

STE Plants: Current situation and prospects

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ESTELA and PROTERMOSOLAR are respectively the European and Spanish Solar Thermal Electricity Associations



Protermosolar, founded in 2004, has now 100 associated members and **covers the whole value chain of the Solar Thermal Electric projects**, from research centers to plant constructors along with engineering companies, component manufacturers, promoters, etc.



ESTELA, founded in 2007, has now 65 associated members and **covers as well the whole value chain of the Solar Thermal Electric projects**. In addition to the European full members, ESTELA has also associated members from the Union for the Mediterranean countries.

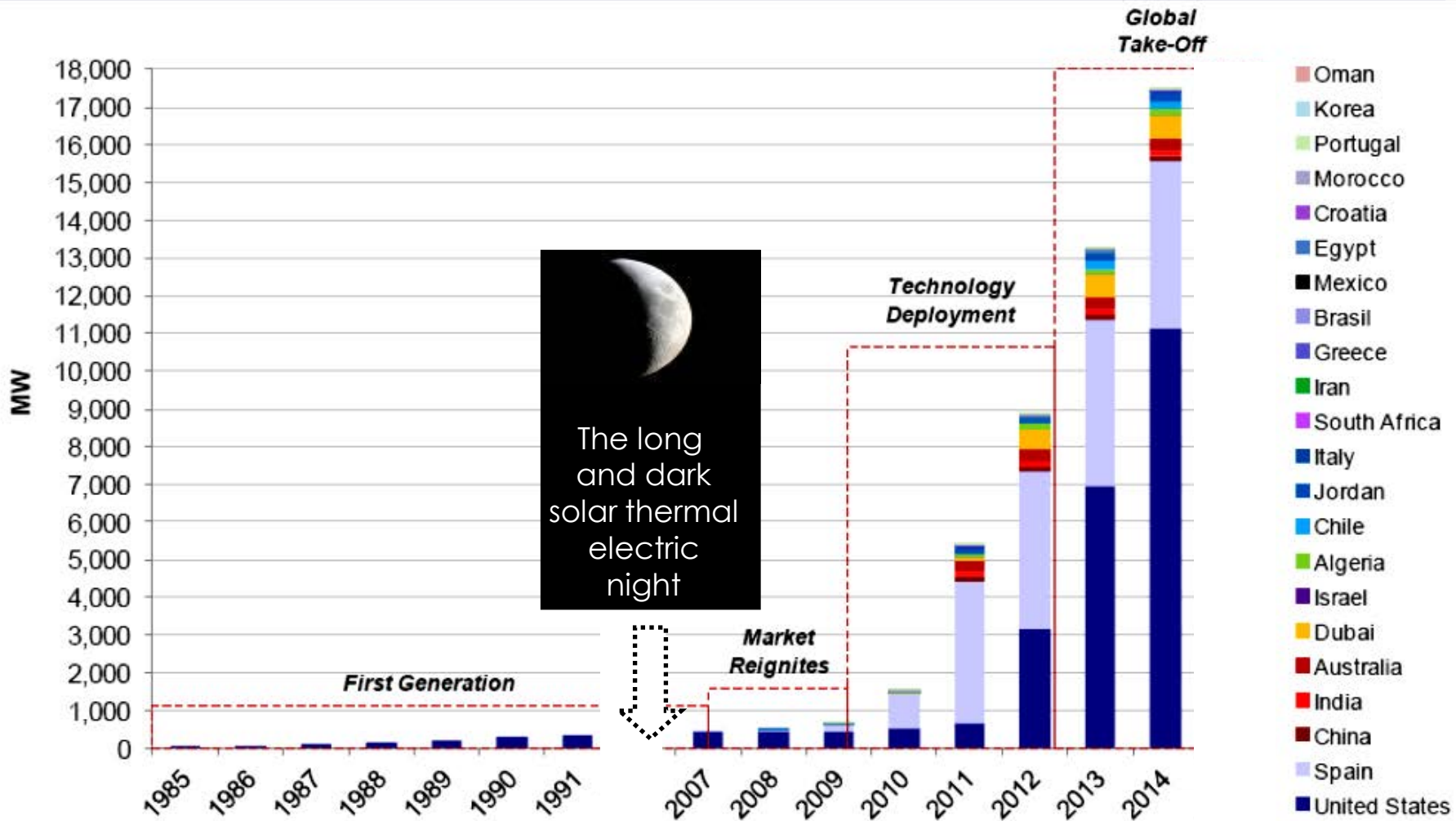


All the operating plants in Spain as well as those others which are under construction or in an advanced planning stage in Spain (more than 2500 MW in total) belong to **Protermosolar** members. **The largest operating plants in USA** (SEGS, Nevada Solar 1 & Martin) as well as the **ISCC in Morocco, Algeria and Egypt** and most of the on going projects around the world have the participation of **ESTELA** and **Protermosolar** members.



The world STE association federation has been recently constituted by SASTELA, AUSTELA and ESTELA

The dawn, the darkness and the renaissance of the STE



Solar Thermal Electricity Plants:

A success story in Spain based in three main pillars:

- ✓ Continuous support to R&D & Educational programs
- ✓ Favorable and effective regulatory environment (in spite of recent events)
- ✓ Capacity and commitment of our industrial companies



Almeria Solar Platform (PSA) 1978-2011

The doubts on the STE future

- ❑ Could the aggressive cost reduction curve of PV jeopardize STE deployment?

The cost of crystalline PV modules seems approaching the asymptotic part of the reduction curve. Total PV system costs will not go too much further down. STE is at the beginning of the cost reduction curve and large reductions are expected



Both PV and STE will play a complementary role in the future (distributed and peak power for PV and centralized and full range of power generation for STE)



- ❑ Could the economical crisis stops support to R.E.s and to STE in particular?

R.E.s in general and specially STE are proven catalysts of economic development. They provide strong GNP increases and they reduce fuel imports and vulnerability of the country's economies

In addition increased pressure for further GHG emission reductions from the electrical generation park will make essential the role of STE

The reasons for a **brilliant** STE future

1. STE is the only dispatch-able renewable technology with potential enough to meet the electricity needs worldwide and to achieve a carbon free generation system

