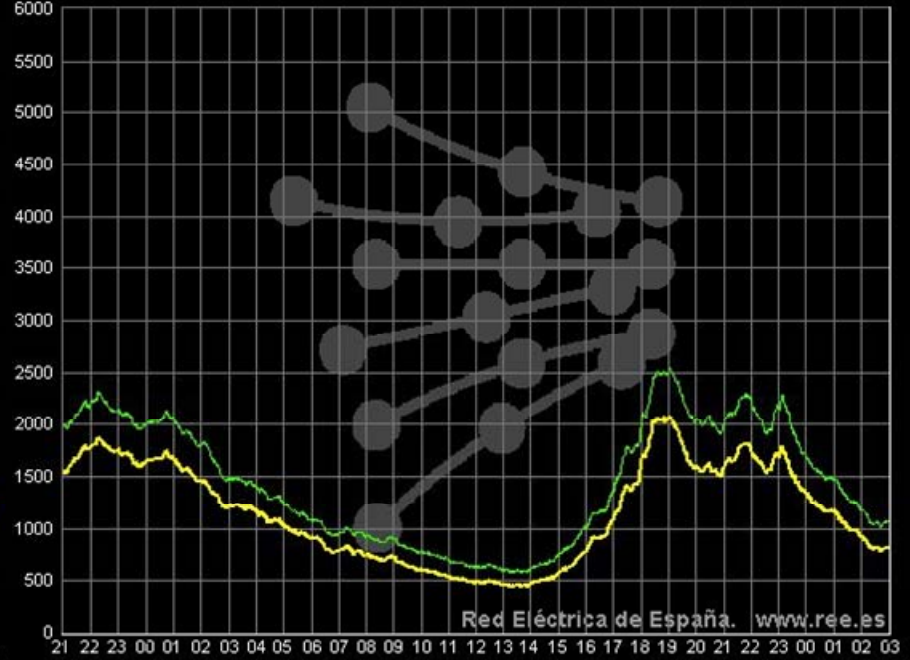
Demanda de energía eléctrica Lunes, 20 Jun 2005

Demanda Real	Máx. 37.460 MW	a las 13:24 h.	Mín. 21.350 MW	a las 04:41 h.
Programada P24	37.515 MW		21.560 MW	
Prevista Actual	37.355 MW		21.574 MW	



Generación de energía eólica Lunes, 20 Jun 2005

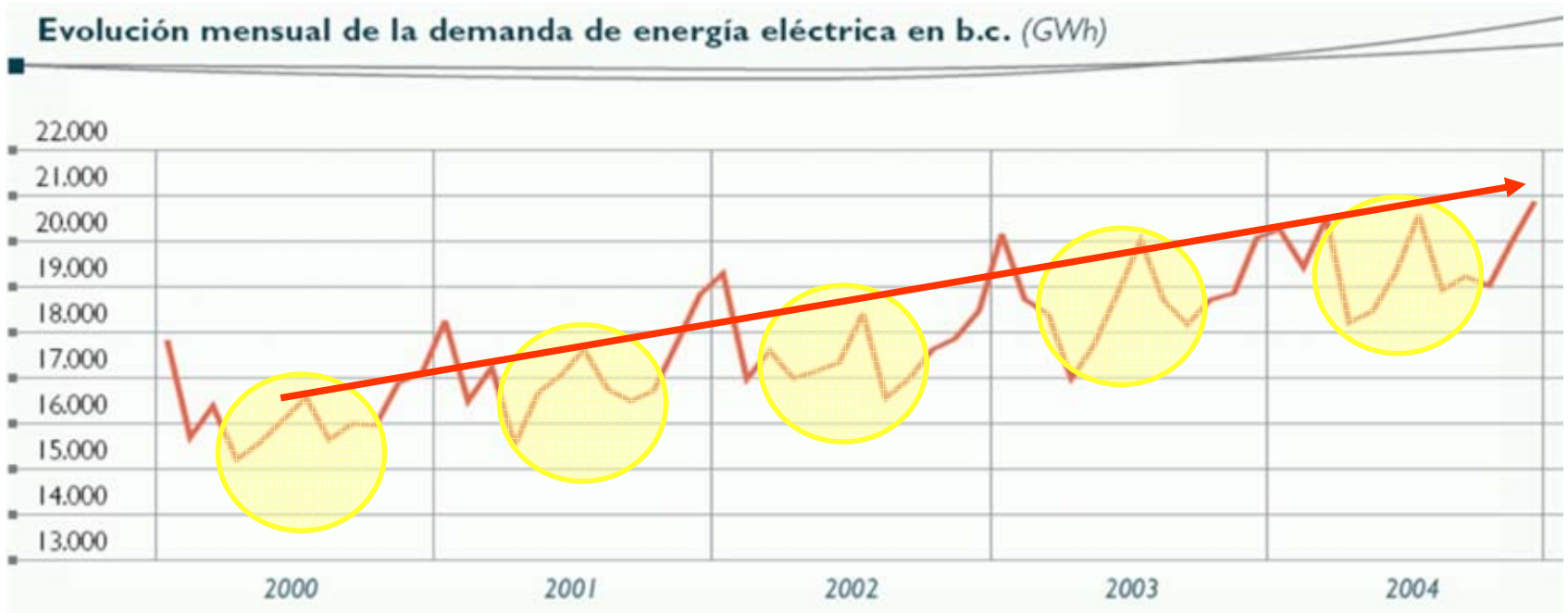
Generación estimada	Máx. 2.534 MW	a las 19:04 h.	Mín. 577 MW	a las 13:39 h.
Generación telemedida	Máx. 2.075 MW	a las 19:04 h.	Mín. 444 MW	a las 13:39 h.



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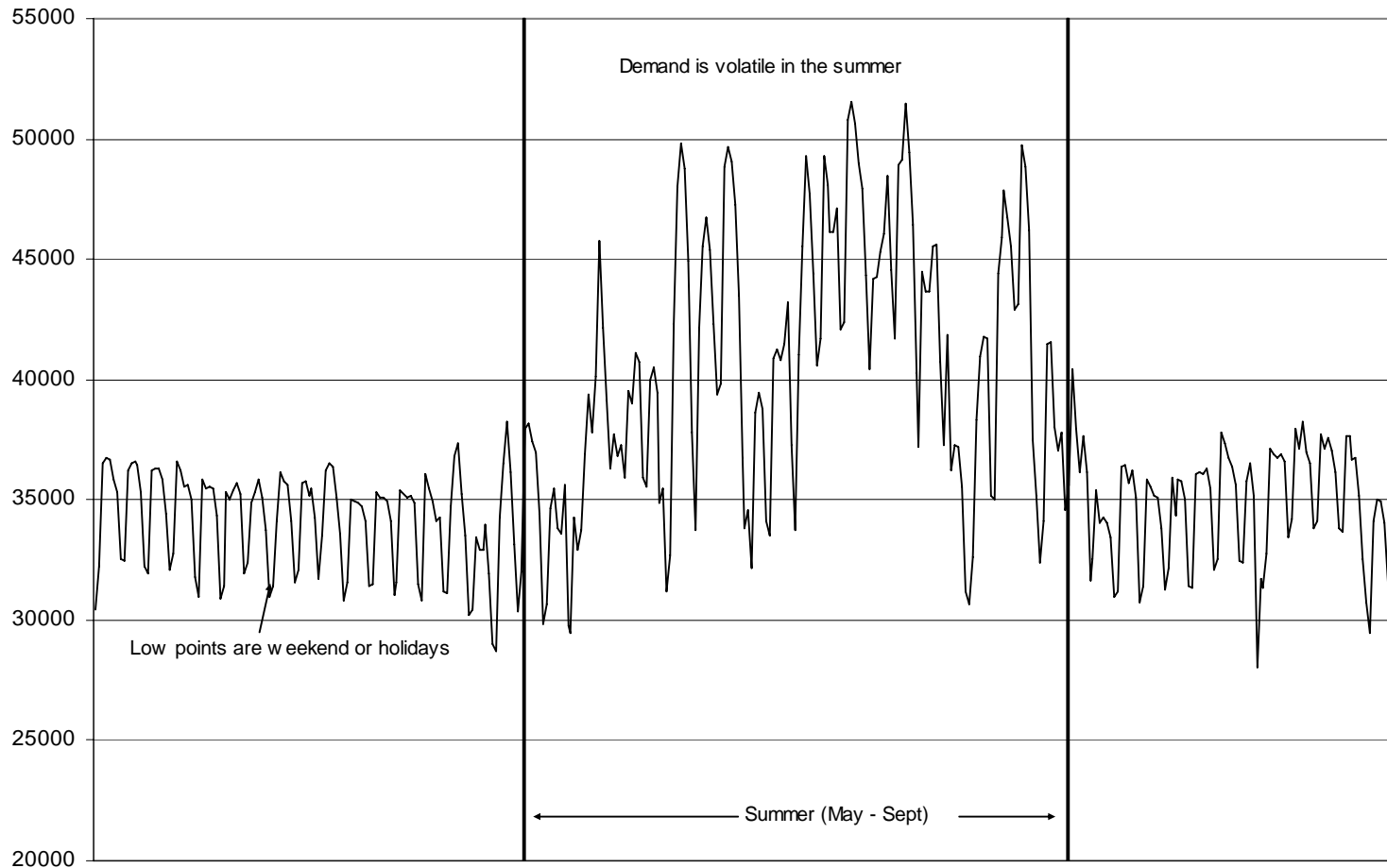
Growth of Spanish Peak Demand 2000-2004



