European Solar Thermal Electricity Association

"Solar Power From The Sun Belt"

The Solar Thermal Electricity Industry's Proposal For The Mediterranean Solar Plan

A Programme Of The

Union For The Mediterranean




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Contents

1 Introduction: The Union for the Mediterranean and the Mediterranean Solar Plan

On 13 July 2008 the Heads of States and governments of the Euro-Mediterranean countries meeting in Paris have agreed to strengthen the process of Barcelona initiated in 1995 and to transform it into the Union for The Mediterranean (UfM): an area of peace, democracy, cooperation and prosperity. In order to accomplish these goals 6 regional projects were created, among them the Mediterranean Solar Plan.
The permanent Secretariat, soon to be established in Barcelona, will be responsible for carrying out the feasibility studies and elaborating the 6 regional projects and, more precisely, the Mediterranean Solar Plan (MSP).
According to the European Commission, UfM activity in the field of energy should contribute to create a regional electricity market and to promote regional trade. Thus building on the EU-Mediterranean 'acquis':

- Supporting a stable legal framework
- Reinforcing the role of a regional energy regulator (MEDREC)
- Fostering the transfer of knowledge and best-practices

Solar Power: the main resource in the Mediterranean region

Solar energy is the main resource in Mediterranean countries. In their latitudes one of the biggest potential in the world is concentrated.
As a regional initiative, the Solar Thermal Electricity (STE) proposal for the MSP could contribute to improve the security of the energy supply in EU countries as well as to meet the increasing domestic demand trough renewable energy sources and to boost economic development in the UfM non-EU countries.
A MSP based mainly on STE could generate new income resources and reinforce the grid infrastructure in these countries, as well as create a new regional industrial sector of solar components manufacturing.
The MSP-STE could also contribute to achieve the renewable energy 2020 targets by EU countries. According to Article 9 (Joint projects between MS and third countries) of the new RES Directive that will enter into force in 2010, EU Member States will be allowed to import energy from third countries.
But the main benefit from the MSP-STE will be to create a regional market for STE electricity that will allow a faster evolution to reduce costs, improve dispatchability and reduce water consumption, thus leading to a fully competitive kWh cost for plants built by 2021 and beyond.
These plants, built with components and engineering produced mainly in Southern Mediterranean countries and in Europe, will produce electricity at a competitive price to be sold locally or in Europe, depending on price and demand in a fully interconnected environment.
The MSP-STE proposed can be perfectly combined with Wind and PV plants. In fact, the grid component, transmission and electricity market scheme is compatible and could be shared with other generation technologies. Locations of different RES plants will depend, mainly, on the availability of the resources, on the transmission capacities and on the demand profile. However, in the present proposal capacities and economics of installed capacities relates only on Solar Thermal Electricity Technology.

2 Solar Thermal Electricity: Achieving the EU Policies and Targets

2.1 STE: a European Industry

The emerging industry of **Solar Thermal Electricity (STE)** has strong European roots. It is growing mainly due to the technical and economic success of the first projects and to the stable green pricing or support mechanisms that bridge the initial gap in electricity costs (i.e. feed-in tariffs). Future growth will depend on a successful cost reduction and a strong effort in R&D to optimize the potential for technical improvement. European component and equipment suppliers invest in R&D in order to improve the performance of the individual components. Energy companies around Europe are joining the effort and starting business in STE in the framework of the EU internal market and in the world market, independently if there is technical potential in their respective countries. There is common understanding that the STE business has a wide market and a high potential both in Europe and abroad, the European industry being in good position for development in these markets, mainly in the EU and the Mediterranean and MENA areas.

The STE industry considers that in the short- and medium-term the European Union should install demand pull instruments and promote support mechanisms such as feed-in laws, the most powerful incentives to boost the solar thermal electricity generation.

In the framework of the internal electricity market all Member States can benefit in the medium or long-term from the huge potential of solar thermal electricity both in South EU countries and South Mediterranean countries.

In the medium-term the Supergrid should be opened to solar power from North Africa, mainly from countries partners of the Mediterranean Solar Plan, and this power importation should be secured by implementing demand pull instruments and Euro-Mediterranean regional agreements in the framework of the Union for the Mediterranean.

STE dispatchability can be an essential factor for the importing countries to be able to achieve their Renewable Energy Sources (RES) goals, as a complement to other intermittent sources, whose contribution will be limited by the grid requirements.

The potential for research and innovation is still of key importance for solar thermal power technologies. R&D is needed to develop and test new materials, components and system development (i.e. coatings, storage, direct steam/molten salt systems, adapted steam generators, beam down). Further research is also needed to improve transmission and the energy grid.

Both the European Union and Member States should continue to fund demonstration plants to push forward new technologies. This is of utmost importance, as only proven technologies are bankable.

2.2 STE: Contributing to Reach the EU Target: 20% of Renewable Energy Sources by 2020

By 2010 there will be more than 500 MW connected to the grid, and the short-term potential for European Mediterranean countries is estimated at 30,000 MW that could contribute, if the necessary measures are taken, to the EU 20% target in the year 2020.

Solar thermoelectric generation is highly predictable, and can be coupled with thermal storage or hybridization, with gas or biomass, enabling stable national or European electricity networks. Solar thermoelectric plants have favorable inertial response as well as the capability for primary, secondary and tertiary electrical regulation in both directions, up and down.

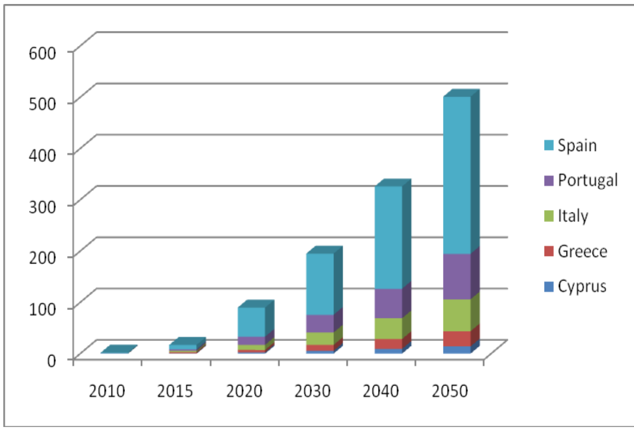
Solar thermoelectric power plants can meet the demand at any time, day and night, and can supply electricity at peak hours if they are anticipated. Furthermore these plants can easily meet the demand curve and contribute to the electrical system's stability through the input of substantial amounts of other less dispatchable renewable resources in the electrical systems, both at European and at regional level, when allowed by the Supergrid development, including the Southern Mediterranean and Northern Baltic areas.

2.3 STE: Contributing to an EU Renewable and Low Carbon Energy System and Sustainability

The great dynamism of the Solar Thermal Electricity European industry, its high potential, operational reliability and current production capacity makes solar thermoelectric generation a strategic resource for planning the European electricity scheme for 2020 and beyond. The good dispatchability characteristics of solar thermal power make the difference with other renewable sectors

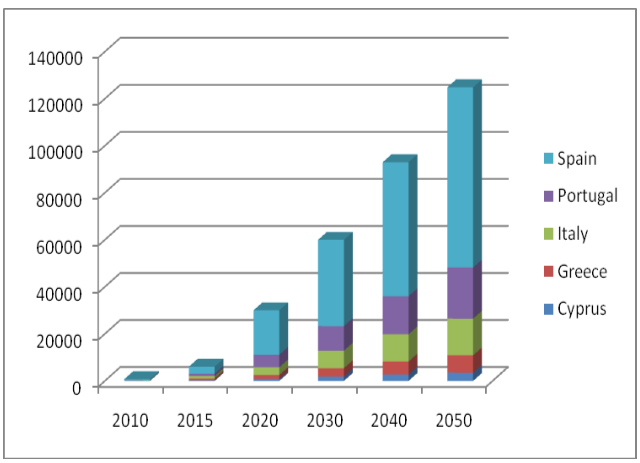
The European countries located in the World's Sun Belt have a high potential to develop solar thermal electricity. The tables below give an estimate of STE in Southern Europe based on the current technology. Further developments in technology and components achieved by the entire European solar industry will lead to more efficiency in converting sun radiation into generated power, thus the long-term estimates will certainly revised upward.