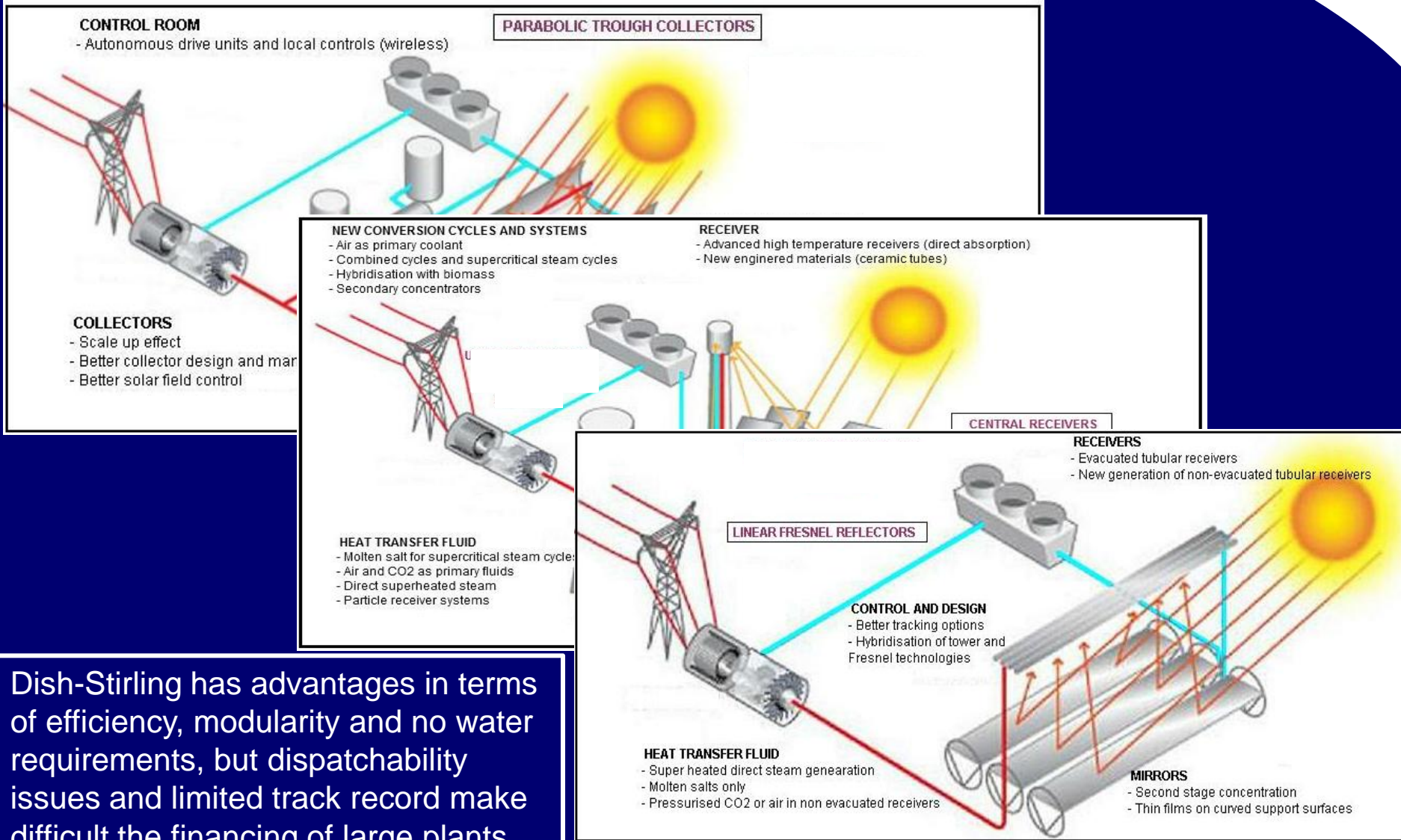
Intermittent RE technologies -which has been largely developed until now- could cover only a part of the supply as they will always require back up from conventional fossil plants.



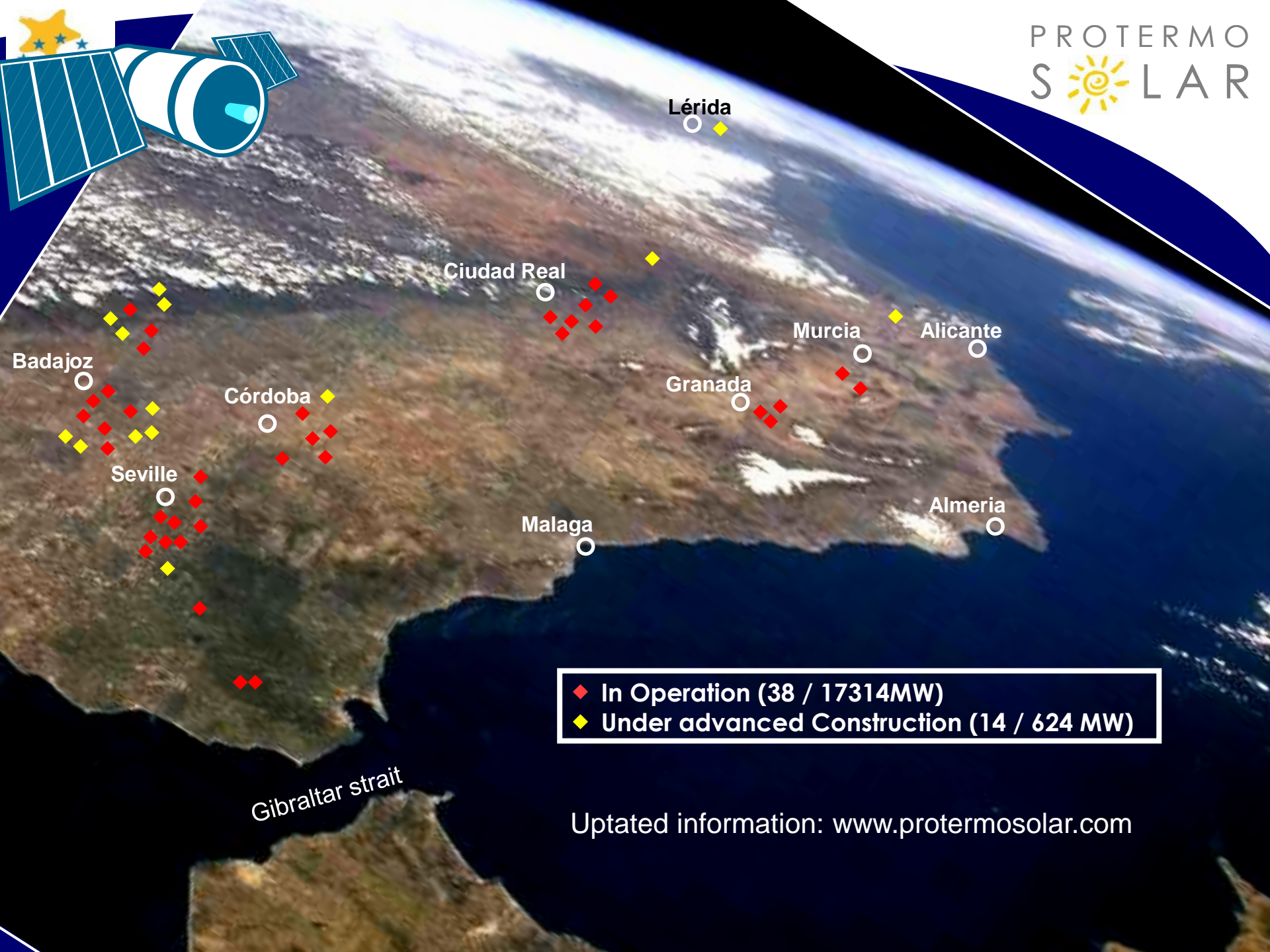
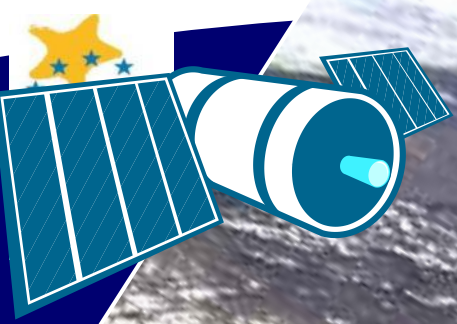
New batteries development could change this statement