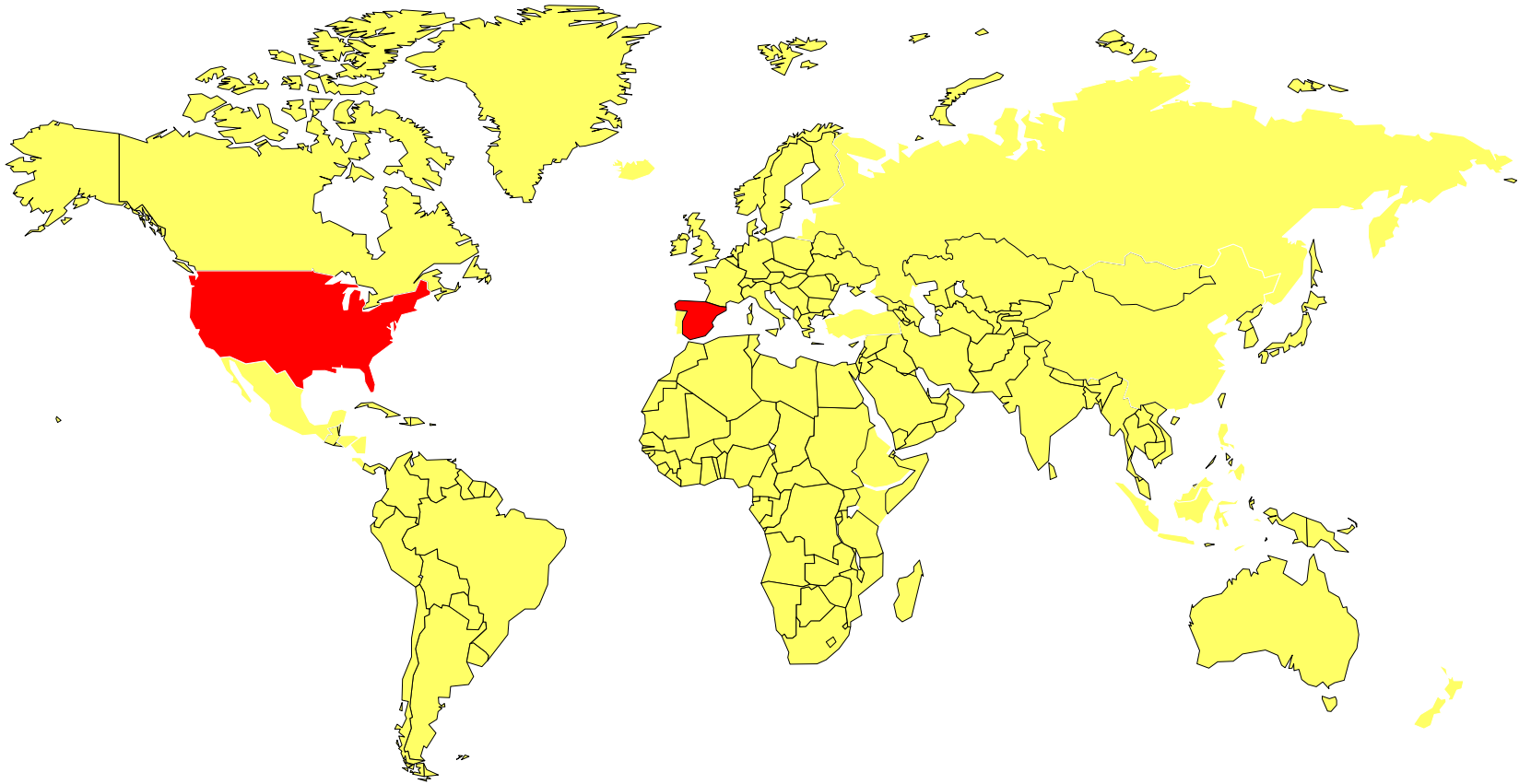
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California Annual Load Curve 2005



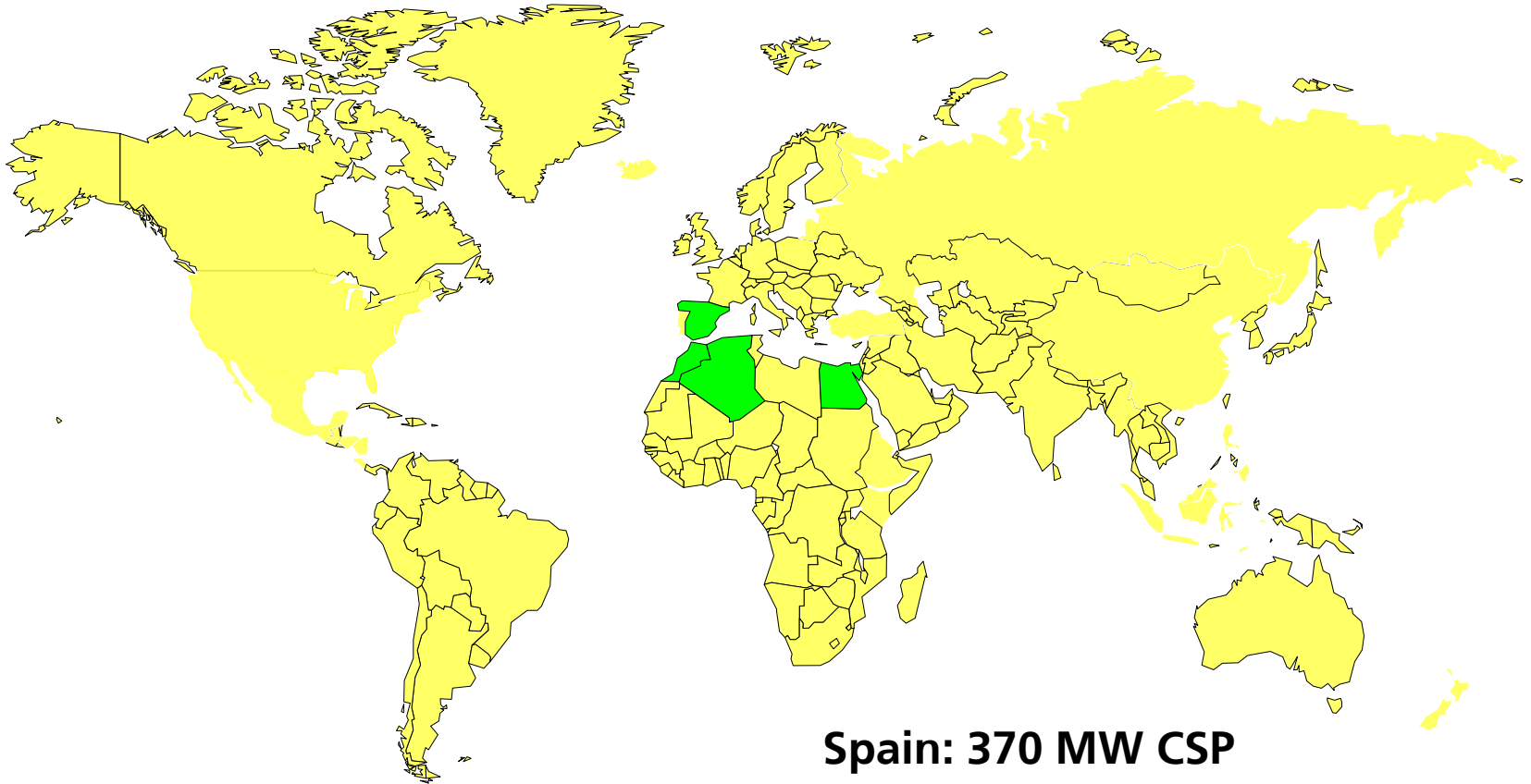
CSP Plants in Operation: 410MW in US and 11 MW in Spain



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2008 CSP Plants in Construction:



Spain: 370 MW CSP

Algeria: 135MW ISCCS with 30MW CSP

Morocco: 450 MW ISCCS with 30MW CSP

Egypt: 135 MW ISCCS with 20MW CSP

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New Spanish Feed-In Law for CSP: Real Decreto 661/2007