STE Estimates 2010-2050: Power Generation Capacity in Southern Europe (TWh/Year)



	2010	2015	2020	2030	2040	2050
Cyprus	0,1	0,7	2,2	5,5	9,2	14,1
Greece	0,1	2,1	5	11,4	19,2	29,5
Italy	0,1	2,8	9,9	24,3	40,6	62,3
Portugal	0,2	2,9	16	34,5	57,5	88,7
Spain	1,5	8,5	56,7	119,3	199,5	306,4
Total	2	17	89.8	195	326	501

STE Estimates 2010-2050: Installed Capacity in Southern Europe (MW)



	2010	2015	2020	2030	2040	2050
Cyprus	70	300	826	1861	2713	3519
Greece	50	750	1653	3535	5490	7378
Italy	50	1000	3311	7468	11597	15585
Portugal	50	1000	5317	10428	16194	21763
Spain	500	3000	18893	36708	57006	76611
Total	720	6050	30000	60000	93000	124856

2.4 STE: Developing a Regional Long-Term Strategy for a Full Renewable Energy System and Sustainability

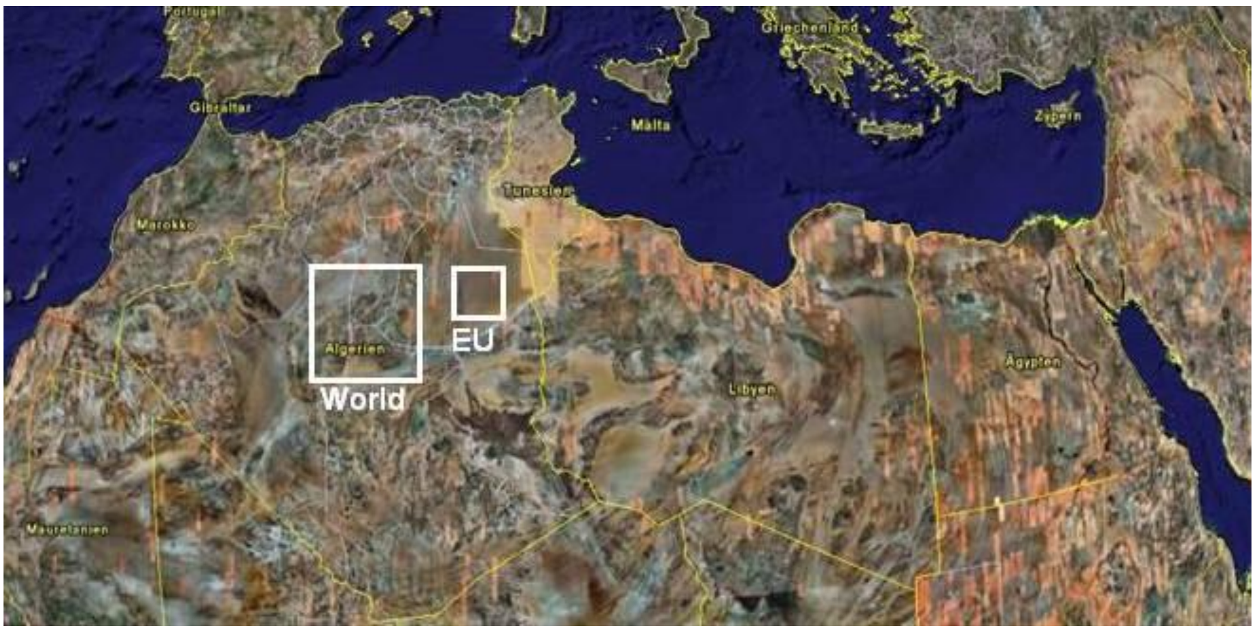
A world-wide long term strategy is needed to build a sustainable low carbon energy system in order to secure the energy supply and to meet the challenges of climate change. For the EU long-term renewable supply regional approaches are of paramount importance (i.e. Baltic Region, East and Central Europe, and the Mediterranean Ring, which includes the non EU countries partners of the Union for the Mediterranean, etc.). In the long-term the Supergrid will be the most economic and efficient way to connect the 'enlarged' Europe and neighboring countries.

Focusing on Solar Thermal Electricity, the EU and its Member States should take advantage of the fact that the largest potential of the world is in Southern Europe and the Union's neighbor countries of the Mediterranean, today partners in the Union for the Mediterranean.

North African countries should develop clean technologies to face the increasing domestic energy demand. In the medium-term, if in the EU a target of 30 GW for 2020 is feasible a much larger contribution could be obtained in a longer-term if the potentials of the Northern Africa countries are developed.

STE Potential Capacity in the EU and NA Countries		**2020**	**2030**
Operating hours/year STE Europe		2,833	2,917
Operating hours/year STE NA		3,258	3,354
Transmission losses NA – Europe		6%	6%
STE share in European grid (inside Europe generation)		2%	4%
STE share in European grid (imports)		1%	6%
STE share in European grid (total)		3%	10%
STE Potential Production in the EU and NA Countries		**2020**	**2030**
Installed capacity of STE plants in Europe	GW	30	60
Electricity generation - STE in Europe	TWh/year	89,8	195
Installed capacity of STE in NA countries	GW	10	85
Electricity generation- STE in NA countries	TWh/year	32	286
Transmission losses NA – Europe	TWh/year	2	17
Electricity import from NA	TWh/year	30	269
Total electricity generation from STE	TWh/year	115	444
STE share over total electricity consumption	%	3%	10.6%
STE share generated inside Europe	%	2%	4.2%
Imported STE share	%	1%	6.4%
Energy consumption Europe	TWh/year	3,734	4,182
			Source: IEA2008, Estela

Dramatic changes are to be introduced in the present energy systems to mitigate their negative impact on the environment and the world's climate. The World's "Sun Belt" extends from latitudes 35° north to 35° south, receives several thousand times the global energy needs: a resource which is currently not exploited. A large part of this enormous energy could be harnessed through solar thermal technologies, conveyed and used in a sustainable way.
In the long-term the huge potential of STE can be developed and generate electricity from solar power for a Euro-Mediterranean market of green electricity that will benefit all partners. This join effort should be developed in the framework of the Union for the Mediterranean, starting with the Mediterranean Solar Plan (2010-2020) that can build the path for a solar future of the Euro-Mediterranean region and therefore, substantially contribute to a EU-wide consistent, versus full, renewable consumption from Finland to Spain, from Greece to Poland or from Ireland to Portugal.
By using a mere 0.4% of the total surface of the Sahara desert, the European demand for electricity could be entirely met, and the global demand by using only 2%.



Areas of the size as indicated by the squares would be sufficient for STE Plants to generate as much electricity as is consumed by the World and by the EU respectively (Source DLR Germany 2005).

2.5 Contributing to Economic Growth and Employment: Lisbon Strategy Goals

STE plants are mainly located in dry areas that are uncultivated, not used for agriculture. Commercial activity within these areas will directly and indirectly benefit local communities. Direct benefits include the collection of taxes and the creation of new jobs, the indirect benefits being an increase in local services to support the new jobs created.
The plants require skilled labour for construction, maintenance and operation. The types of jobs initially created would most likely be technical or construction ones, but opportunities for manufacturing and services jobs may also develop as facilities evolve.
The calculation of the new jobs created is based on current industry practices to assess the number and type of jobs that will result from the enactment of renewable energy programs in recent years. For STE plants, every 100 MW installed will provide 400 man/year equivalent manufacturing jobs, 600 in contracting and installation, and 60 in O&M.
A community can benefit indirectly from economic development, i.e. through an increasing demand in local services commodities. It is widely accepted that for each construction job, four service jobs are created in support. Once construction is completed, O&M will also require local services.

2.6 Reinforcing the World Leadership of the European Solar Thermal Electricity Industry

European countries are the world leaders in this technology as demonstrated not only by the number of plants under construction, but also by the ownership and construction of new plants in the USA, and the international tendering of plants in northern Africa or the Middle East that are awarded to European companies.
Components are manufactured all over Europe, there are factories in many EU countries. Regarding parabolic mirrors, absorber tubes, collector structures, heliostats, steam turbines, alternators, transformers and other components, the European solar plant constructing industry and engineering are world references.
Today this emerging sector accounts companies from 12 EU-countries, more if we take into account non specific STE components manufacturers that are, however, part of the normal equipment of electricity generation trough thermal processes.
Furthermore, the number of R&D activities promoted and developed by research centers and by the industry are also key indicators.
In short, the European industry is perfectly prepared to lead the development of these technologies worldwide. It is a world leader and should remain so. It is the challenge for the coming years.

3 The Solar Thermal Electricity Industry's Proposal: creating a UfM Regional Renewable Electricity Market

The main objective of the Union for the Mediterranean is to create a regional area of growth, sustainability and social development. The Mediterranean Solar Plan can contribute to the main objectives of the energy sector: a diversified, safe and economically sound supply, as well as an increased share of renewable sources in the energy mix to face the climate change challenges.
The Solar Thermal Electricity industry estimates at 30GW the potential for installed capacity in the EU by 2020, mostly in the Southern countries. The potential in Mediterranean Southern countries is technically several times the world demand. We can imagine that a lower target than for the EU is economically viable, for instance 20GW.
The benefits of developing Solar Thermal Electricity plants are in terms of new low carbon installed capacity to meet the increasing energy demand. In terms of social benefits, if 20 GW of solar thermal power new capacities are built in the Northern African countries, estimates on job creation until 2020 could be a total of 235,280 man/year jobs: 80,000 in manufacturing (40,000 on site and 40,000 in Europe), 120,000 in construction and 35,280 in O&M.

3.1 General Concepts of the MSP-STE

Assumptions have been made as an example or model in order to contribute to the definition and implementation of the MSP.

- The electricity produced by the plants will be used on their respective local markets, a part of it could be sold in EU countries, in other words within the Euro-Mediterranean regional market.
- The plants promoters must be technically and financially viable. They will have to guarantee the investment cost, the completion time, the performance and the O&M costs.
- The plants mix should have an adequate compromise between cost, dispatchability, future potential and relevancy with the intended regional market purpose.
- The rate of deployment will have to be accelerated progressively to allow time for the CSP cost reduction and a possible increase of the electricity market price.