2. Local content of STE plants will be one of the main drivers behind the support policies in many countries of the sun belt.
3. The cost of STE plants will show important reductions when approaching from the current 2 GW installed to the similar values of Wind (250 GW) and PV (80 GW)

Some relevant comments and technological improvement lines of the different commercial technologies for large plants



Dish-Stirling has advantages in terms of efficiency, modularity and no water requirements, but dispatchability issues and limited track record make difficult the financing of large plants



◆ In Operation (38 / 17314MW)
◆ Under advanced Construction (14 / 624 MW)

Uptated information: www.protermosolar.com



Situation of approved STE plants in Spain



In operation
as of Nov01 2012:
38 / 1731 MW

By Dec-2012
43 / 1925 MW

Under
construction
14 / 622 MW

Propietario	Nombre	Población	Provincia	Tecnología	Potencia (MW)	Almacenamiento (horas a carga nominal)	Producción estimada* (GWh/año)	Emissiones evitadas (V año de CO2)	Fase pre registro	Fecha de inicio de pruebas** (mes-año)	Superficie de terreno ocupada (Ha.)	Área de captación solar (m2)
Abengoa Solar	PS10	Sanlúcar la Mayor	Sevilla	TVS	10	1	24	15.456	n/a	nov-06	65	75.000
RREEF/ANTIN/COBRA	Andasol-1	Aldeire	Granada	CCP	50	7,5	170	109.480	n/a	nov-08	200	510.120
Abengoa Solar	PS20	Sanlúcar la Mayor	Sevilla	TVS	20	1	44	28.336	n/a	abr-09	90	150.000
Navatec	Puerto Errado 1	Calasparra	Murcia	Fresnel	1,4	0,5	2	1.288	1	abr-09	1	18.000
RREEF/ANTIN/COBRA	Andasol-2	Aldeire y La Calahorra	Granada	CCP	50	7,5	170	109.480	1	jun-09	200	510.120
Iberdrola Energía Solar de Puertollano	Ibersol Puertollano	Puertollano	Ciudad Real	CCP	50	n/a	100	64.400	n/a	jun-09	150	290.000
Acciona/ Mitsubishi Corp.	La Risca	Alvarado	Badajoz	CCP	50	n/a	100	64.400	1	sep-09	130	350.000
COBRA	Extresol-1	Torre de Miguel Sesmero	Badajoz	CCP	50	7,5	170	109.480	1	sep-09	200	510.120
COBRA	Extresol-2	Torre de Miguel Sesmero	Badajoz	CCP	50	7,5	170	109.480	2	abr-10	200	510.120
Abengoa Solar	Solnova 1	Sanlúcar la Mayor	Sevilla	CCP	50	n/a	100	64.400	1	may-10	115	350.000
Abengoa Solar	Solnova 3	Sanlúcar la Mayor	Sevilla	CCP	50	n/a	100	64.400	1	jun-10	115	350.000
Renovables SAMCA, S.A.	La Florida	Badajoz	Badajoz	CCP	50	7,5	170	109.480	1	jul-10	220	550.000
Abengoa Solar	Solnova 4	Sanlúcar la Mayor	Sevilla	CCP	50	n/a	100	64.400	1	ago-10	115	350.000
Acciona/ Mitsubishi Corp.	Majadas	Majadas	Cáceres	CCP	50	n/a	100	64.400	1	oct-10	110	380.000
Renovables SAMCA, S.A.	La Dehesa	La Garrovilla	Badajoz	CCP	50	7,5	170	109.480	1	oct-10	220	550.000
Acciona/ Mitsubishi Corp.	Palma del Río II	Palma del Río	Córdoba	CCP	50	n/a	100	64.400	1	dic-10	135	380.000
COBRA	Manchasol-1	Alcázar de San Juan	Ciudad Real	CCP	50	7,5	170	109.480	2	dic-10	200	510.120
COBRA	Manchasol-2	Alcázar de San Juan	Ciudad Real	CCP	50	7,5	170	109.480	3	abr-11	200	510.120
Torrresol	Gemasolar	Fuentes de Andalucía	Sevilla	TS	20	15	100	64.400	2	abr-11	195	304.750
Acciona/ Mitsubishi Corp.	Palma del Río I	Palma del Río	Córdoba	CCP	50	n/a	100	64.400	1	jul-11	135	380.000
Valoriza/Siemens	Lebrija 1	Lebrija	Sevilla	CCP	50	n/a	100	64.400	2	jul-11	188	412.000
S. Millennium/Ferrosstaal/RWE/Rhein E./SWM	Andasol 3	Aldeire/la Calahorra	Granada	CCP	50	7,5	170	109.480	1	ago-11	220	512.000
Abengoa Solar/TEON	Helioenergy 1	Écija	Sevilla	CCP	50	n/a	100	64.400	2	sep-11	180	500.000
Elecnor/Elser/Aries	Asteso II	Badajoz	Badajoz	CCP	50	7,5	170	109.480	3	nov-11	190	510.120
Torrresol	Arcosol-50	San José del Valle	Cádiz	CCP	50	7,5	170	109.480	3	nov-11	180	510.000
Torrresol	Termesol-50	San José del Valle	Cádiz	CCP	50	7,5	170	109.480	3	dic-11	180	510.000
Elecnor/Elser/Aries	Aste 1A	Alcázar de San Juan	Ciudad Real	CCP	50	8	170	109.480	2	ene-12	180	510.120
Elecnor/Elser/Aries	Aste 1B	Alcázar de San Juan	Ciudad Real	CCP	50	8	170	109.480	2	ene-12	180	510.120
Abengoa Solar/TEON	Helioenergy 2	Écija	Sevilla	CCP	50	n/a	100	64.400	2	ene-12	180	500.000
Navatec, EBL, IWB, EWZ, EKZ y EWB.	Puerto Errado II	Calasparra	Murcia	Fresnel	30	0,5	50	32.200	2	ene-12	50	302.000
Abengoa Solar/IGC Corporation	Solarcar 1	El Carpio	Córdoba	CCP	50	n/a	100	64.400	2	feb-12	115	350.000
Abengoa Solar/IGC Corporation	Solarcar 2	El Carpio	Córdoba	CCP	50	n/a	100	64.400	2	mar-12	180	500.000
Abengoa Solar	Hellos 1	Puerto Lapice	Ciudad Real	CCP	50	n/a	100	64.400	1	may-12	180	500.000
Iberdrola	Morón	Morón de la Frontera	Sevilla	CCP	50	n/a	100	64.400	2	may-12	161	380.000
Abengoa Solar/ITOCHU	Solaben 3	Logroñán	Cáceres	CCP	50	n/a	100	64.400	3	jun-12	180	500.000
FCC/Mitsui	Guzmán	Palma del Río	Córdoba	CCP	50	n/a	100	64.400	3	jul-12	200	510.400
Abengoa Solar	Hellos 2	Puerto Lapice	Ciudad Real	CCP	50	n/a	100	64.400	2	ago-12	180	500.000
Abengoa Solar	Solaben 2	Logroñán	Cáceres	CCP	50	n/a	100	64.400	3	oct-12	180	500.000
SUB TOTAL CONECTADAS					38		1.731	4.500	2.898.000		6.100	15.895.236
Renovalia	Casa de los Pinos	Casa de los Pinos	Cuenca	DP	1	n/a	2,25	1.449	3	mar-11	3,5	5.280
Grupo Ditz - Grupo TSK - Magtel	La Africana	Pesada	Córdoba	CCP	50	7,5	170	109.480	1	jul-12	230	549.360
Iberdrola	Olivensa 1	Olivensa	Badajoz	CCP	50	n/a	100	64.400	3	jul-12	198	403.000
Acciona	Oreilana	Oreilana	Badajoz	CCP	50	n/a	100	64.400	1	ago-12	190	405.480
COBRA	Extresol-3	Torre de Miguel Sesmero	Badajoz	CCP	50	7,5	170	109.480	3	ago-12	200	510.120
Abengoa Solar/ITOCHU	Solaben 1	Logroñán	Cáceres	CCP	50	n/a	100	64.400	4	mar-13	115	350.000
Abantia /Camsa ENTE	Termosolar Borges	Borges Blanques	Lleida	CCP + HB	22,3	n/a	98	63.111	3	dic-12	70	181.000
Nextera-FPL	Termosol 1	Navalvillar de Pela	Badajoz	CCP	50	9	170	109.480	4	mar-13	205	521.200
COBRA	Cáceres	Galisteo y Valdeobispo	Cáceres	CCP	50	7,5	170	109.480	4	mar-13	220	550.000
COBRA	Casablanca	Casablanca	Cáceres	CCP	50	7,5	170	109.480	3	jul-13	200	510.120
FCC	Enerstar	Villena	Alicante	CCP	50	n/a	100	64.400	4	jul-13	214	327.000
Nextera-FPL	Termosol 2	Navalvillar de Pela	Badajoz	CCP	50	9	170	109.480	4	jul-13	212	521.200
Abengoa Solar	Solaben 6	Logroñán	Cáceres	CCP	50	n/a	100	64.400	4	ago-13	115	350.000
RREEF/Solar Millennium/DHL	Aravaca	Morón de la Frontera	Sevilla	CCP	50	7	170	109.480	4	oct-13	220	510.000
SUB TOTAL EN CONSTRUCCIÓN					14		624	1.700	1.152.921		2.333	5.696.760