MINISTERIO DE INDUSTRIA,
TURISMO Y COMERCIO

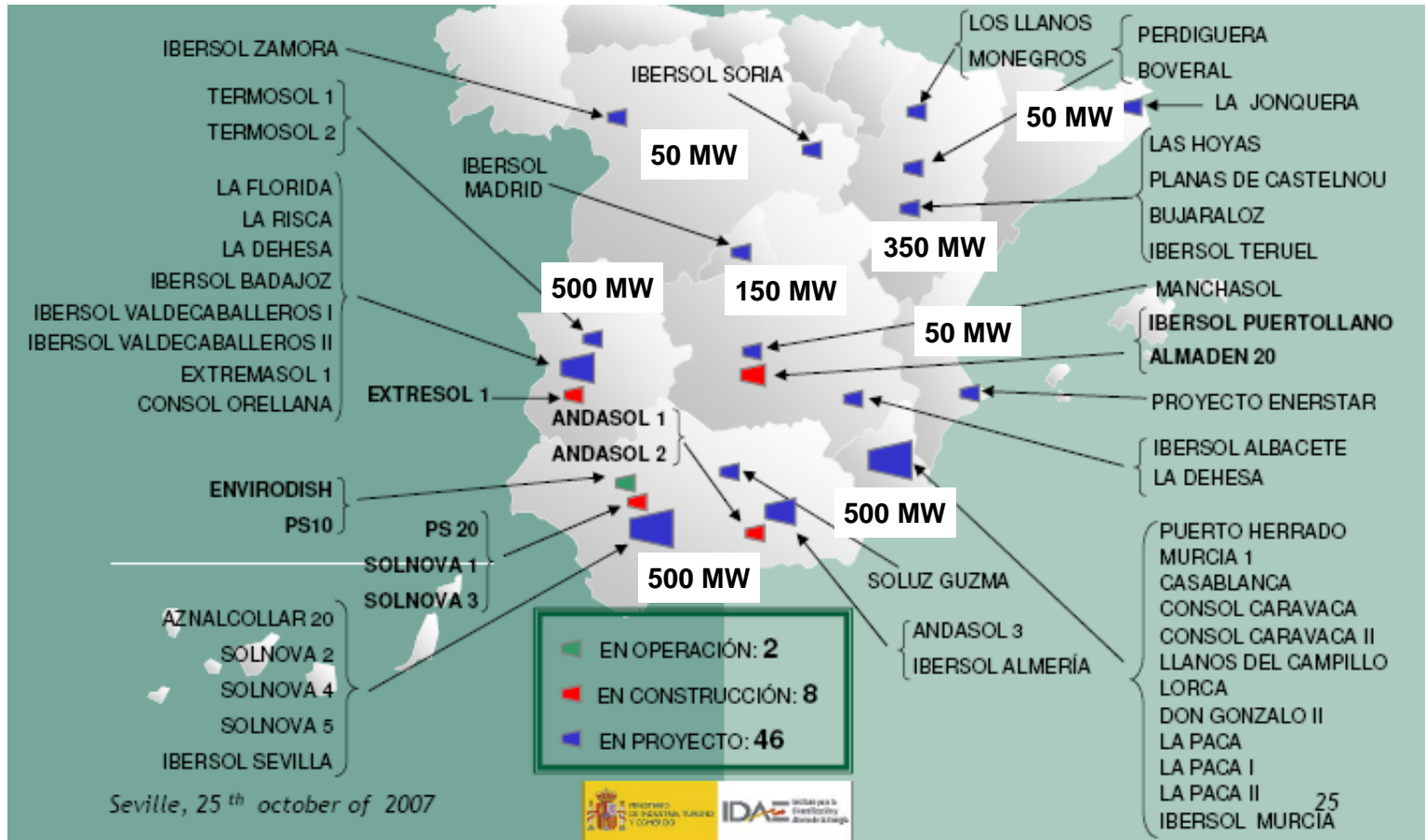
10556 REAL DECRETO 661/2007, de 25 de mayo, por el que se regula la actividad de producción de energía eléctrica en régimen especial.

Subgrupo b.1.2. Instalaciones que utilicen únicamente procesos térmicos para la transformación de la energía solar, como energía primaria, en electricidad. En estas instalaciones se podrán utilizar equipos que utilicen un combustible para el mantenimiento de la temperatura del fluido transmisor de calor para compensar la falta de irradiación solar que pueda afectar a la entrega prevista de energía. La generación eléctrica a partir de dicho combustible deberá ser inferior, en cómputo anual, al 12 por ciento de la producción total de electricidad si la instalación vende su energía de acuerdo a la opción a) del artículo 24.1 de este real decreto. Dicho porcentaje podrá llegar a ser el 15 por ciento si la instalación vende su energía de acuerdo a la opción b) del citado artículo 24.1.

- Cost covering with 0.27Euro/kWh
- Bankable with 25 year guarantee
- Annual adaptation to inflation
- 12-15% natural gas backup allowed to grant dispatchability and firm capacity
- After implementation of first 500MW tariff will be revised for subsequent plants to achieve cost reduction

Subgrupo	Potencia	Plazo	Tarifa regulada c€/kWh	Prima de referencia c€/kWh	Límite Superior c€/kWh	Límite Inferior c€/kWh
b.1.2		primeros 25 años	26,9375	25,4000	34,3976	25,4038
		a partir de entonces	21,5498	20,3200		

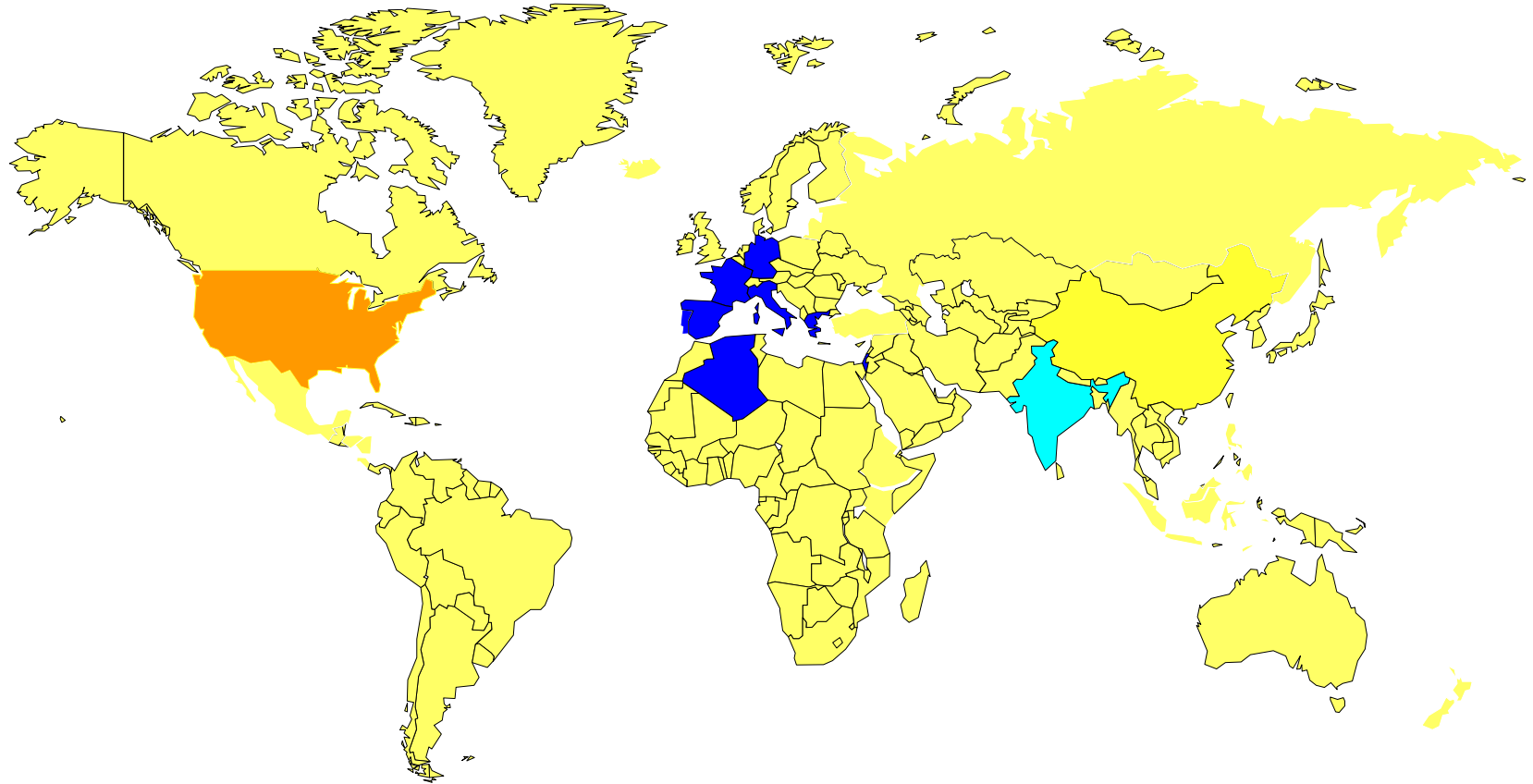
Spanish CSP Projects as of Mar 2008



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Renewable Energy House
 Rue d'Arion 63-67 - B-1040 Brussels - Belgium
 Tel.: +32 (0)2 400 10 90 - Fax: +32 (0)2 400 10 91
 estela@estelasolar.eu - www.estelasolar.eu