- The financial effort required should be kept reasonable, and the scheme should attract as much private capital as possible in the funds needed. The timetable for implementation will be consequently adapted.
- A successful implementation will require consistent political support.

Such a successful implementation will only possible with a HVDC Euro-Mediterranean super grid, capable of accommodating by 2020 the transport of at least 15 GW between Northern Africa to Europe, and with sufficient transportation capacity within Europe.

Furthermore, it is expected that local utilities or independent power producers (IPP's) will build other non dispatchable renewable plants, included or not in the Mediterranean Solar Plan. Wind farms will have an attractive price once their production is assured through the increased interconnection capacity among Southern Mediterranean countries and with EU countries. Photovoltaic and parabolic disc concentrating solar plants using batteries or hybridisation will have a role as distributed generation, particularly adequate for small remote villages

3.2 Main Goals of the MSP-STE

One of the main goals of the MSP is to contribute to the creation of a Euro-Mediterranean regional renewable electricity market provided with a regional legal framework, and rules and mechanisms for trade. As part of the MSP, building 20GW of Solar Thermal Electricity plants by 2020 could generate a win-win process for all UfM partners. If successfully implemented, the conditions for an accelerated, purely market driven, development of STE plants will be created. These plants will feed the long term electricity needs of the UfM countries by using the virtually endless potential of the North African deserts.

The MSP will also help the economic development of Southern Mediterranean countries by creating a new income resource, providing electricity to enhance their own development, reinforcing the grid infrastructure and allowing a new industrial sector of solar components manufacturing to be created.

The Mediterranean Solar Plan will finally, strengthen the leadership of the European industry, facilitate the transfer of technology and know-how among UfM partners and, in the mid-term, create a powerful regional market and industry to lead this global emerging sector.

3.3 Creating a Regional Electricity Market

By 2020, 30GW in EU and 20 GW in South Mediterranean countries of newly installed capacity should be integrated in the grid both reinforcing existing infrastructures and by building new transnational and transmediterranean ones, which could be the basis for a Euro-Mediterranean Supergrid. This will create an optimum mix and the dispatchability of CSP in order to get the adequate integration into the system. New HDVC transmission lines will allow the transport of a share of the energy produced. Different options are possible.

Concerning decentralised generation, dish Stirling systems hybridised with fossil fuels or biomass and photovoltaic installations with batteries might be the object of a different programme. They could provide electricity to remote villages in standing along systems or mini-grids. However, the planning, financing and implementation of such decentralised programmes are totally different and deserve a separate and specific approach.

HVDC Transmission Lines: Technology and Cost

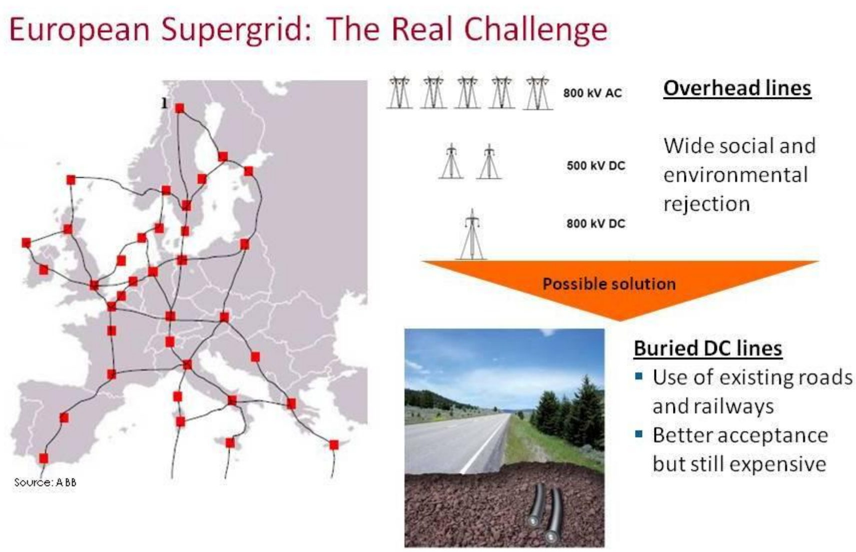
There are many examples of HDVC lines in the world, and Europe in particular. Overhead lines can transport tension up to 800 KV at an overall comparable cost to AC lines of the same capacity. For the time being submarine and underground lines can only transport up to 350 KV and still have a higher cost.

Due to developments in cable isolation, the main cable suppliers expect to increase voltage within the next 5 years within reasonable costs. Converting stations manufacturers will improve both cost and voltage, thanks to new transistors technology. The combination of improved cables and improved converting stations will increase the HVDC transmission capacity to reach costs comparable to AC lines.

The main transmission companies and transmission system operators (TSO's) still do not show great enthusiasm about subterranean HDVC because of cost consideration. It is only when the need is extremely urgent that they decide to use this technology like they have done for the French-Spanish connection through the Pyrenees.

There are many factors which affect the cost of an HDVC line whether it is overhead, subterranean or submarine. The rate at which this cost will decrease is dependent of technological improvements and the market size. An investment of 2 M€/km for a 400 MW line seems to be a fair estimate.

A relevant plan to implement a Euro-Mediterranean[1] Supergrid will encourage investments and lead to a substantial decrease in the costs of cables, fabrication of converting stations and deployment. A transmission cost of 10 €/MWh per 1,000 km should be possible within the next few years.



[1] (The EU Commission in its Green Paper on a European grid, safe, sustainable and competitive – COM(2008)782final) of 13.11.2008 includes as one of the main projects the "Mediterranean Ring" in order to develop renewable energy projects in the region and to increase the security of energy supply.

There remain several barriers to the importation of electricity in Europe. All over the continent national AC grids and interconnectors are saturated. In most European countries the peak power growth of the last years has not been compensated by a corresponding development of the transportation system, furthermore the construction of new overhead transmission lines seems virtually impossible. In other countries the required timeframe to build new transmission lines is quite long (between 10 and 15 years).
The recent creation by 42 transmission system operators (TSOs) from 34 European countries of a new association, the European Network of Transmission System Operators for Electricity (ENTSO-E), aiming at enhancing the integration of the European electricity market may pave the way to a transeuropean transmission system capable of handling the 2020 and beyond renewable generation requirements.

3.4 Phases of the MSP-STE

Roadmap to enable the transportation of renewable energy from North African countries to Europe**:**

Phase 1: 2009 – 2012: The exportation share through the existing Morocco to Spain electrical interconnection

Phase 2: 2013 – 2016: Additional transmediterranean grid interconnections between North Africa and Europe (the basis of the Euro-Mediterranean Supergrid) and reinforcement of the existing one allowing the transport of part of the electricity produced by the new STE plants

Phase 3: 2017 – 2020: Real European electricity market with a Euro-Mediterranean Supergrid of much higher interconnection capacity inside Europe

Phase 4: 2021 onwards: Accelerated STE deployment will not require additional public support.

3.5 Economic and Social Benefits of the MSP-STE

As an example, if 20 GW of solar thermal power new capacities are built in the South Mediterranean countries, estimates on job creation until 2020 could be a total of 235,280 man/year jobs: 80,000 in manufacturing (40,000 on site and 40,000 in Europe), 120,000 in construction and 35,280 in O&M.
Furthermore, the creation of these jobs will allow for the development of a permanent educational system (schools, vocational training institutes, etc) to continuously train skilled manpower (i.e. technicians, engineers, developers etc).

Solar Mediterranean Plan – Solar Thermal Electricity - Employment Projections (*)

Year	Installed Capacity (MW)	Manufacturing Jobs in Europe man/year	Manufacturing Jobs in NA man/year	Construction Jobs man/year	O&M man/year		Total man /year
					New	Accumulated	
2011	200	400	400	1,200	120	120	2,120
2012	300	600	600	1.800	180	300	3,300
2013	500	1,000	1,000	3,000	300	600	5,600
2014	700	1,400	1,400	4,200	420	1,020	8,020
2015	1,000	2,000	2,000	6,000	600	1,620	11,620
2016	1,400	2,800	2,800	8,400	840	2,460	16,460
2017	2,000	4,000	4,000	12,000	1,200	3,660	23,660
2018	2,900	5,800	5,800	17,400	1,740	5,400	34,400
2019	4,500	9,000	9,000	27,000	2,700	8,100	53,100
2020	6,500	13,000	13,000	39,000	3,900	12,000	77,000
Total	**20,000**	**40,000**	**40,000**	**120,000**	**-**	**35,280**	**235,280**

(*) In this table only the period from 2011 to 2020 is taken into account, while the jobs will last during the whole operating life of the plants estimated at 50 years. As mentioned before, the job creation after 2020 would be even more impressive, as many more plants will be built under full market conditions

3.6 Cost Estimations of the MSP-STE

The table below shows what ESTELA thinks is a reasonable implementation plan for the solar thermoelectric initiative in the South Mediterranean countries. The initiative should encompass the expansion/construction of facilities to export part of the electricity produced to Europe through a new electrical transmission system.
The main goal is to reach by 2020 an amount of 20,000 MW installed power in the desert areas. At first, the implementation of STE plants will require significant support such as feed-in tariffs, but with time the more electricity will be produced, the less help will be needed.