SOLNOVA 1, 3 & 4 / PS 10 & PS 20, Sevilla

PROTERMO
SOLAR

11 MW, 1 h St.
20 MW, 1h St.



3 x50 MW



ANDASOL 1, 2 & 3, Granada

PROTERMO
S  LAR

3 x50 MW, 7 h St.





GEMASOLAR, Sevilla

19 MW, 15 h St.





PUERTO ERRADO 1 y 2, Murcia

PROTERMO
SOLAR

1,4 MW

30 MW

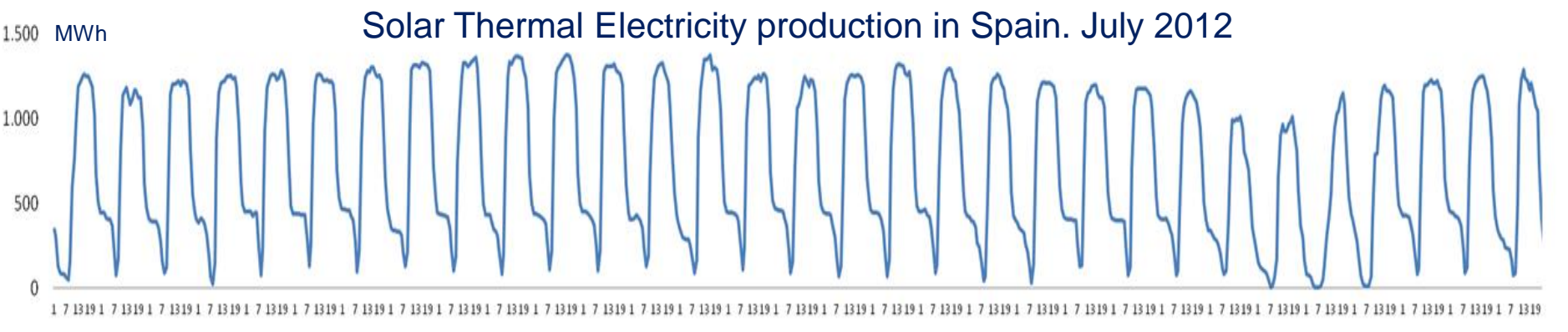
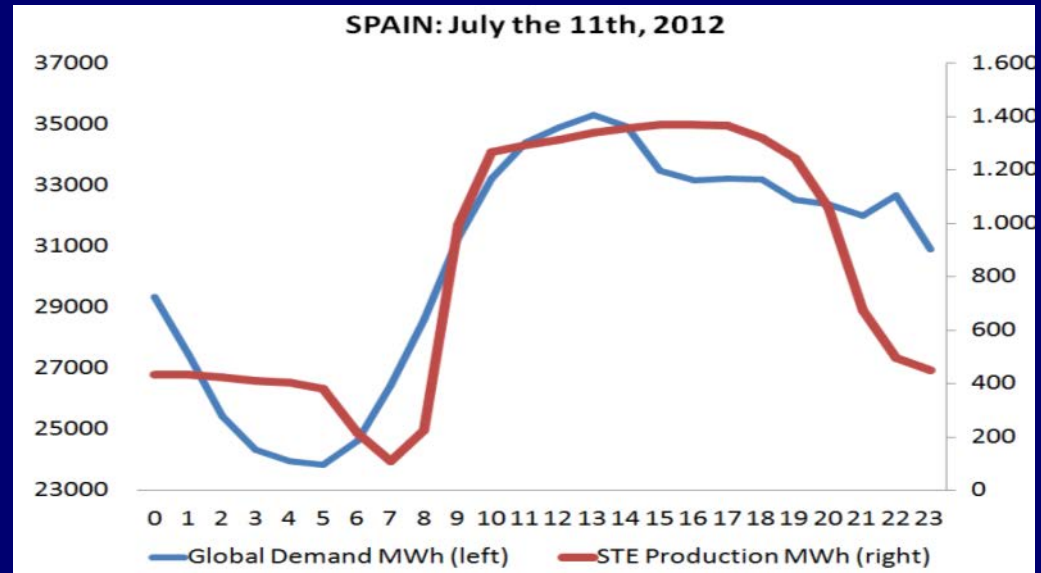