Countries with Published CSP Tariff



DIRECTIVE 2001/77/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 27 September 2001
on the promotion of electricity produced from renewable energy sources in the internal electricity
market

Four simple principles

Member states must commit renewable targets

Member states are free in incentive Mechanism

**Portugal, Spain, France, Germany, Greece, Italy have
chosen mechanism of feed-in tariff**

Member states must report fulfillment

**Member states must setup objective, transparent and
nondiscriminatory rules for grid access**

Algerian Feed In Law 28-3-04

Renewable Energy Target
5% of Electricity Production by 2010

N° 19

Dimanche 7 Safar 1425

43ème ANNEE



Correspondant au 28 mars 2004

الجمهورية الجزائرية
الديمقراطية الشعبية

الجريدة الرسمية

اتفاقات دولية، قوانين، ومراسيم
قرارات وآراء، مقررات، منشور، إعلانات و بلاغات

JOURNAL OFFICIEL

DE LA REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

CONVENTIONS ET ACCORDS INTERNATIONAUX - LOIS ET DECRETS
ARRETES, DECISIONS, AVIS, COMMUNICATIONS ET ANNONCES

(TRADUCTION FRANÇAISE)

Art. 12. — Pour l'électricité produite à partir d'installations utilisant de l'énergie solaire thermique par des systèmes hybrides solaire-gaz, la prime s'élève à 200% du prix par KWh de l'électricité élaboré par l'opérateur du marché défini par la loi n° 02-01 du 22 Dhou El Kaada 1422 correspondant au 5 février 2002 susvisée, et ceci quand la contribution minimale d'énergie solaire représente 25% de l'ensemble des énergies primaires.

Pour les contributions de l'énergie solaire inférieure à 25%, la dite prime est servie dans les conditions ci-après :

— pour une contribution solaire 25% et plus : la prime est de 200%,

— pour une contribution solaire 20 à 25% : la prime est de 180%,

— pour une contribution solaire 15 à 20% : la prime est de 160% ,

— pour une contribution solaire 10 à 15% : la prime est de 140% ,

— pour une contribution solaire 5 à 10% : la prime est de 100% ,

— pour une contribution solaire 0 à 5% : la prime est nulle.

In 2000 our 2000 hectares near Seville



.... only grew Solar Trackers Version 0.0



In 2007

**We connected the first
solar thermal plant
in Spain**



**world's first
commercial power
tower
PS10**

Clean electricity from Tower technology



Tower technology

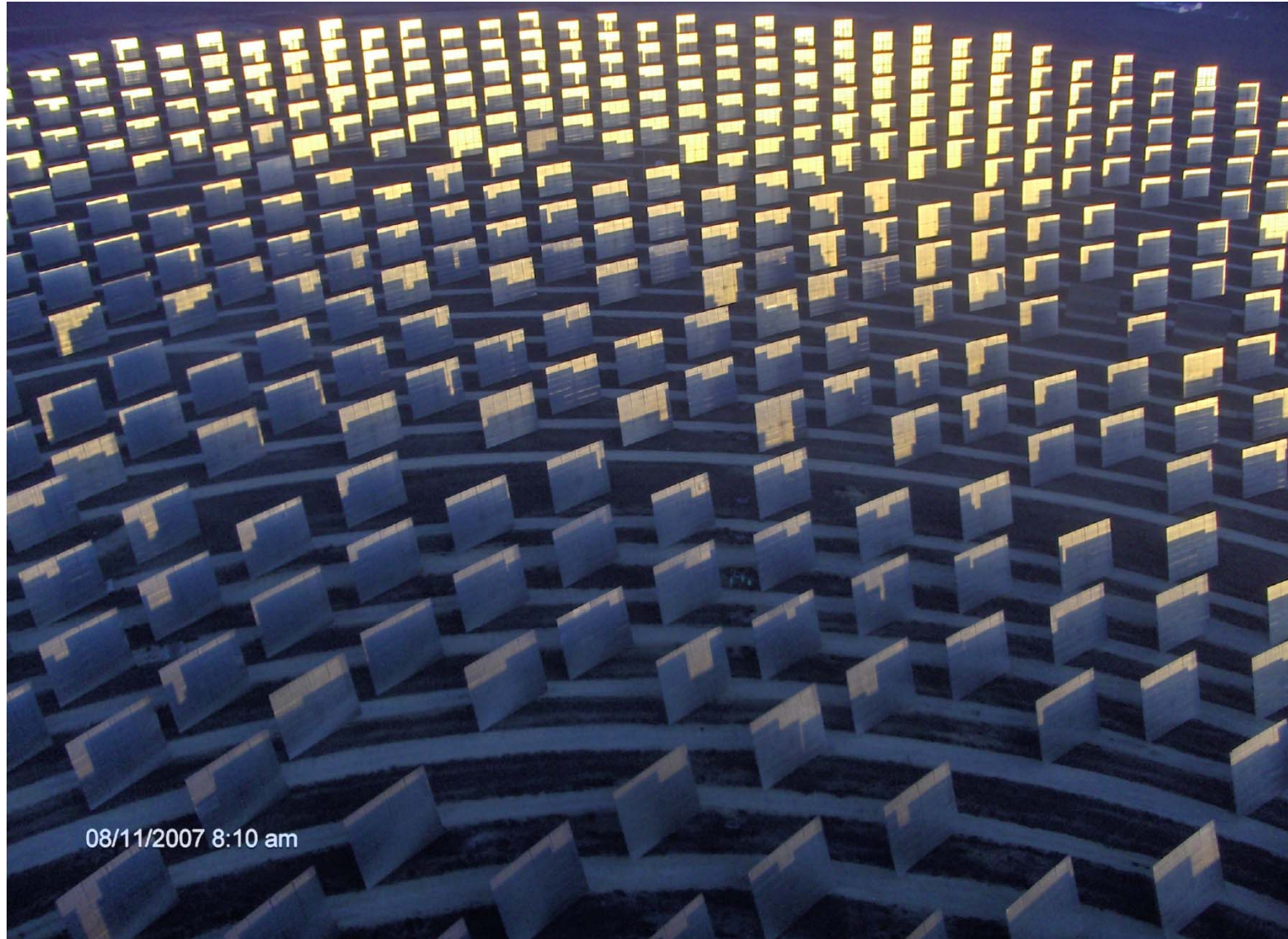
PS10: 11 MWe

- ✓ 624 heliostats of 120 m² each
- ✓ Proprietary Technology: Sanlúcar 120 Heliostat and PS Tower
- ✓ 24,3 GWh/year that will feed 6.000 Spanish households
- ✓ 9.600 Tm. de CO₂ saved yearly
- ✓ Total land use 60 ha
- ✓ Tower height: 100 m.
- ✓ Possibility to burn 12-15% of natural gas