Solar Mediterranean Plan – Solar Thermal Electricity: Project Cost Projections (cost per kWh for the initial 20 years) *(1)*

Year	New Installed Capacity (MW)	Investment (€/Kw)	Accumulated Power (MW)	Annual Investment (€ x 1,000)	Production Costs (c€/kWh)	Transp. & Loss. Costs (c€/kWh)	Total Cost ((c€/kWh)
2011	200	5,000	200	1,000,000	21.6	2.3	23.9
2012	300	4,854	500	1,456,311	20.6	2.2	22.8
2013	500	4,713	1,000	2,356,490	19.6	2.1	21.7
2014	700	4,576	1,700	3,202,996	18.7	2.1	20.8
2015	1,000	4,,442	2,700	4,442,435	17.8	2.0	19.8
2016	1,400	4,313	4,100	6,038,261	16.9	2.0	18.9
2017	2,000	4,187	6,100	8,374,843	16.1	1.9	18.0
2018	2,900	4,005	9,000	11,789,827	15.4	1.9	17.3
2019	4,500	3,947	13,500	17,761,708	14.6	1.8	16.4
2020	**6,500**	**3,832**	**20,000**	**24,008,544**	**13.9**	**1.8**	**15.7** *(2)*

Total Investment in Power Plants 81,331,414
Total Investment in Transmission Lines 16,000,000
Total Solar Programme Investment 97,331,414

(1) ***After repayment of the debt, this total cost will decrease to a fraction, as only O&M costs will remain***
(2) ***After 2020 we may expect further reduction in the kWh cost***

Other explanatory notes:

All economic figures are given on a constant 2008 basis.
The figure of installed power per year follows a typical progressively increasing curve. The first 200 MW could be installed in 2011 provided that an operative program is set up in 2009. A ratio of 6,500 MW of new capacity added per year is reached in 2020, which is consistent with the overall projections of CSP development in NA countries by 2030 and 2050. In all cases 15% of hybridisation with gas has also been taken into consideration.
The investment per kW installed has been initially estimated at 5,000 €, which is the average of the cost of plants with 7 hours storage (6,000 €/kW) and the others that only have a small operational storage (4,000 €/kW).
A reduction of 3% per year for the installation costs has been taken into account.
A reduction of 5% per year of the electricity production costs has been calculated as a result of the aforementioned reduction of the installation costs combined with a continuously improving efficiency of the plants.
Electrical losses of 6 % on the HVDC transmission lines, including converter stations, have been estimated.
The impact of the new transmission lines into the energy costs have been estimated on the basis of current commercial information at an internal return of 10% over 30 years, considering a utilisation factor of 65%. The length of the HVDC lines has been estimated at an average 2,000 km, with 200 km of submarine cables and including converter stations at both ends. This represents an additional cost of 0.98 c€/kWh to the electricity to be consumed in Europe.

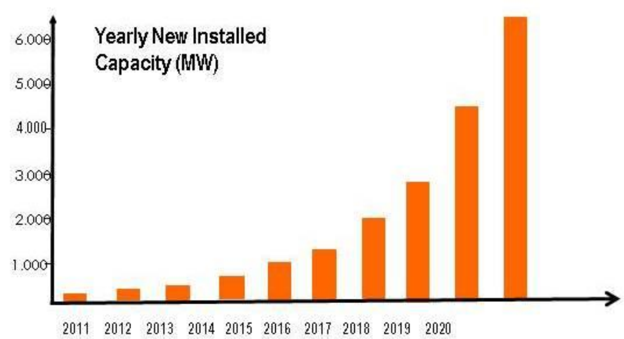
3.7 Financing of the MSP-STE

Taking into account the most likely scenario of a continuous increase of the electricity price produced by fossil fuels operated power plants, the right question is not “how much public support is needed to reach the 20,000 MW goal by 2020?” but rather “how big will the savings be for the consumers during the whole life span of the solar plants to be created under the Plan?”

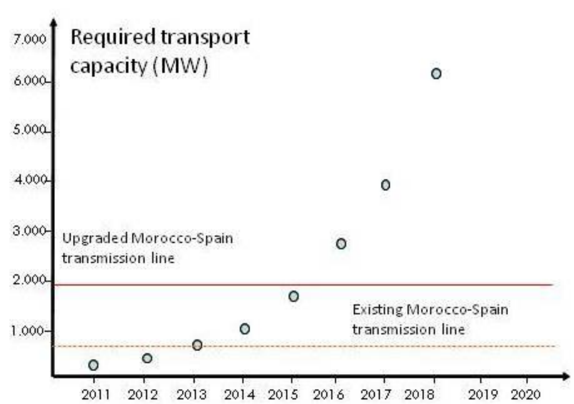
There is no doubt that there will be a time when the costs of the electricity produced by solar thermoelectric power plants will be lower than those of the electricity produced by conventional gas plants. As the electricity costs produced by solar power plants will be stable, without being affected by the oil price, the savings until the end of the operational life could be very high.
Nevertheless, until this breakeven point is reached some public support will be of utmost importance to favour the investments by the private industrial sector within the Solar Mediterranean Plan – Solar Thermal Electricity.
This support could be formulated, for instance, through a 20 year Power Purchase Agreement (PPA) covering the production costs. After this period the reference PPA price could be significantly reduced for a second PPA period. Other alternatives can be designed to value this long term (above 40 years) capacity of producing dispatchable electricity at an almost fixed cost.
The volume of this initial collective effort will strongly depend on the trend of the oil/gas price increase, which will determine when the cross between the decreasing solar costs curve and the increasing fossil fuel costs curve is reached. According to this possible schedule, a large proportion of the plants to be initiated before 2020 (likely those to be initiated closer to that date) will be able to generate electricity at prices below the contemporary alternative fossil fuel electricity from their start-up date. If this were the case, no financial help would be required for this potentially large proportion of plants.

4 Implementation of the MSP-STE

The MSP-STE is proposed to be implemented progressively during 10 years. The progression is scheduled as follows:

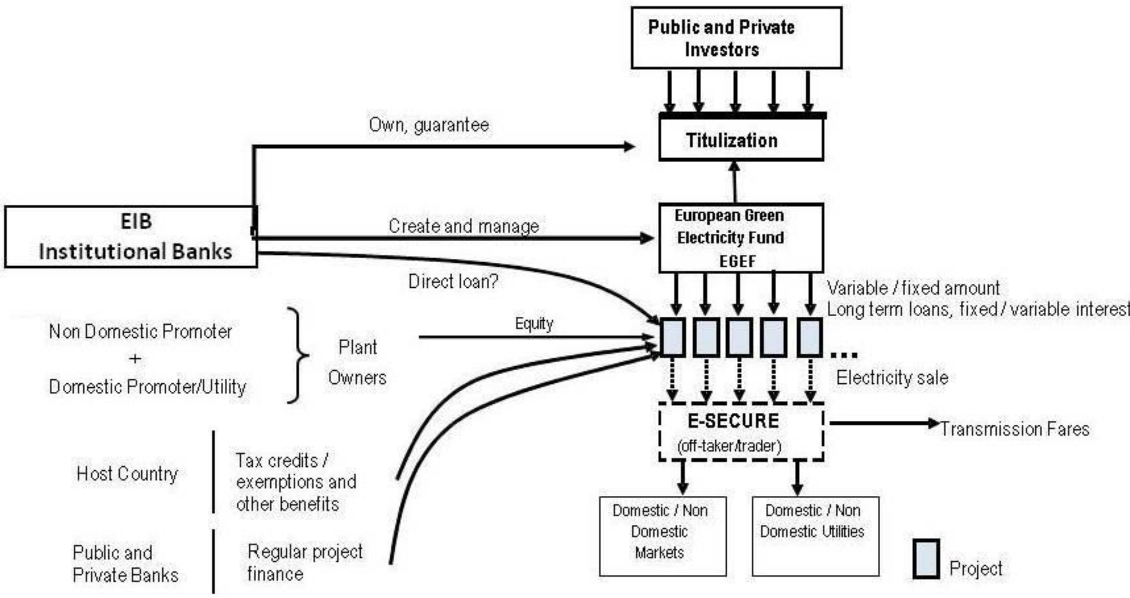


There would be no real transmediterranean interconnection capacity needs until 2016.



4.1 Role of the Main Stakeholders in the MSP-STE

The main actors of the MSP-STE are the financing bodies, the promoters and the regulators, according to the following scheme:



European Investment Bank (EIB): EIB can have two different roles.
- It participates in the direct finance of the projects, in a similar way as it presently does in European CSP projects, alone or in association with private banking institutions,
- If and when considered adequate, it creates and manages the European Green Energy Fund (EGEF) and provides the private and public investors in EGEF with EU backed guarantees. EGEF vocation might be to extend the present 20-year loan to a duration more adequate to the technical life of CSP plants.