Some recent data on production in Spain

Important milestones
in July 2012:

- ✓ Max. contribution 4,1%
(July the 11th at 17:00)
- ✓ Max. daily contribution 3,2%
(July the 15th)
- ✓ Monthly production 2,3%
(524 GWh in July)





Impacto macroeconómico del Sector Solar Termoelectrico en España

PROTERMO SOLAR
Deloitte

PROTERMO
SOLAR

Incentive policy for this technology was an efficient economic decision for Spain

Download:
www.protermosolar.com
Available in Spanish and English





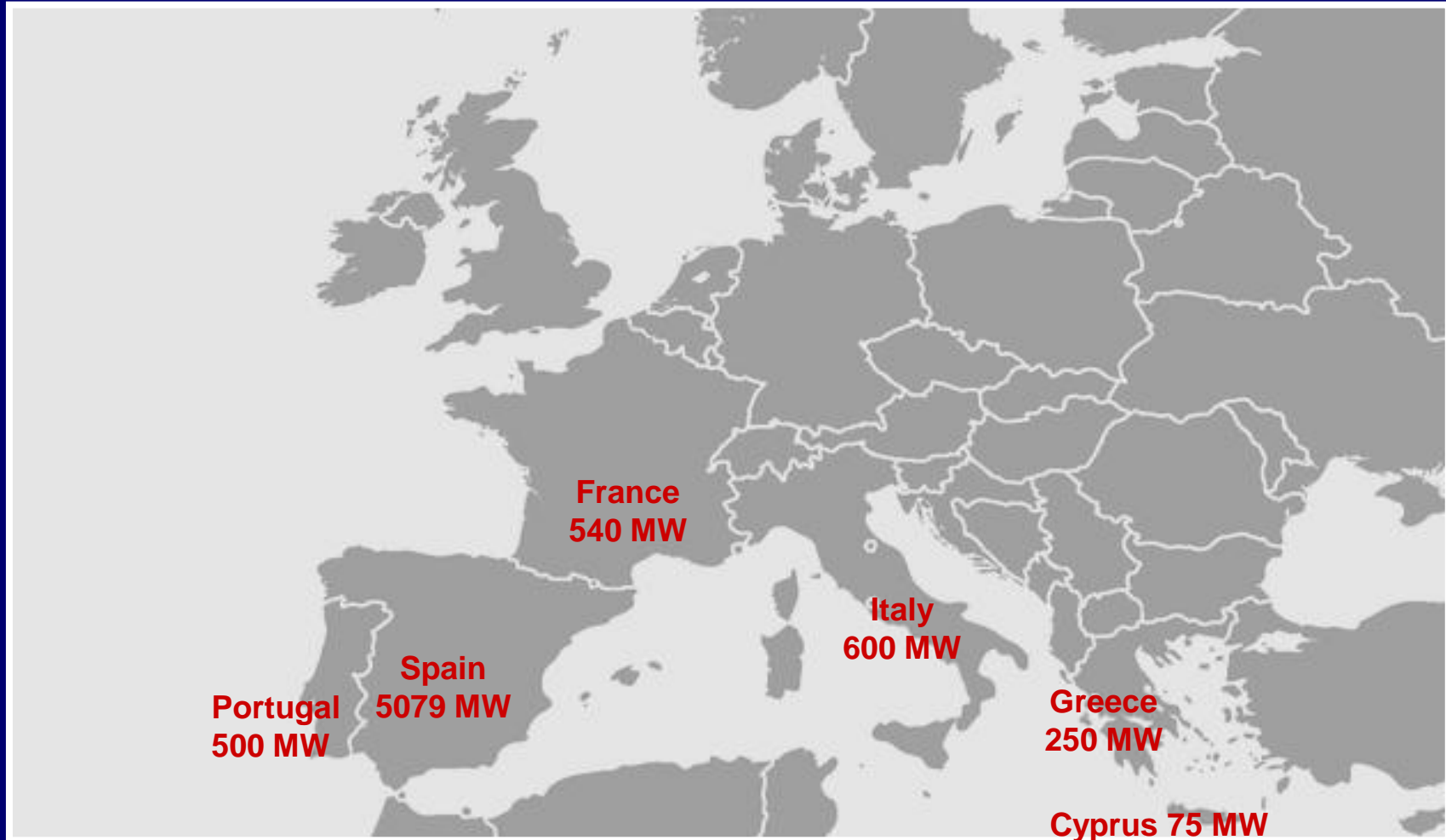
The experience of CSP in Spain: A success story with important drawbacks

- 😊 Quick deployment: 500 MW/year in the last 3 years
- 😊 Relevant macroeconomic impact
- 😊 Plant references with proven performances
- 😞 Inappropriate and unstable regulatory framework
- 😞 Too much quite similar projects
- 😞 Reduced learning curve effect

TODAY:

- Moratorium (Jan – 2012)
- New Law (still in the Parliament). It includes new taxes and retroactive restrictions on the use of gas

Forecast in European countries by 2020 (NREAP's)



+ NER 300 Program

Current STE projects in other European countries

□ ITALY

5 MW pilot plant in Sicily
ISCC using molten salt as
working fluid in the solar field.

The new law will push STE plants
In the near future



□ FRANCE

Recently approved a 12 MW -Fresnel type with storage- in
Corsica and another one of 9 MW near the Pyrenees

□ Good chances for GREECE and CYPRUS regarding NER
300 program



EU RES Directive Opportunities

Member States 2020 Objectives

- Articles 6, 7 & 8 of the RES Directive (Flexibility mechanisms)