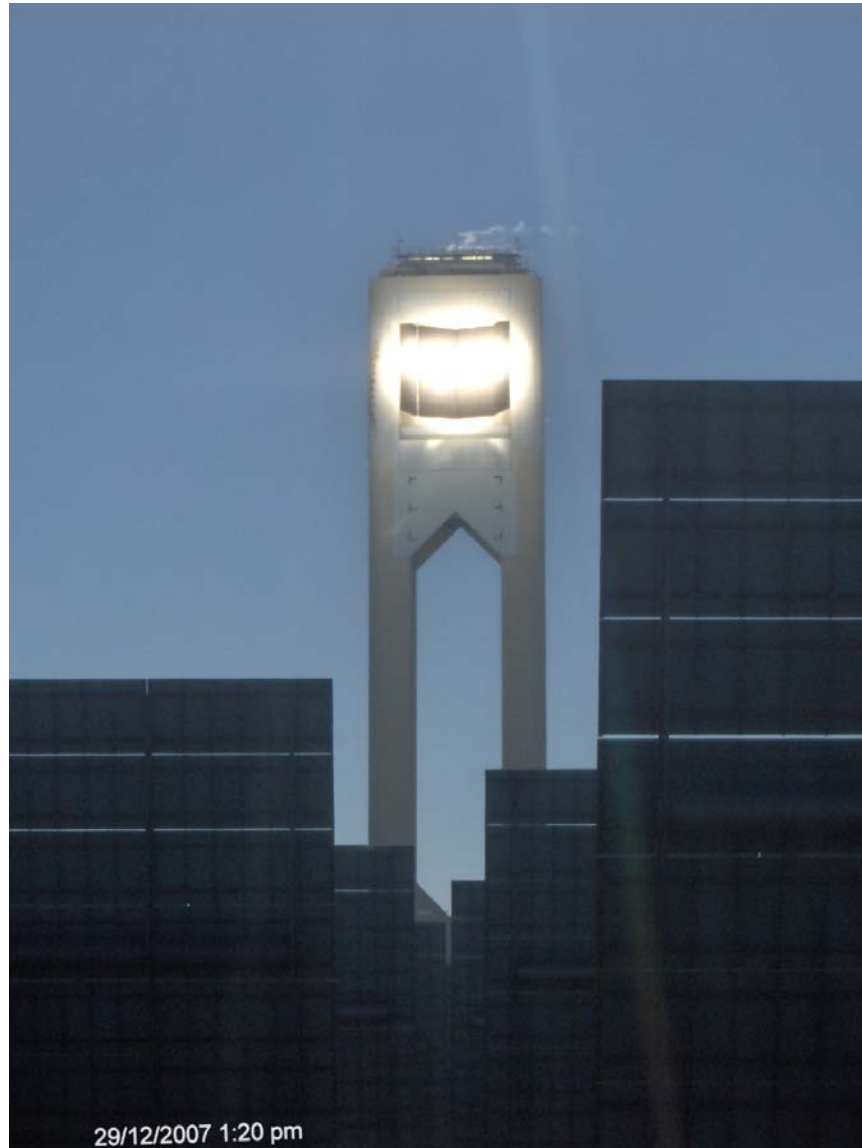
PS10

First commercial tower in the world





08/11/2007 8:10 am



PS20: World's largest Solar Power Tower



Tower technology

PS20: 20 MWe

- ✓ Second commercial tower under construction
- ✓ 1.255 heliostats of 120 m² each one
- ✓ Proprietary Technology: Sanlúcar 120 Heliostat
- ✓ 48,6 GWh/year that will feed around 12.000 Spanish households
- ✓ 19.200 Tm. de CO₂ saved
- ✓ Tower of 160 m. Total land use: 90 ha
- ✓ Possibility to burn 12 -15 % of natural gas

PS20

Largest tower under construction

Developing the Solar Power Tower 2.0



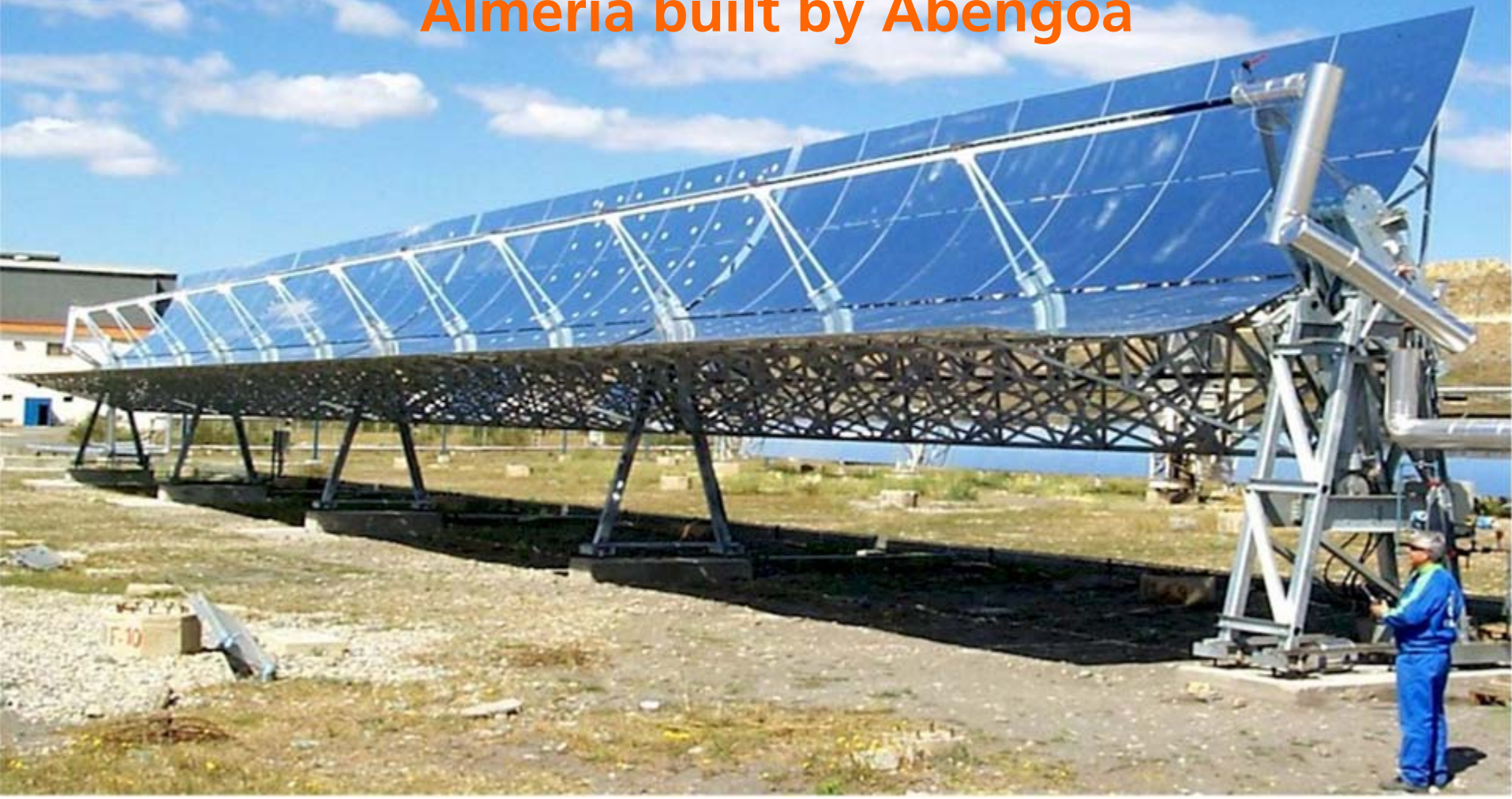
We have joined forces with the German Aerospace Agency DLR, to develop Solar Power Towers for Gas Turbines and Combined Cycles

Just awarded 6 Mio Euro from EU 7FWP
Demo Program 2008

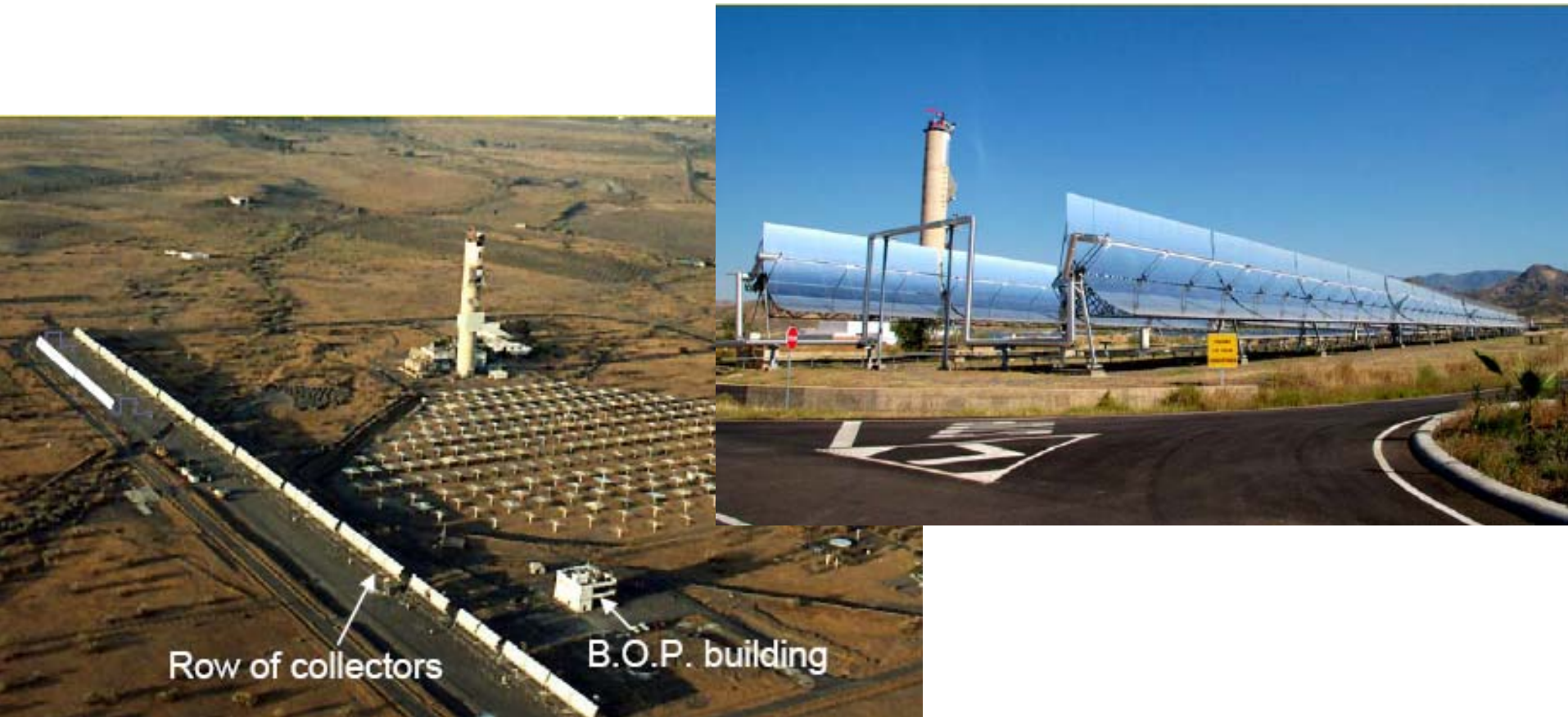


- Ideal Solution for Solar-Fossil Hybrids**
- Best efficiency for solar-fossil hybrids
 - No cooling water needs