E-SECURE: E-SECURE will set up long-term agreements with countries to help them achieve their targets by 2020 and beyond. Mainly acting as a trader E-SECURE will buy the electricity from the companies owning the plants and sell it on the local and European markets. As such E-SECURE will have a positive margin from the first year of the MSP:
- Sales prices, which will include "ad-hoc" feed-in premiums and/or tariffs, or any other incentives mechanism (which may differ for each of the relevant countries) and CO2 rights shall be above the contracted PPA prices since the beginning. Depending on the evolution of the feed-in premiums, the CO2 rights and the PPA costs, such a margin may grow with time to reach very significant level.
- E-SECURE will launch tenders to select the promoter for the ownership of new plants as planned by the host country within the MSP. As E-SECURE is the focal point of future profits, its nature and shareholding structure will have to be further discussed. Nevertheless, national agencies of the MSP countries, such as the French ADEME or the Spanish IDAE, and their counterpart in Southern shore countries, might share the ownership of E-SECURE. Long-term profits would be reinvested in energy related sustainability initiatives.

European Green Energy Funds (EGEF): The EGEF can help in different ways.

- Enhance the EIB funding capacity,
- Extend the tenure of the loans,
- Reduce and/or postpone the interests of the loan for the promoting companies to the end of the first 20 years term as explained below,
- EGEF could also be used to help to finance the Euro-Mediterranean Super grid.

Promoters: They will be specific companies which will initially be incorporated to a local utility appointed by the host country. Once the tender for the relevant plant will be awarded, the winning company will take a controlling share depending on the local legislation while the local utility will retain the remaining share. By the time of the award, the initial owner will be expected to have completed the process in order to build the project (permits, land acquisition, power evacuation etc.). Once the company having won the tender takes control of the vehicle company it will take in charge the EPC award, the PPA signature, the financial closing of the project, the construction, the O&M contractor's hiring and the operational strategy to improve the sales price of the electricity (for STE dispatchable plants).

4.2 Pricing Principles for Electricity in the MSP-STE

STE Dispatchable Plants: The operational strategy will be defined by the plant owner with the end goal to maximise the sales price. The energy produced at any particular hour will be sold locally or to any of the European market depending of pricing. The amount sold to any market will be accounted for the share fixed in the tender conditions and be adjusted on a yearly basis. E-SECURE will pay the owner on the basis of the offered price following a floor-and-ceiling mechanism. For instance, the ceiling price will be the firm price fixed by the promoter in the tender plus 15% and the floor price will be the same fixed price minus 5%, thus creating an incentive for the owner to adapt the production to the system needs, when feasible.

4.3 Financial Scheme of the MSP-STE

The financial term will be determined as per financial market conditions. Concerning STE plants a 40-year financial scheme will help reduce the LEC to 140 €/MWh for plants starting operations in 2012 to less than 100 €/MWh for plants starting operations in 2020 (125 MW plants with 4-hour storage using cooling towers, 2008 prices). An alternative 20-year typical "project finance" financial scheme will lead to an initial sales price around 190€/MWh for the same type of plants. Such a scheme will be chosen if a 40-year one is considered unachievable.
In case a 20 years term is envisaged, a way to profit from the longer technical life of STE is (as part of the tender conditions) to create an option for E-SECURE to extend the initial PPA period of 20 years to another 20-year term, with a reduced price.
With the price offered for the initial 20 years, the promoter is expected to finance the project on a project finance basis, and make a reasonable profit.
During the second 20-year term, E-SECURE can make a large profit, as cost will be down and selling prices will likely be much higher.
Another alternative, leading to a reduced energy cost for the initial 20-year period, would be the launch of bonds to be issued to institutions and private investors. The bonds issuance usually requires the qualification of the asset as "investment grade" and/or the endorsement by a strong institution such as the EIB, the EGEF, the World Bank and/or similar institutions.
The initial sale price of the kwh will depend on the tenure and interest conditions of such bonds.

4.4 Electricity Sales by E-SECURE in the MSP-STE

While there is no completed single European market, E-SECURE will sell the electricity to the host country and the EU national markets, directly or through appointed market agents.
As the scheme progresses, E-SECURE will manage a number of PPAs with different conditions, as power will be produced at different times in different places and with different costs.
Similarly, selling conditions may differ from one country to another, depending on the particular incentives and, when applicable, market conditions. Where there is a specific feed-in tariff in place, the selling price of electricity will be fixed in accordance with this tariff, if not the sales price will be fixed through any mechanism relevant for the specific market. The CO2 rights will be sold to the electricity buyer or to other parties.
E-SECURE may contract specialised companies for the management and optimisation, in close cooperation with the plant's owners, and as far as feasible, of generation, transmission and delivery to the purchasing markets.

E-SECURE will pay for the interconnection rights and other transmission fares when applicable. This point will be the object of further discussion particularly for the first phase of the MSP-STE.

5 Possible Roadmap to Implement the MSP-STE

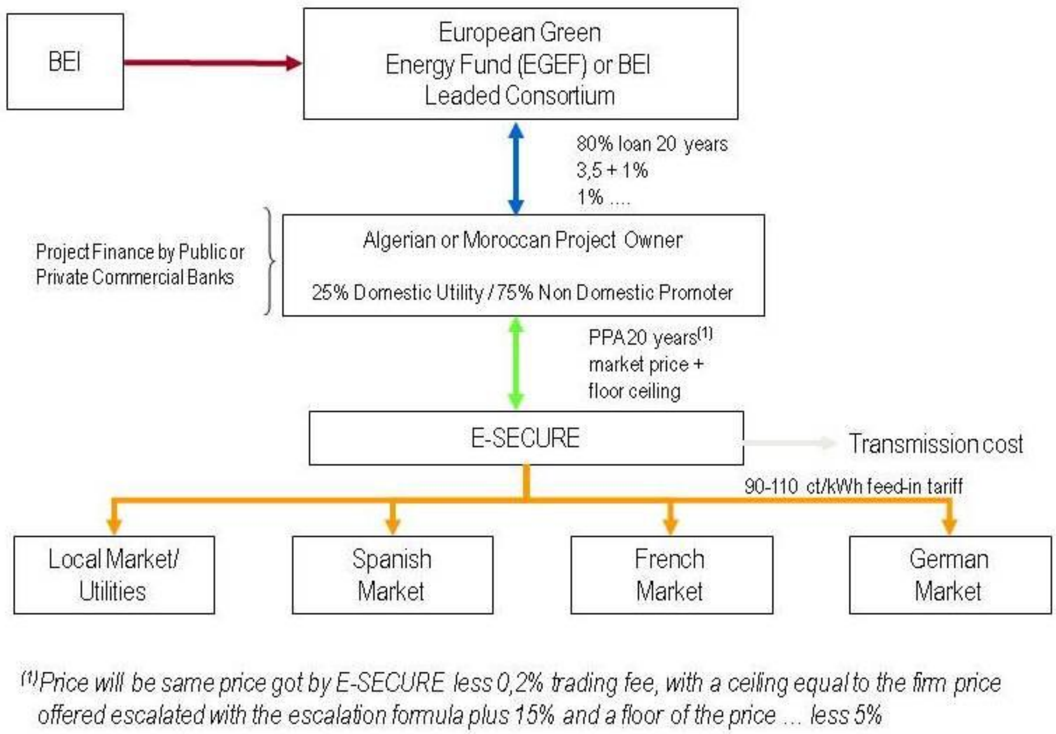
The MSP-STE development must adapt to the evolution of physical and legal infrastructure, and to costs, following the assumptions below:
Physical Connections: Nowadays Gibraltar is the only available connection. Its present capacity is AC 600 MW and is planned to be upgraded to HVDC 2000 MW. Other connections and additional transmission infrastructure within Europe (i.e. Central and Eastern) should be built to accommodate the MSP-STE importation demand, as well as other renewable and non renewable electricity interchanges above the present needs. This will form part of the Euro-Mediterranean Supergrid
Legal Infrastructure: A progressive convergence of the European electricity markets should be logical, leading to a European electricity market. The progressive deployment of the Euro-Mediterraean Electricity Supergrid will accelerate the creation of this market.
Generation costs: The STE generation costs reduction and fossil costs increase will lead to a reduction in feed-in premiums. The price of CO2 rights (or equivalent mechanism) may grow.
As a result, three main phases are envisioned:

5.1 Phase 1 (2008-2012) - Assumptions

Physical connections: Gibraltar is still the only available connection, with its present AC 600 MW capacity. The projected reinforcement of the present connection between Morocco and Algeria is not completed.
France, Germany and Spain (or any other combination of EU countries) may want to buy part of the electricity produced by two new CSP plants: one in Morocco (ONE takes a share of the production) and one in Algeria (Sonelgaz takes a share of the production).
In case each of these plants produce 120 MW (240 in total), the Spanish grid can easily accommodate 180 MW importation from Morocco, through the Gibraltar connection. Technical and legal feasibility and costs are to be further checked.
Even if the Spanish and French grids and Pyrenees connection can accommodate 120 MW transportation to France and the French and German grids and connections can accommodate 60 MW from France to Germany, proving the physical transportation of the electricity to those countries is not required to allow the purchasing country to account for the relevant national renewable target. This provision of the recently approved Directive will allow different approaches for the commercialization of the electricity and the associated renewable credits, including the carbon rights.
Selecting the projects: Both Algeria and Morocco already have projects in the pipeline which could be adapted for this purpose.
Appointing the local partner: Both Algeria and Morocco have national utilities (NEAL, ONE) which can be appointed in order to take care of the permits, land acquisition etc. and to get the local share of the promoting company.
Selecting the promoter: A tender can easily be organised either by the UfM or another entity assisted by a specialised consultant. ESTELA could provide the technical assistance. A committee including the UfM Secretariat, EIB and the appointed authorities of the host country award the tender.
Buying the energy: E-SECURE will buy the energy. The floor-and-ceiling mechanism will apply.
Selling the energy: As an example**,** E-SECURE will sell a share of the energy to the German, France and Spanish systems at the sales price and scheme applicable as per the relevant country feed-in regulation and with a similar

premium over the market prices. During this first phase 240 €/MWh could be enough. The local share will be sold to the local utility (ONE or Sonelgaz/Sonatrach) at a similar price.
Financing the projects: The projects could be financed through a typical project finance scheme.
Financing E-SECURE: E-SECURE will get a credit facility to cover its working capital needs.