Spain is prepared to help other M.S. with joint STE Plants

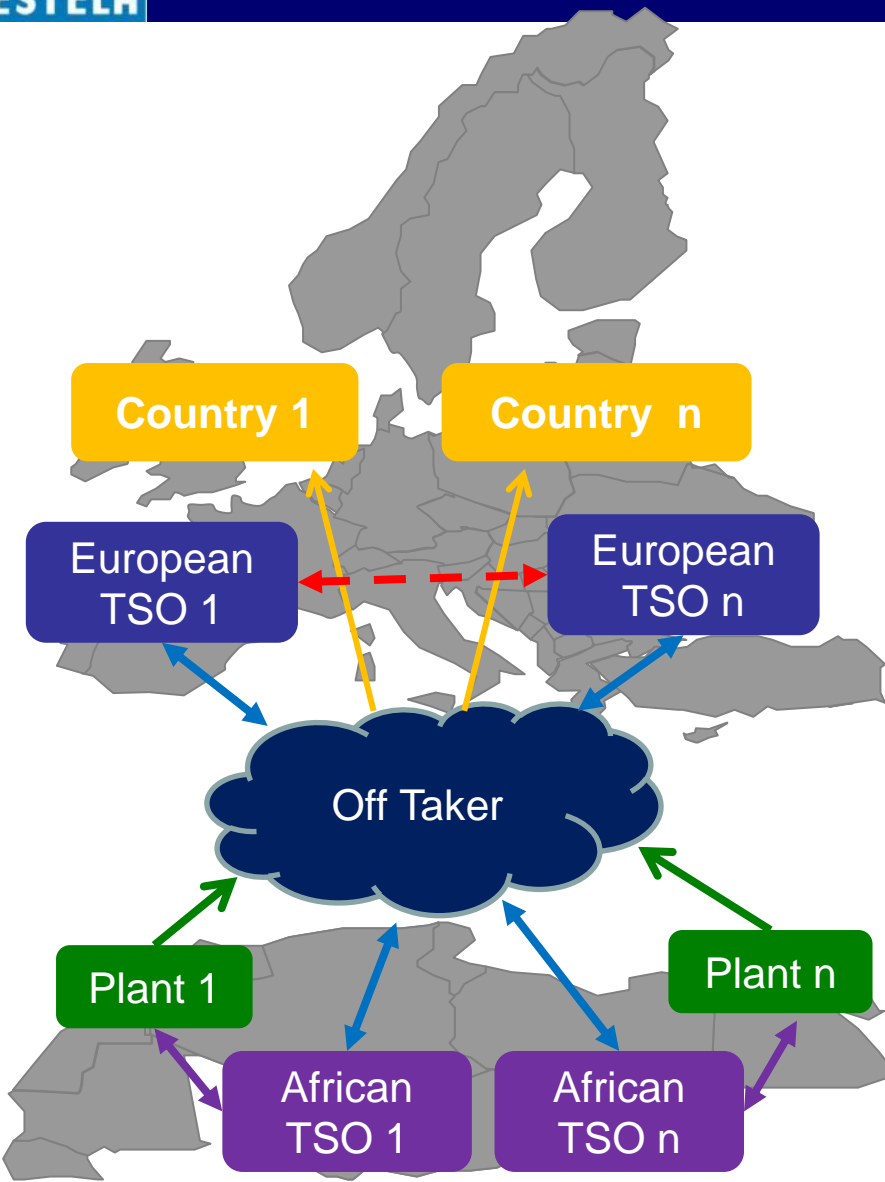
- Article 9 refers to the importation from third countries (MENA / MSP)



Grid interconnections are essential in both cases

- ✓ Not only connecting Africa with Europe but inside Europe as well

The essential role of the Off Taker



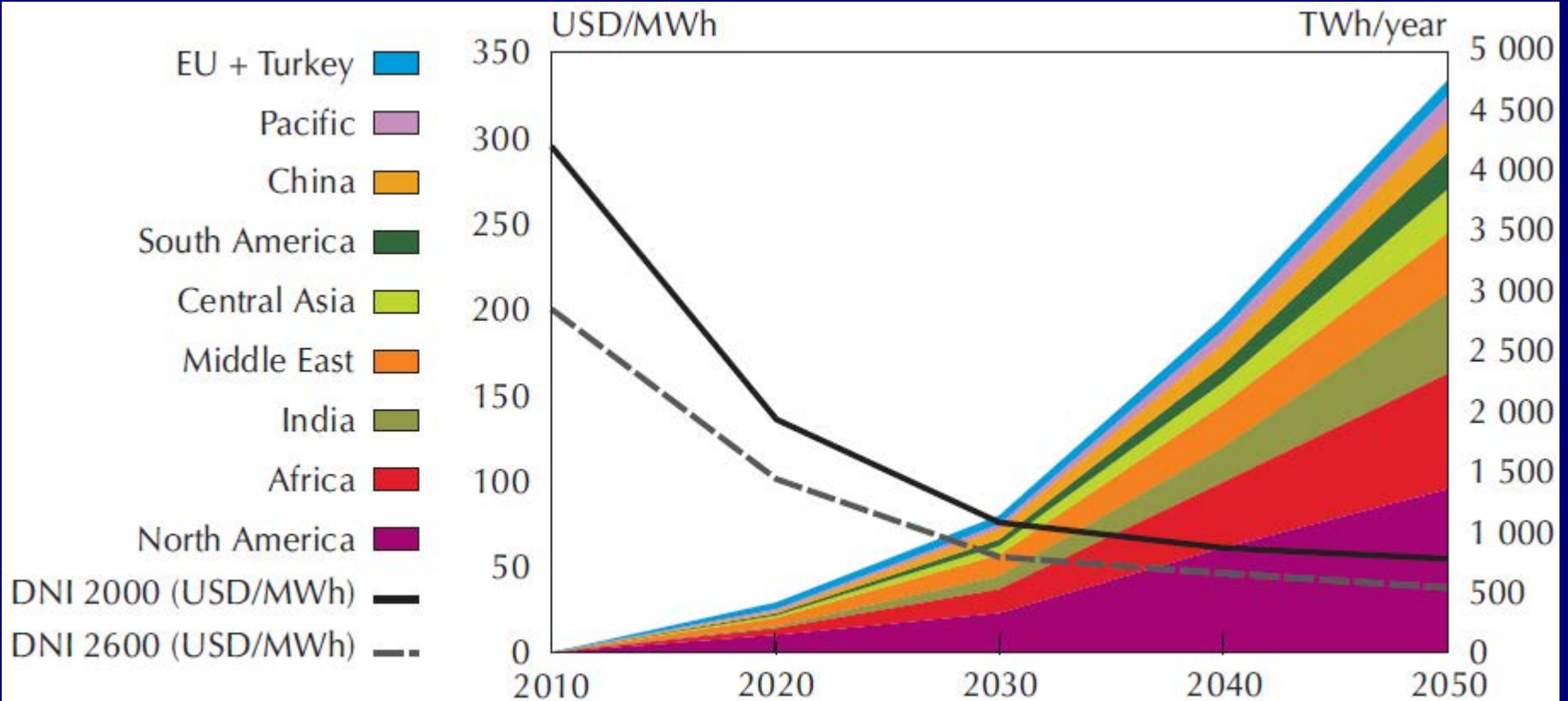
- The off taker will be constitute by the national RE Agencies in European and African countries
- Agreements with EIB and Development Banks will be considered

- Operating procedure**
- ✓ Identify needs of supply and/or certificates in European countries
 - ✓ Activate the fulfillment of all administrative requirements
 - ✓ Reach price agreements with the country systems and/or distribution companies
 - ✓ Establish the necessary agreements with European TSOs on transport and certification
 - ✓ Reach promotional agreements with African countries
 - ✓ Establish the necessary agreements with European TSOs on transport and certification
 - ✓ Tender the plants on PPA basis

CONCENTRATING SOLAR POWER ROADMAP



Decreasing cost and increasing production



USA

- ✓ 392 MW (3)
- ✓ 110 MW (1)
- ✓ 2 x 280 MW
- ✓ 250 MW (1)
- ☐ En promoción avanzada (900)