1998 first Eurotrough Prototype at Plataforma Solar Almeria built by Abengoa



2001 first Direct Steam DISS collectors at Plataforma Solar de Almeria built by Abengoa



Developing the Parabolic Trough 3.0



Constructing the first 100 of 300MW in Sevilla



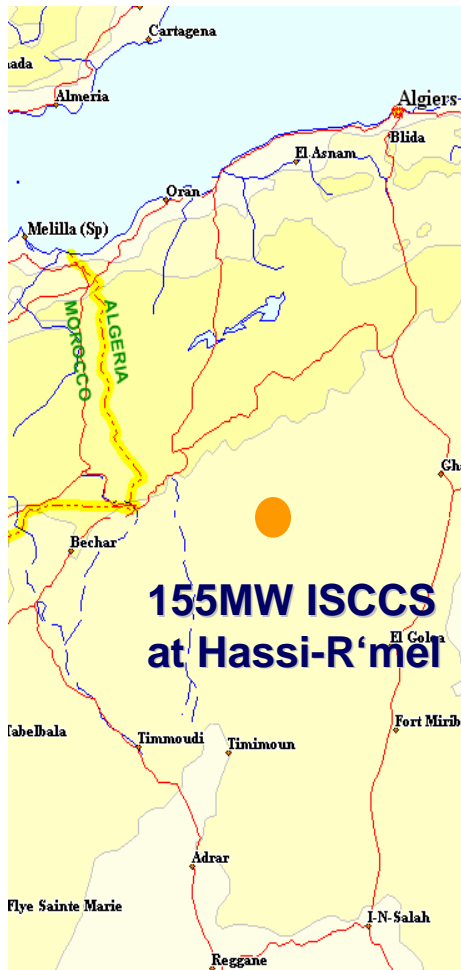
Solnova 1: 50 MWe

Solnova 3: 50 MWe

- ✓ Proprietary Technology: Solúcar TR trough
- ✓ 110 GWh/year that will supply 30.000 Spanish households
- ✓ 45.000 Tm. de CO₂ saved per year
- ✓ Total reflective area 300.000 m².
- ✓ Total land use: 120 ha

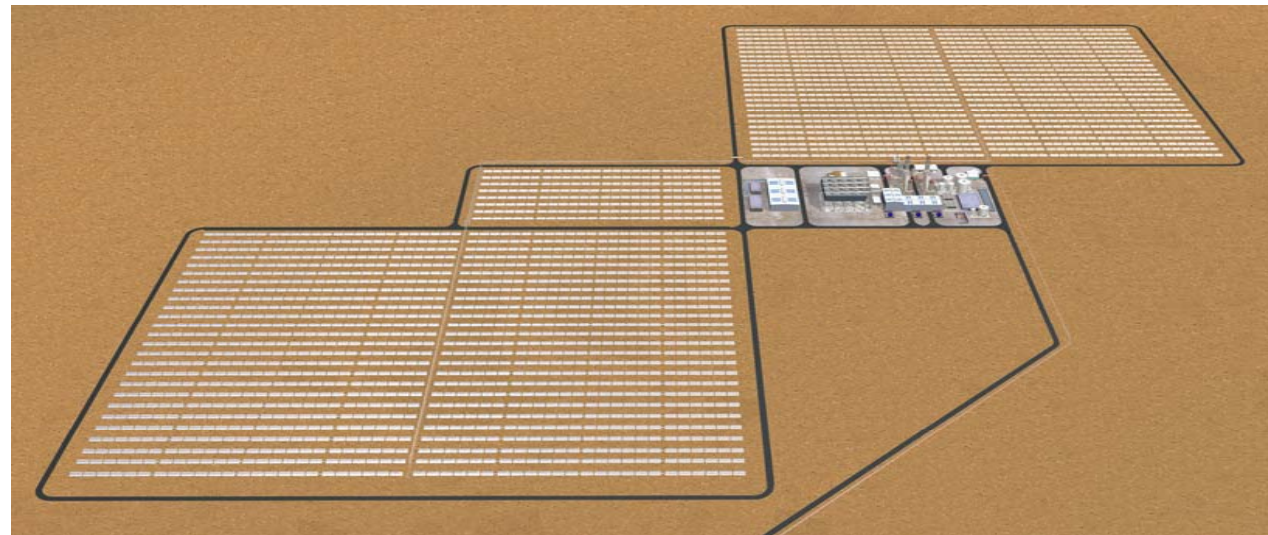
Solnova 1 and Solnova 3

We have won first solar thermal BOO in North Africa



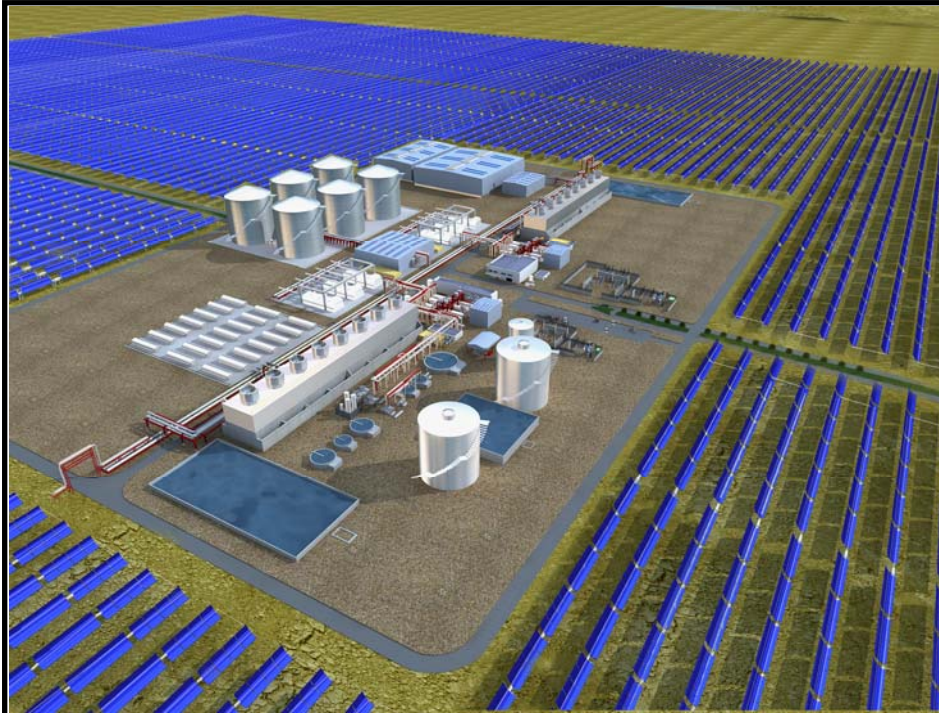
- ➔ Ownership Abengoa (66%) and NEAL (34%)
- ➔ 130MW Combined Cycle
25MW solar field with 183.000 m²
- ➔ First private financing of solar thermal plant in North Africa (entirely financed by banks of Algeria)
- ➔ BOO based on Algerian Ffed-in law 04-92
- ➔ Construction started

We have won EPC contract for world's largest ISCCS



- ➔ Ownership ONE Office Nationale d'Electricité
- ➔ EPC financed by ADB, ONE and 50Mio GEF Grant
- ➔ 450MW ISCCS with 183.000m2 solar field
- ➔ Abener started EPC construction