Phase 1: Example of Pilot Projects Financing Structure



5.2 Phase 2 (2013-2016) - Assumptions

Physical connections: Around 2013 the existing Gibraltar connection should be upgraded to 2000 MW HVDC adding the corresponding converting stations (expansion and conversion is presently at planning stage). A new submarine connection should be established between Algeria and Italy. Other HVDC lines built inside Spain and Italy will help to transport the new importation to France and other Northern EU countries.
Other conditions: The rest of the conditions will be very similar to those of Phase 1. During this period, , feed-in tariff for STE could be reduced to 180-200 €/MWh plus another 15-20 €/KWh corresponding to CO2 or equivalent rights. The corresponding feed-in premiums can be adjusted to keep a reasonable balance in E-SECURE P&L accounts.

5.3 Phase 3 (2017-2020) - Assumptions

Physical connections: A number of new connections will be built, as well as the corresponding converting connections within the European Super Grid.
Other conditions: E-SECURE will sell to the new European Electricity market, with reduced feed-in tariffs which eventually could only correspond to the equivalent ones for the CO2 rights. If fossil electricity prices evolve as expected, E-SECURE will make profit which can later be used for other UfM projects.

5.4 Rolling out Phase 1

Political aspects: A general concept, such as the one described in this document, should be approved by the EU and the UfM at the adequate level.. A Protocol of Intentions should be signed by the (i.e.) five interested countries to launch the First Phase with the two 125 MW CSP plants in Algeria and Morocco. E-SECURE should be incorporated, with its initial partners being the Renewable Agencies of the initial participants, but open to new National Renewable Agencies or similar bodies for future expansion within the MSP. EIB shall proceed to the required internal approvals to develop the chosen structure. Algeria and Morocco shall appoint the local parties (utilities) to be the local counterpart for the two initial projects, and shall make a final decision on the project selection.
Legal aspects: An in-depth legal study should be conducted to verify all the concerned legislation which should be amended in any of the participating countries (both the EU and the Southern Mediterranean countries) at any of the Phases of the MSP. In particular, the priorities to get access for the imported energy to the existing and new interconnections and the CO2 rights treatment should be carried out (see a full list of suggested legal items to be verified).
Technical: The local counterparties should take care of the land acquisition and permits among others for the new projects as well as of the power evacuation, water needs, etc. A tendering procedure should be developed and approved.

5.5 Immediate Action Plan

It is necessary to collect views and build a consensus among the main political stakeholders (The UfM, the EU Commission, the initial participant countries), to approve a general concept document, a general schedule and a list of items to be further developed, and to approve and sign a Protocol of Intentions for the First Phase.
A “task force” with one representative from each of the main actors should be created in order to further progress until the proper institutions are created: the Union for the Mediterranean Secretariat (an EU public company or an EU agency) and E-SECURE. Lobby should be conducted in all the concerned institutions to accelerate the creation of the HVDC Super Grid.
The following studies should be carried out as soon as possible in order to prepare a fast and easy roll-out of phase one:

- A technical and legal feasibility study of national grids and interconnections regarding the transportation of the 250 MW projected from the producing countries to the acquiring countries
- A study concerning the existing capacity and commitments for the use of the interconnections between Algeria – Morocco, Morocco – Spain.
- Technical, environmental and economical feasibility studies of the two flagship projects in Morocco and Algeria, including site identification.
- A basic design of the 125MW pilot plants for the specific site specification (to be defined).
- A detailed development of the financial scheme (objectives, structure, stakeholders, budget, implementation plan, guarantees, time horizon, etc.).
- A study concerning the preparation and implementation of a tendering system, including the preparation of the tender documents.
- A study concerning the constitution of E-SECURE, with the initial participation of the participating renewable agencies.

Annex 1
STE: a Commercial Technology with a Huge World Potential

STE has the largest potential and the most suitable characteristics to convert solar radiation into electricity. Solar thermoelectric power plants are fully dispatchable, perfectly meet the demand curve and can additionally provide other fluent renewable conversion technologies (wind, mini-hydro) with the necessary back-up.

How STE Became a Proven Technology: History

In the early 80's parabolic trough solar power plant technology has been largely proven with parallel programs of the International Energy Agency in Almería (Spain) and the Sandia National Laboratories in Albuquerque (U.S.A.).
From 1985 to 1989 nine commercial power plants called SEGS were installed in the Mojave Desert, California (U.S.A.) with a total installed power close to 400 MW. These plants are still in operation with a very positive track record along these 20 years.
During the 90's the lack of effective supporting systems stopped the deployment and further implementation of this technology until new requirements in some states of the U.S.A. and the new feed-in tariff system in Spain provided great business opportunities.
Yet, since 2000, several test loops of real size parabolic trough collectors have been installed in different testing facilities in the U.S.A and Spain by the industry, in order to provide financial institutions with technical evidence in terms of feasibility and performance.
R&TD programs are being carried out in several countries (Germany, Spain, Italy, U.S.A., etc.) in order to improve the performance and reduce the cost of these plants.
The first parabolic trough of this new generation was constructed in Nevada, U.S.A. and its operation began in June 2007. The power is 64 MW and it is generating electricity in a regular operation since then.
Another approach was the implementation of a central receiver in the top of a tower and a surrounding heliostat field with mirrors. It was first tested in the early 80´s in several European countries as well as in Japan and the U.S.A. The first commercial power plant of 10 MW has been operating in Seville (Spain) since mid-2007 with excellent results.
Since the end of 2008, the first European parabolic troughs plant with storage (Andasol 1), is operating successfully in Granada, Spain.
Fresnel type reflective trough collectors and Stirling motors mounted on parabolic dishes are also promising technologies. There are several examples of significantly large installations in Europe and the U.S.A. with proven results.

The Present Situation of STE

The following facts demonstrate the involvement and the amount of financial risk on solar thermoelectric projects which is being assumed at an international level by the private sector.
By June 2009, 25 plants of 50 MW each (parabolic trough collector type) and an additional one of 17 MW (central receiver type with 15h storage) are under construction in Spain. Four of them are expected to be connected to the grid shortly. The total investment for these projects is roughly 5,000 M€.
These projects have been mainly financed through a purely commercial financial scheme, after having passed the corresponding detailed due diligence (technical and economical) processes. Hereby is a non exhaustive list of the participating banks: EIB, Caja Madrid, Banco Sabadell, BNP Paribas, Dexia, ICO, West LB, BBVA, Banco Caixa Geral, and Banesto. Project Finance structures have been achieved in similar contractual terms to those of wind farms.
Two solar plants, conceived to provide additional energy to the steam part of combined cycle plants, are under construction in Algeria and Morocco.

Around 20 more plants are in a fairly advanced stage in Spain and their construction could start in a 12-month period if the Spanish regulation provides the required feed-in tariff. The estimated investment for these plants amounts to more than 5,000 M€.
The total applications requesting connecting points into the grid in Spain amounts to more than 12,300 MW according to recent information from REE. Since May 2007 all the new applicants have deposited a guarantee of 20,000 €/MW along with their request.
The Spanish feed-in tariff system motivated many Spanish companies and gave them the will to participate in solar thermoelectric projects, however, the solar thermal equipment and components industry are built and manufactured by companies settled in many countries, mainly, Germany, Portugal, France, Italy, U.S.A, etc. Some European companies are also operating in Spain, either as promoters or as suppliers of goods and services. Hardware and software suppliers are located all over Europe.
15 companies of the IBEX 35 (the Spanish Stock Market, the main reference Index) are currently participating in solar thermoelectric projects in Europe and abroad, either as promoters or as suppliers of financial services.
The manufacturers of the specific components for the plants (parabolic mirrors and collector tubes) have recently built new factories and are currently increasing their capacities exponentially.
There are a significant number of open tenders and approved projects for utilities and other organizations to build solar thermoelectric plants in countries all around the world (U.S.A., Arab Emirates, China, Australia, etc) with a total power amount of more than 1,000 MW.