MEXICO

- ✓ 15 MWequiv. ISCC en Agua Prieta

China

- ✓ 4 x 50 MW
- ✓ 1 x 90 MW
- ☐ 1000 MW en promoción

50 MW

Programas en muchos países (> 2000 MW)

- ☐ Anuncio Arabia Saudita (900 MW + 25 GW)

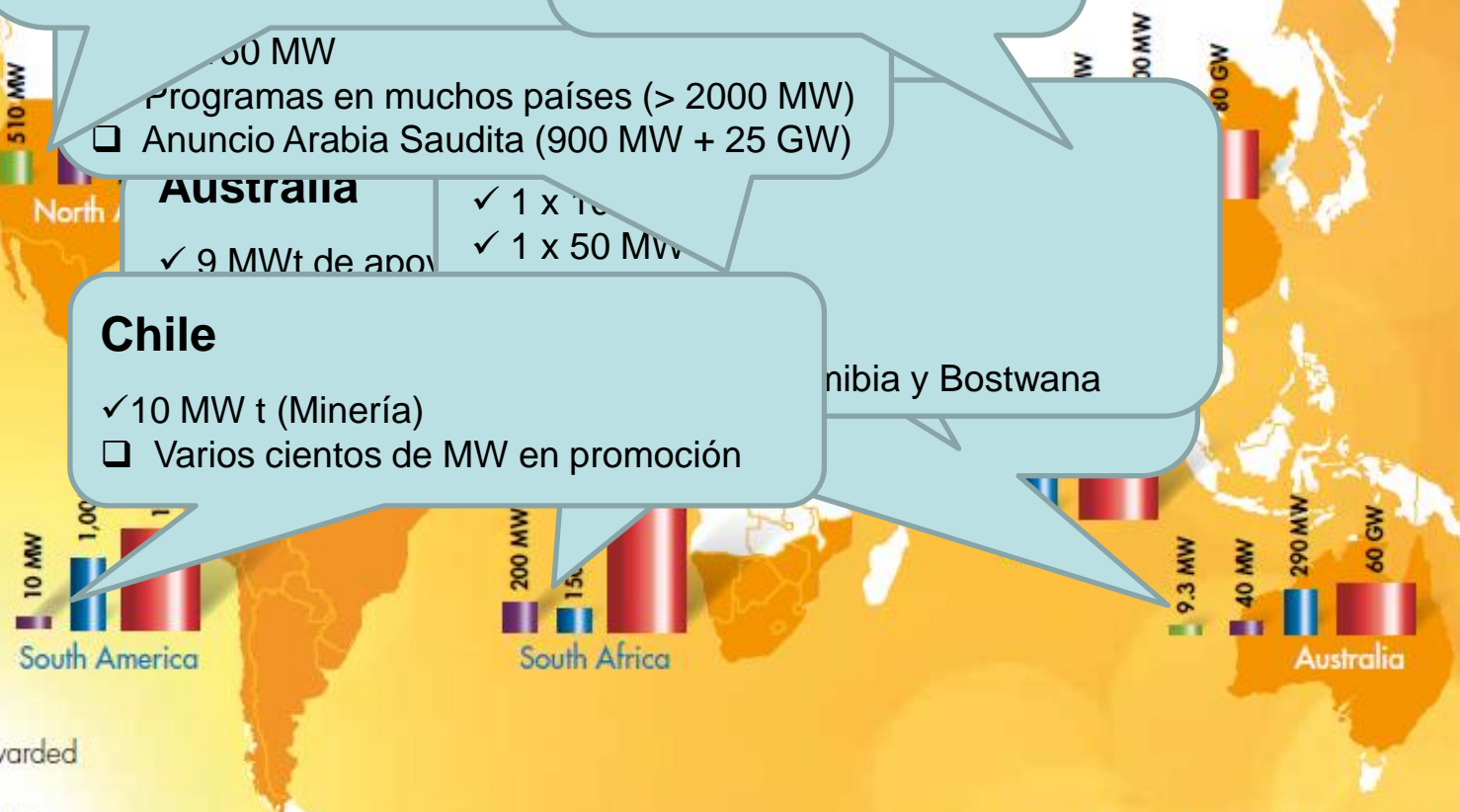
Australia

- ✓ 1 x 100 MW
- ✓ 9 MWt de apoyo
- ✓ 1 x 50 MW

Chile

- ✓ 10 MW t (Minería)
- ☐ Varios cientos de MW en promoción

Botswana y Bostwana



■ Operation
■ Construction/Awarded
■ Promotion
■ Estimated by 2050



The way to competitiveness: Increasing efficiency and reducing costs

❑ System level:

- Increasing efficiency (New concepts, new cycles, new fluids, ...)
- Reducing cost (Storage concepts, hybridization, larger plants, ...)

❑ Component level:

- Increasing performances, extending the limits.
- Reducing manufacturing cost (new materials & processes, larger component sizes, ...)
- Reducing degradation
- Scale factor

❑ Operation:

- Improving forecast and control to improve performance
- Improving start-up and shutdown procedures
- Reducing O & M costs