Clean electricity from Trough technology



Parabolic Trough Technology

Solana : 280 MW_e

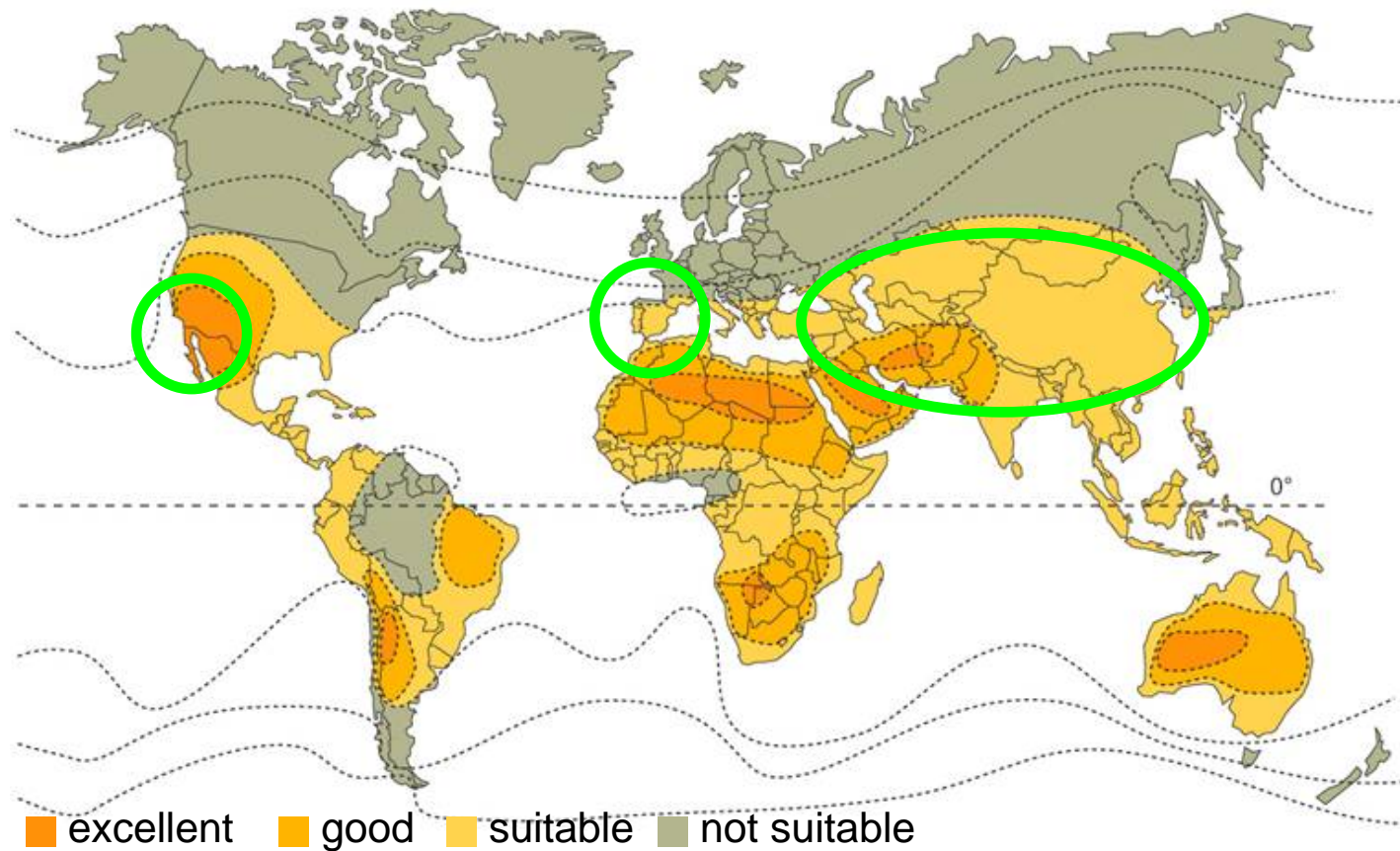
- ✓ Proprietary Technology Solúcar TR
- ✓ Will produce electricity for 70,000 households
- ✓ 400,000 Tons.of CO₂ avoided yearly
- ✓ Land required: 800 ha
- ✓ Molten salt as heat storage

Solana

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Solar Power for a Sustainable World

World CSP Market Perspectives

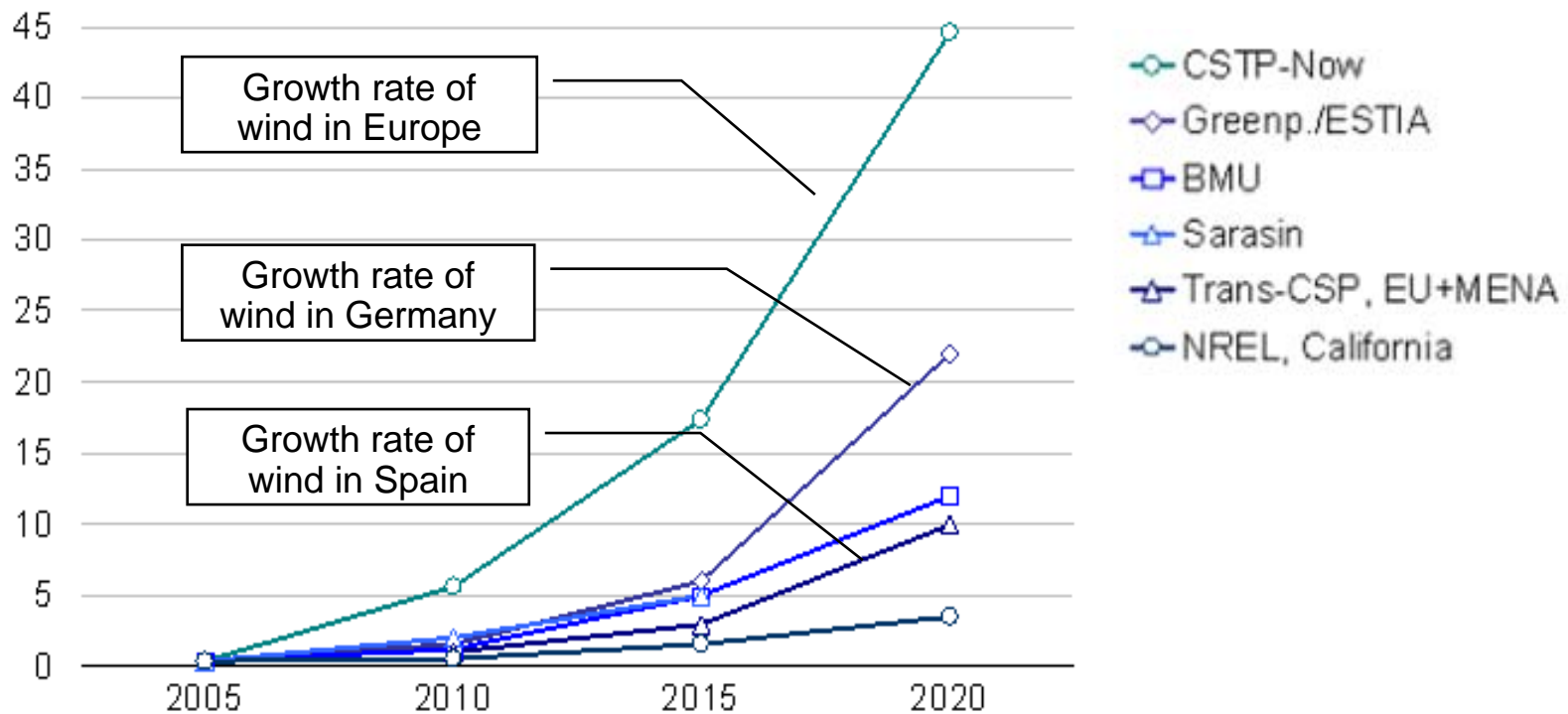


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Solar Power for a Sustainable World

How fast will the CSP-Market grow?

Capacity in GW

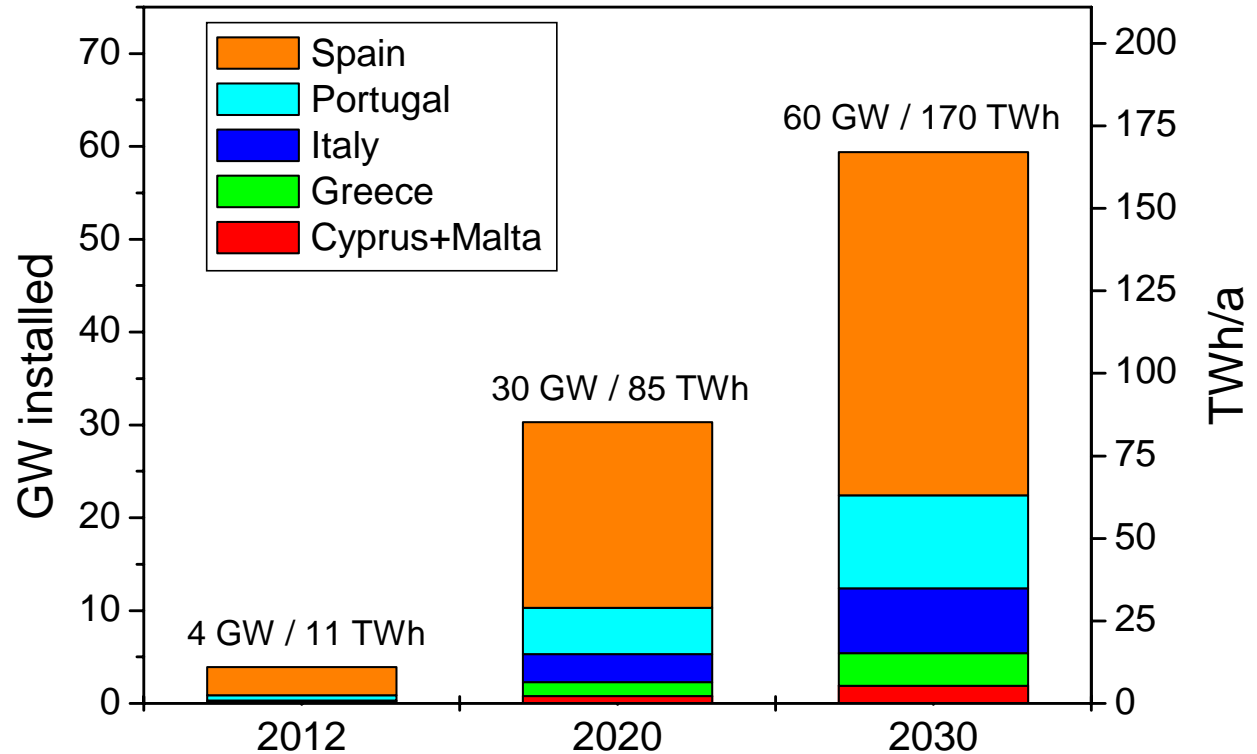


□ Forecasts for next 15 years between 4 and 45 GW (cum.)