Market Perspectives for STE Plants

Electricity generated by STE plants is dispatchable and its dispatchability can be enhanced by new technologies and/or hybrid concepts using other renewable or conventional fuels. They allow the grid to accommodate more non dispatchable renewable sources.
Dual applications might bring important benefits in some specific areas (i.e. electricity and water desalination).
Generation costs remain high and the conversion cycle water needs for cooling has to be reduced. The costs will be brought down by innovation in systems and components, improvement of production technology, increase of the overall efficiency, enlargement of operation hours, bigger power blocks, decrease in the O&M costs, learning curve in construction and economies of scale

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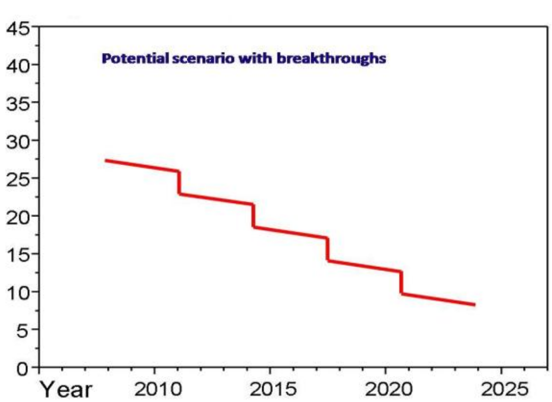
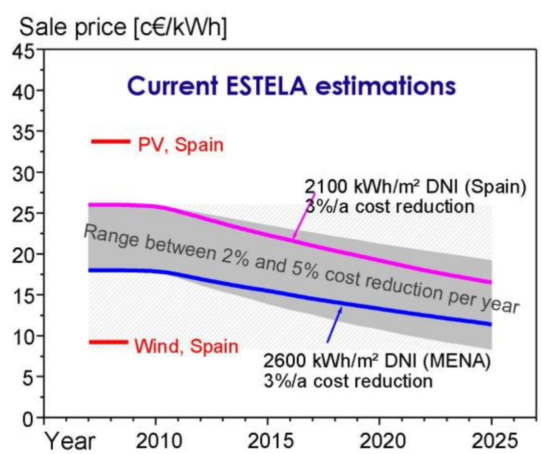




Annex 2
Solar Thermal Electricity: Concentrating Solar Power Technologies

Solar Thermal Electricity, also known as Concentrating Solar Power (CSP) technology, is produced using concentrating solar radiation technologies. It provides clean and reliable power in units ranging from 10 kW to 300 MW. The first commercial solar thermal power plants were built in the 80s and in 2008 around 500 MW were commercially operated in the world.
In Europe around 1,500 MW of solar thermal power plants are either recently operating or under construction. The installed capacity in Europe is expected to be of 2,000 MW by 2012 and an amount of more than 30,000 MW by 2020 could be reached. The technical potential in Europe in the long run can be estimated at least at twenty times that figure within reasonable generation costs.
At different stages of technical development, there are four main STE technologies to produce thermo-electricity from the sun: Parabolic Trough Plants, Central Receiver Plants, Dish Stirling Systems and Linear Fresnel Systems. Each technology will progress thanks to a favorable policy framework and to its capacity to reduce generation costs and satisfy the specific needs of the power market.

Parabolic Trough Plants

Size: 50 to 300 MW
Proven utility scale technology
Commercial operation since 1984
Preferred technology for new plants in the USA, Spain and North Africa (Morocco, Egypt and Abu Dhabi)

These plants use line-concentrating parabolic trough collectors which reflect the solar radiation into an absorber tube. Synthetic oil circulates through the tubes and is heated up to approximately 400°C.
Parabolic trough collectors are the most commonly used thermoelectric technology in the market. Its track record began in the 80's in the USA with a total power installed of about 350 MW. New plants have been constructed in the last years, such as the 65 MW plant of the Spanish company Acciona in Nevada (USA). In June 2009, 25 plants are under construction in Spain which amounts to more than 1,200 MW, and a number of new projects are being developed in the USA. In addition, two plants in Algeria and Morocco of 20 MW electrical equivalent power for two solar bottomed combined cycles have been awarded to Spanish companies as a result of an international tender and a 20 MW plant is under construction in Egypt. A tender for a 100 MW plant is under way in Abu-Dhabi as well as additional expressions of interest from Middle East, China and other sunny countries. The current total investment for the aforementioned projects is close to 7,000 M€. This technology is commercially and technically viable, and plants are being financed by the banks on a regular basis. Nevertheless public promotion and support schemes by means of direct investment, tariff increase (feed-in) or by means of mandatory targets are still necessary. The Spanish case is a good example of an effective legal framework: 27 c€/kWh in feed-in tariff scheme for plants up to 50 MW and the possibility of using 15 % natural gas or in hybridization with 50% biomass to improve the dispatchability. Investment and land use depend strongly on the solar field collector surface and the storage capacity ratio.
Some of the Spanish 50 MW power plants under construction have been designed to produce not only the nominal power during sunny hours but also to store energy, allowing the plant to produce an additional 7.5 hours of nominal

power after sunset, which dramatically improves the integration of solar thermal power plant into the grid. Molten salts are normally used as storage fluid in a hot-and-cold two-tank concept.
The maximum power output of a single plant is theoretically not limited by any physical constraint and power levels of some hundred MW with a unique power group are being designed. The commonly seen 50 MW figure in all of the ongoing Spanish plants is the limit fixed by Spanish legislation and by no means a technical limit.
The expectations on the reduction of the kWh generating costs are based upon the efficiency increase based on higher working fluid temperature, a more efficient use of the generation group by means of the storage, new concepts for the collectors design and/or the contribution of the other primary sources (gas or biomass) and by the size optimization, and also by market evolution, without artificial administrative barriers (such as the 50 MW limit in Spain).
The maximum nominal efficiency of these plants is currently about 16 % and it is limited by the working fluid temperature. R&TD activities are being carried out in order to find more efficient fluids such as direct steam generation or molten salts. These technologies are not commercially available today, but there are many ongoing development initiatives, which are expected to be commercially available shortly. Europe has the world leadership in these technology development initiatives, carried out by R&D institutions and industry, with the support of the EU R&TD Framework Programs.
The cost of the energy produced is directly related to the available solar radiation resource, which has to be taken into account when defining the feed-in tariff scheme.
At the end of 2008 more than 12,000 MW of projects under development were registered in Spain.

Central Receiver Plants

Size: 10 to 50 MW
Demo plants built in the 80's
First commercial 10 MW and 20 MW plants in operation in Spain and another one under construction (17 MW + 15h storage)
Larger projects announced in the USA

This conversion technology, also called tower technology, uses big mirrors (heliostats) larger than 100m^2 which are almost flat and track the sun on two axes. The concentrated radiation beam hits a receiver atop a tower. The working fluid temperature depends on the type of fluid which is used to collect the energy and is within the range of 500 to 600°C.
The PS 10 of Abengoa in Seville is the only power plant of this kind in operation today. The nominal power output is 10 MW and it is designed with a northern heliostat field and saturated steam as working fluid in the receiver. The storage system is only designed to cope with transient situations. On the same site, a second plant of 20 MW nominal power and with a similar design has recently begun operation.
Another 17 MW plant owned by Torresol is under construction. It is located in the province of Seville, with a circular field type equipped with a molten salt receiver and have a storage capacity of 15 hours.
The size of these plants might be limited by the maximum distance of the last row of heliostats from the tower.
At this time, it is premature to already establish reliable cost/power ratios for this technology as the number of operational or ongoing projects is small, but it will not be too different from the parabolic trough plants. The land use is slightly less effective in the case of solar tower plants.
On the other hand this technology does not require a flat land surface like a parabolic trough plant does. A further advantage is the potential increase of the overall conversion efficiency (up to 20%) that can be achieved by raising the working fluid temperature.
The commercial confidence in this technology is growing as more operational plants are being built and consequently it will improve in the near future.
Hybridisation is feasible, but no commercial projects have been built so far.

Dish Stirling Systems

Size: 10KW to 100MW+
Several small scale installations in operation; utility-scale installations slated for construction in 2010
Applications appropriate for both utility-scale projects and stand-alone distributed energy projects

In this case the system consists of a solar concentrator in a dish structure that supports an array of curved glass mirrors. The parabolic dish tracks the sun throughout the day and concentrates the radiation onto the heat absorption unit of a Stirling engine. The focused solar thermal energy is then converted to grid-quality electricity. The conversion process involves a closed cycle, high-efficiency solar Stirling engine using an internal working fluid (usually Hydrogen or Helium) that is recycled through the engine. The working fluid is heated and pressurized by the solar receiver, which in turn powers the Stirling engine.

The dish Stirling systems have decades of recorded operating history. For over 20 years, the Stirling Energy System (SES) dish has held the world's efficiency record for converting solar energy into grid-quality electricity, and in January 2008, it achieved a new record of 31.25% efficiency rate.

Dish Stirling Systems are flexible in terms of size and scale of deployment. Owing to their modular design, they are capable of both small-scale distributed power output, and suitable for large, utility-scale projects with thousands of dishes arranged in a solar park (two plants in the US totaling over 1.4GW are slated to begin construction in 2010 using the Stirling Energy Systems (SES) technology).