Cost is the main issue

Data on current projects are not homogeneous at all

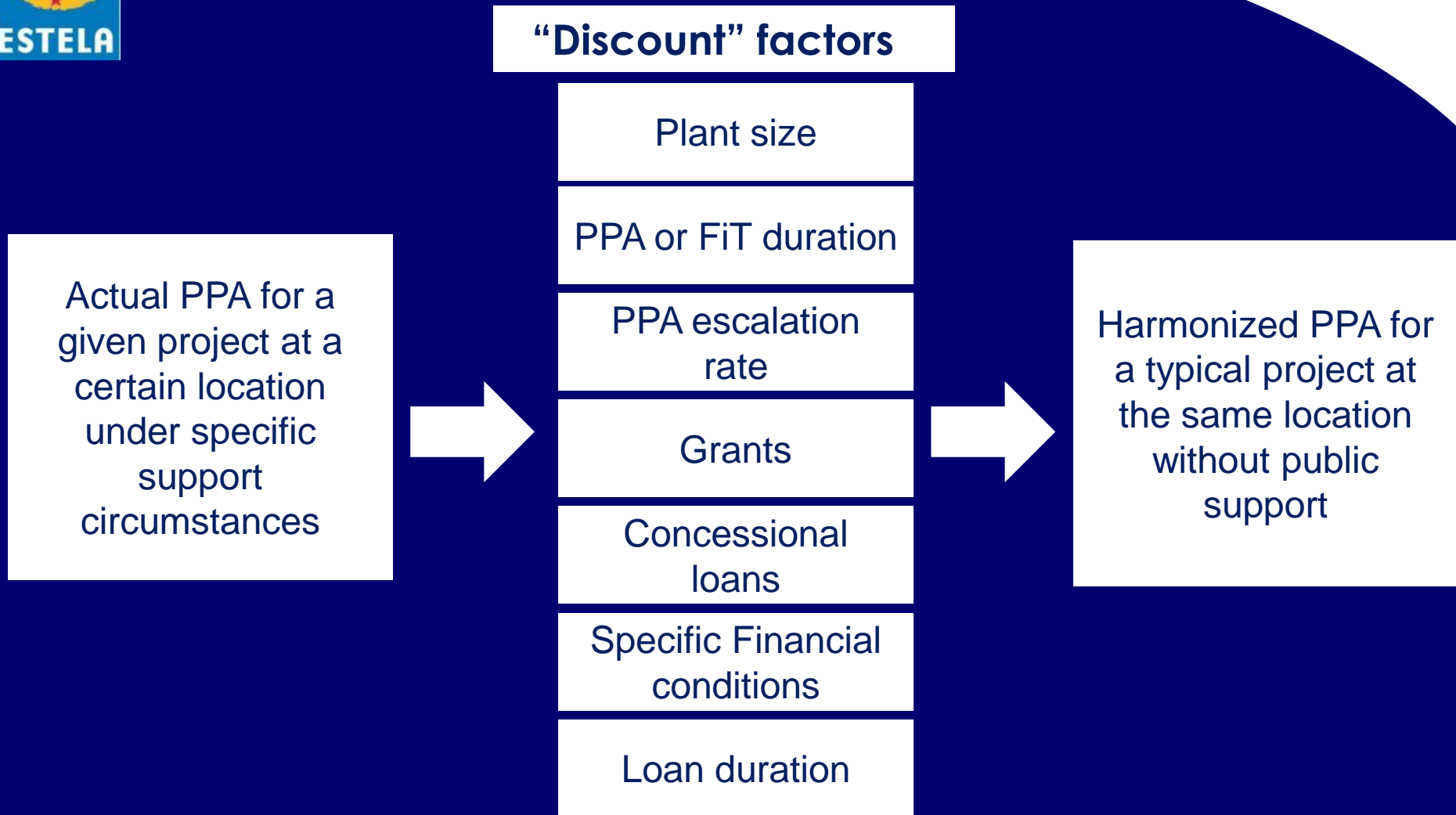
- ❑ **Spain:** The FiT 30 c€/kWh for projects under construction corresponds to low DNI, low size, 2007 designs and component acquisition commitments in 2009
- ❑ **USA:** PPAs in the range of 13 c\$/kWh and they benefit from grants and soft guaranteed loans. They are large projects located at very high DNI values
- ❑ **India:** FiT in the range of 23-27 c\$/kWh. Projects are medium size at low DNI locations. Indian developers have particular strategic position
- ❑ **Morocco:** estimated PPA of 14 c€/kWh corresponds to a large project at a medium DNI location with a high percentage of concessional loans

And so on in South Africa, Australia, Arab Emirates, ... (China?)

In addition PPA duration, escalation with inflation, financial conditions, specific country requirements, etc. differ from one project to another



The “harmonization” model

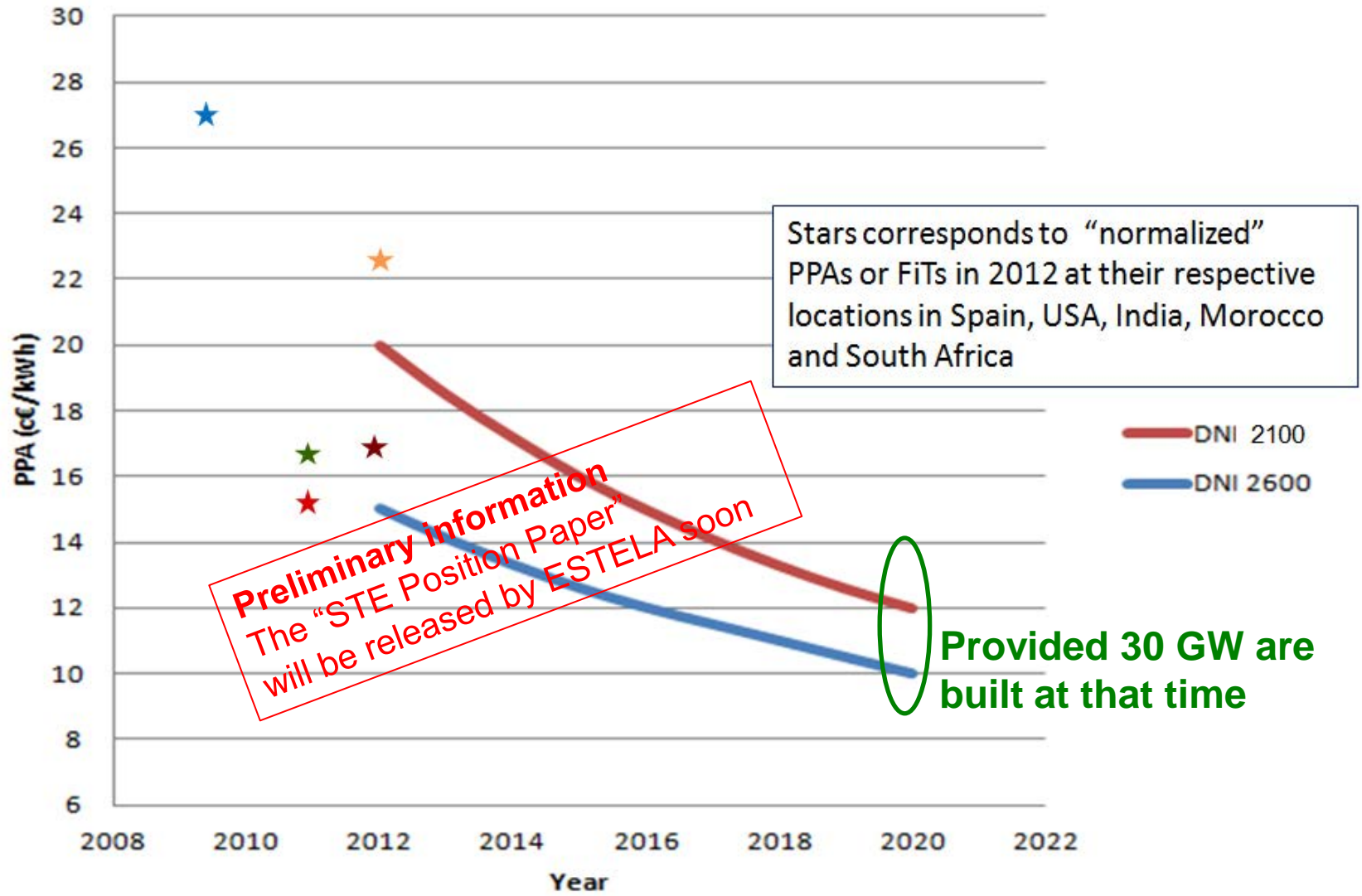


DISCLAIMER: This attempt to provide reference prices must be considered approximated. There are many default values that might be not applicable to all projects as well as some country specific requirements.



Cost reduction estimations: The view from the Industry in 2012

Required value of a 25 years PPA for a 150 MW, 4 hours storage, STE plant without any public financial aids and no escalation





**We will make it
but we need to hurry up!**





Thank you for your attention!

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