□ in which forecast should we trust ?

Roadmap for CSP Plants

Potential of CSP in Europe:
installed capacity and annual energy production





European Solar Thermal
Electricity Association

Ensure stable and bankable Financing Instruments

- Longterm and stable Feed-In-Tariffs have proven as the most efficient instrument for sustainable renewable market penetration
- Ensure that the Kyoto instruments such as CDM and JI are applicable to CSP and mechanisms are bankable and sufficient.
- Establish loan guarantee programs via existing windows at multilateral banks, existing national lending programs and global environmental programs such as GEF, UNEP, and UNDP for CSP for North Africa's developing economies

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European Solar Thermal
Electricity Association

Open Transnational Renewable Energy Market Inside and Outside EU

- Let renewable electricity cross Intra-European borders (Schengen for Green Electrons)
- Let renewable electricity enter the European Union from outside
- Establish bankable transnational renewable transfer tariffs for such interchange

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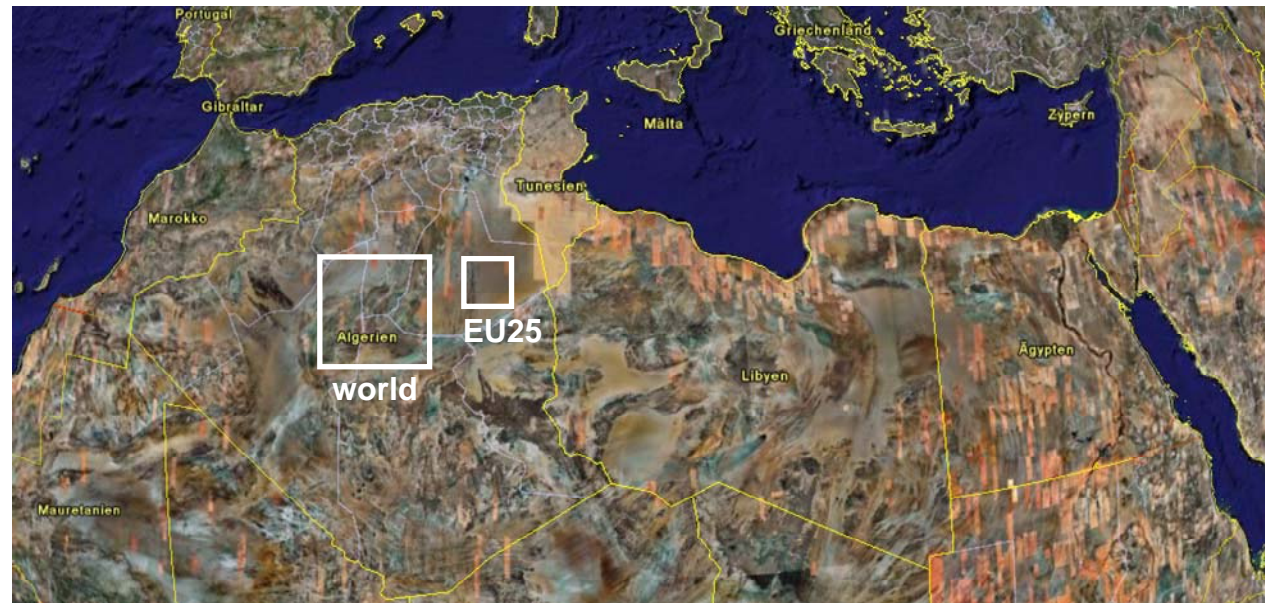
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Europes Electricity demand can be covered in MENA

Electricity import from Northern Africa is viable option

- 0.4% of Sahara area covers Europes electricity demand (world: 2%)
- HVDC technology provides efficient transmission (~10% losses)





European Solar Thermal
Electricity Association

Shake Hands with Northern Africa

- Tap Africa's unlimited solar resource
- Share the technology, know how and employment
- Build up an industrial and human resource base for the implementation of CSP
- Develop economic relationships and create an investment framework by supporting electricity market liberalization in North Africa
- Such CSP employment opportunities will offer alternatives to emigration

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European Solar Thermal
Electricity Association

Grant the Future for the Next Generation

- Next generation technologies will significantly drive down costs
- Pre-commercial demonstration plants allow next generation technologies to enter the market
- Demonstration plants need loan guarantees from the EU to cover the technology innovation risk

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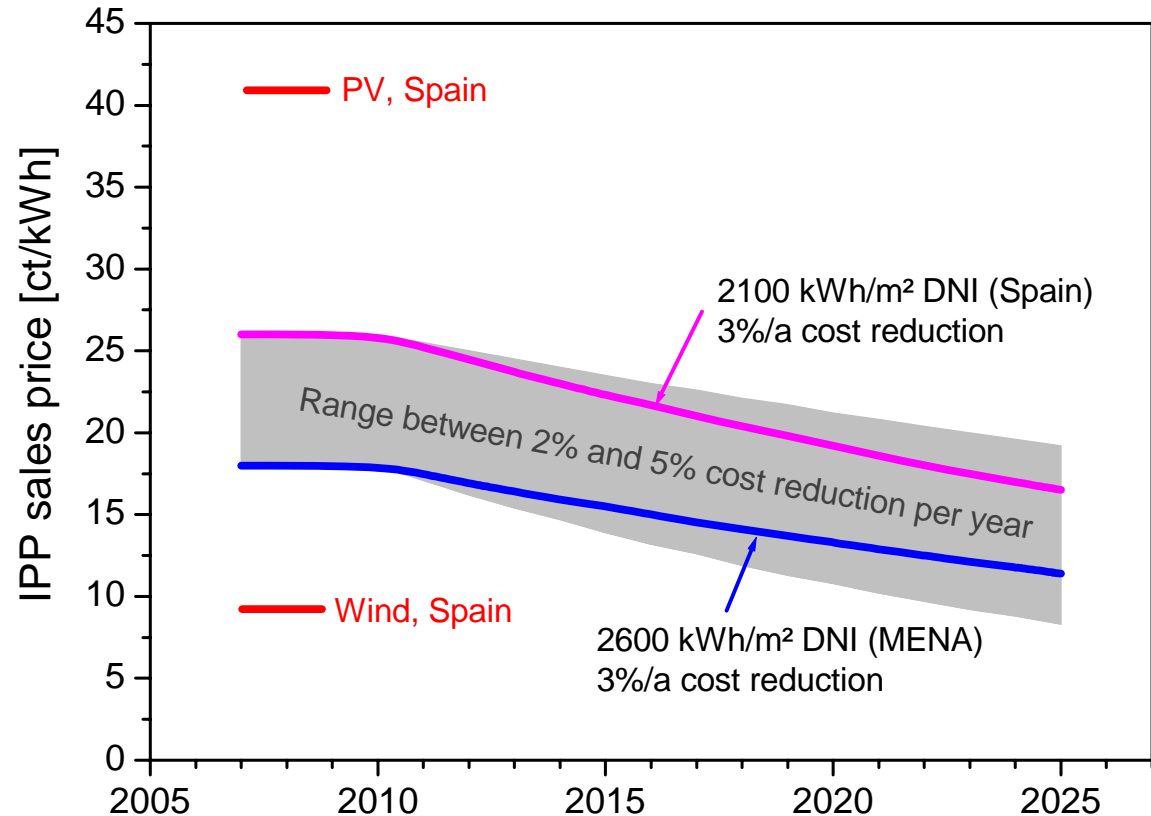
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European Solar Thermal
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Roadmap for CSP Plants

Estimated IPP baseline sales price for CSP in Europe and MENA.



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European Solar Thermal
Electricity Association

The Role of the EU

Push technology, pull demand, push generation

Market development and penetration:

- **Install demand pull instruments, promote feed-in-laws as most powerful instrument to push generation**
- **Open the European transmission grid for solar power from North Africa and secure this power import by implementing demand pull instruments**

Technology:

- **R&D-funding for material, component and system development (e.g. coatings, storage, direct steam/molten salt systems, adapted steam generators, beam down)**
- **Fund demonstration plants to push new technologies**

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Key Success Factors for a Strong Market Growth

- Technical and economical success of the first projects
- Stable green pricing or subsidies to bridge the initial gap in LECs (e.g. feed-in tariffs)
- Successful cost reduction
- Strong R&D to leverage the potential of technical improvement
- New markets and market opportunities (Power from North Africa to Europe)
- Strong CSP industry