This technology uses no water in the power conversion process (either for steam generation or cooling) and the only water needed is for the washing of the mirrors, a key differentiator from other solar thermal platforms. Dish Stirling technologies are furthermore attractive due to their high efficiency and modular design, which gives the systems several key advantages, including a higher degree of slope tolerance and site flexibility, meaning it does not require flat land, significantly reducing grading costs and environmental impact; high overall availability due to the fact that there is no singular point of failure and scheduled maintenance on the dishes can occur on individual units while the others continue to generate power; and a low-cost of manufacture and deployment as a result of high-throughput automotive style production and assembly.

Although certain Dish Stirling systems have been tested and proven for over two decades with no appreciable loss in the key performance criteria, there are currently no utility-scale plants in operation, however recent strategic investments by established renewable energy companies, such as the $100 million investment by Ireland's NTR in Stirling Energy Systems (SES), have signaled renewed interest and potential for accelerated commercial deployment for utility-scale applications. Currently, there is a pilot plant running at the Sandia National Laboratories in New Mexico in association using Stirling Energy Systems, and a 60 dish commercial installation (1.5MW) will be completed in Q4 2009 in Arizona.

Linear Fresnel Systems

Current demo projects up to 6 MW
Larger plants under development (up to 150 MW)

Linear Fresnel collectors are line focusing systems like parabolic troughs with a similar power generation technology and thus the same limitations. These systems are in a developing stage with the first demonstrators recently built and operated. The difference with parabolic troughs is the fixed absorber position above a field of horizontally mounted flat mirror stripes, collectively or individually tracked to the sun.
So far in Europe no fully commercial plants based on the Fresnel principle are being developed. Demonstration plants in the several MW-scales are being built in Europe and the USA to evaluate and prove electricity generation costs, to gain operation experience and eventually commercial confidence.
The EIB is participating in the PE1 project being built in Spain by Novatec BioSol.

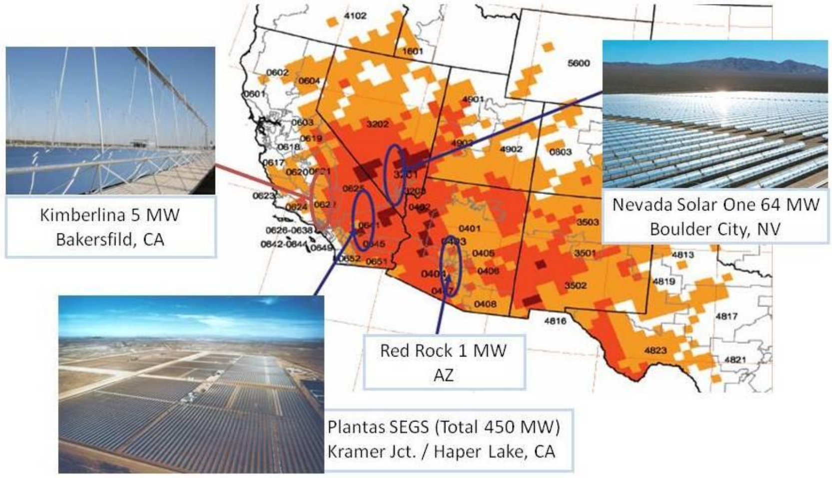
STE Plants in the World

New generation plants, both in operation and under construction, are located mainly in Europe (Spain), in the USA and in the MENA (Middle East and North Africa) countries.

Europe

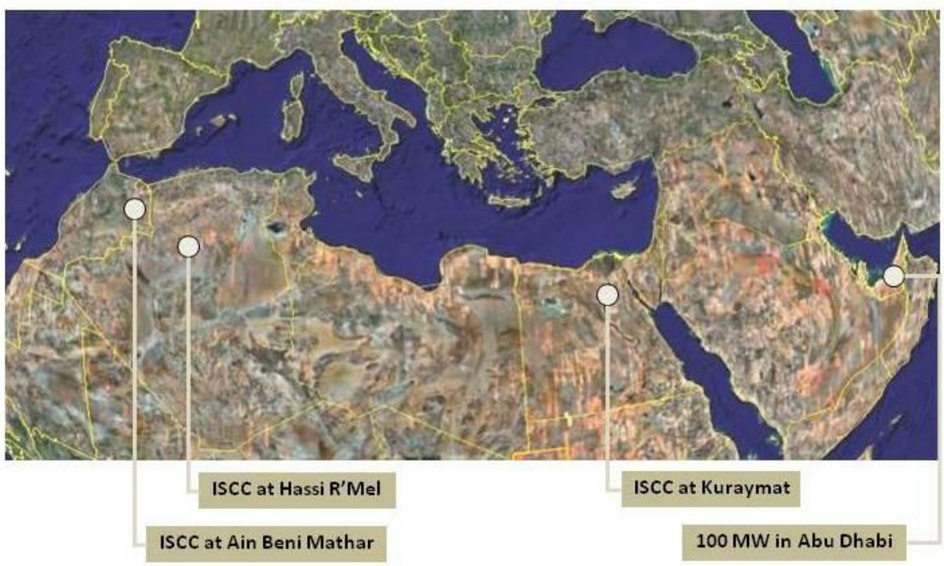
Most of the plants are located in Spain, pilot plants already exist in Italy, France and Germany. In Spain, an area of 3,000 km2 (see the orange square on the map below) devoted to CSP plants (75 GW) could produce 250 TWh/Year, almost the equivalent of the annual electricity of the whole peninsula.

The USA



MENA (Middle East and North Africa)

The Integrated Solar Combined Cycle System (ISCCS) plants in these countries are with small solar share. The plants in Morocco and Egypt are financed by EGEF (European Green Energy Fund), the project in Adu Dhabi is under development.



Annex 3
ESTELA
European Solar Thermal Electricity Association, asbl

ESTELA is the industry European Solar Thermal Electricity Association that was created in 2007 and started operating in Brussels in March 2008.

ESTELA currently has 47 members. One of these members, the national Spanish association PROTERMOSOLAR has more than 60 members itself. Thus, ESTELA represents -directly and indirectly- more than 100 companies, in fact most of the European companies that have activities in the solar thermal electricity sector.

The solar thermal electricity industry is a European-wide industry. ESTELA's members are located in Spain, Germany, Italy, France, Portugal, Greece, the United Kingdom, Ireland, Belgium, the Netherlands and Algeria.
One of the main activities of ESTELA is to closely collaborate with the EU Institutions in order to obtain mutual benefits. ESTELA believes that developing solar thermal electricity technologies will help achieve most of the EU policies and initiatives in the field of energy.

ESTELA's main objectives are in line with some current EU principles.

As stated in its Statutes, ESTELA's objectives are:

- To promote high and mid temperature solar technologies for the production of thermal electricity to move towards sustainable energy systems,
- To promote thermal electricity in Europe at policy and administrative levels (local, regional, national and EU),
- To promote the EU's actions in favor of a European industry development and to contribute to reach the EU's energy objectives and its main renewable energy targets,
- To support research and innovation, including vocational training, and favoring equal opportunities,
- To promote excellence in the planning, design, construction and operating of thermal electricity plants,
- To promote thermal electricity at international level, mainly in the Mediterranean area and developing countries,
- To cooperate at international level to fight against climate change,
- To represent the solar thermal electricity sector at European and worldwide level.

ESTELA believes that all these principles are especially linked to the general EU policies and initiatives: the Lisbon Strategy goals and the 20% renewable energy target for 2020, the implementation of the Mediterranean Solar Plan in the framework of the Union for the Mediterranean and to help secure European leadership in the solar thermal electricity sector worldwide.

Annex 4
Members of ESTELA

Abengoa Solar	*Spain*
Acciona	*Spain*
Alstom Power	*United Kingdom*
Archimede Solar Energy	*Italy*
Areva Renewable	*France*
BASF Española	*Spain*
Cener	*Spain*
Cevital Energie Renouvelable	*Algeria*
CIEMAT - Plataforma Solar de Almería	*Spain*
CNIM	*France*
Cobra	*Spain*
Consorzio Solare XXI	*Italy*
CSP Services	*Germany*
DLR – German Aerospace Center	*Germany*
Endesa	*Spain*
Enea	*Italy*
Enel	*Italy*
Enolcon	*Germany*
Epuron	*Germany*
ESB International	*Ireland*
EUKEP – European Knowledge Economy Platform	*Netherlands*
Evonik - Steag	*Germany*
Extresol	*Spain*
Flabeg	*Germany*
Fundación Tekniker	*Spain*
Iberdrola Renovables	*Spain*
INASMET-Tecnalia	*Spain*
Kraftanlagen München	*Germany*
Mainstream Renewable Power	*Ireland*
MAN Ferrostaal	*Germany*
MAN Solar Millennium	*Germany*
PPC Renewables	*Greece*
Saint-Gobain Solar Glass	*France*
Schott Solar	*Germany*
Sener	*Spain*
Senior Berghöfer	*Germany*
Siemens AG	*Germany*
Siemens Geared Motors	*Germany*
Solar Euromed	*France*
Solar Millennium - Flagsol	*Germany*
Solel	*Spain*
SQM Europe	*Belgium*
Tecneira – Tecnologías Energéticas	*Portugal*
Tessera Solar International	*United Kingdom*
VDI/VDE Innovation + Technik	*Germany*
Veolia Energie	*France*

National Spanish Association:

Protermosolar (≥ 60 Members)	*Spain*

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