EUROPEAN SOLAR THERMAL ELECTRICITY ASSOCIATION

"SOLAR POWER FROM EUROPE'S SUN BELT"

A EUROPEAN SOLAR THERMO-ELECTRIC INDUSTRY INITIATIVE CONTRIBUTING TO THE EUROPEAN COMMISSION "STRATEGIC ENERGY TECHNOLOGY PLAN"

BRUSSELS, JUNE 2009

Contents

1 Solar Thermal Electricity: Achieving the EU Policies and Targets

1.1 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.

1.2 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.

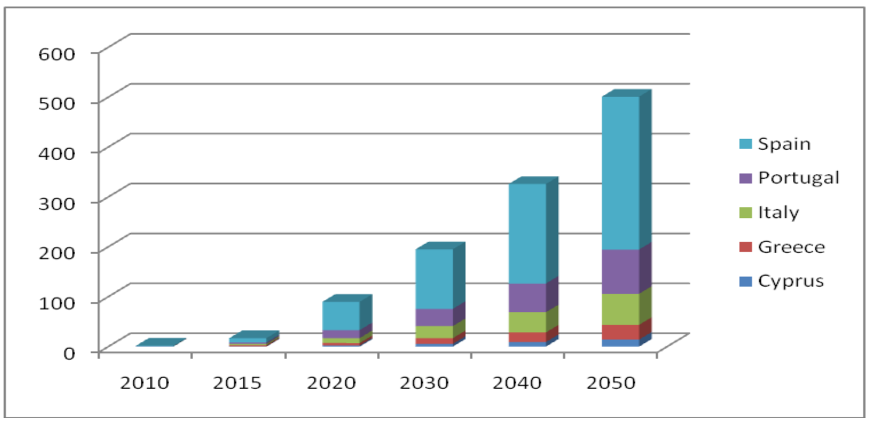
Solar thermoelectric power plants can meet the demand at any time, day and night, and can supply electricity at peak hours if they are anticipated. Furthermore these plants can easily meet the demand curve and contribute to the electrical system's stability through the input of substantial amounts of 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.

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

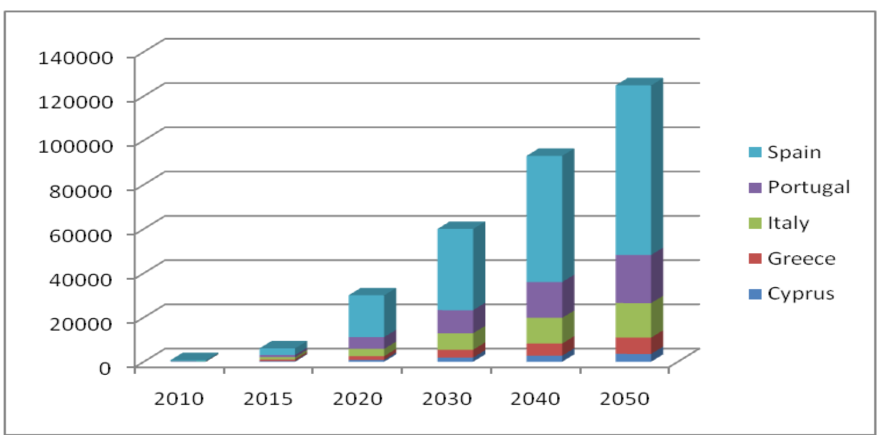
The great dynamism of the Solar Thermal Electricity European industry, its high potential, operational reliability and current production capacity makes solar thermoelectric generation a strategic resource for planning the European electricity scheme for 2020 and beyond. The good dispatchability characteristics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



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



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

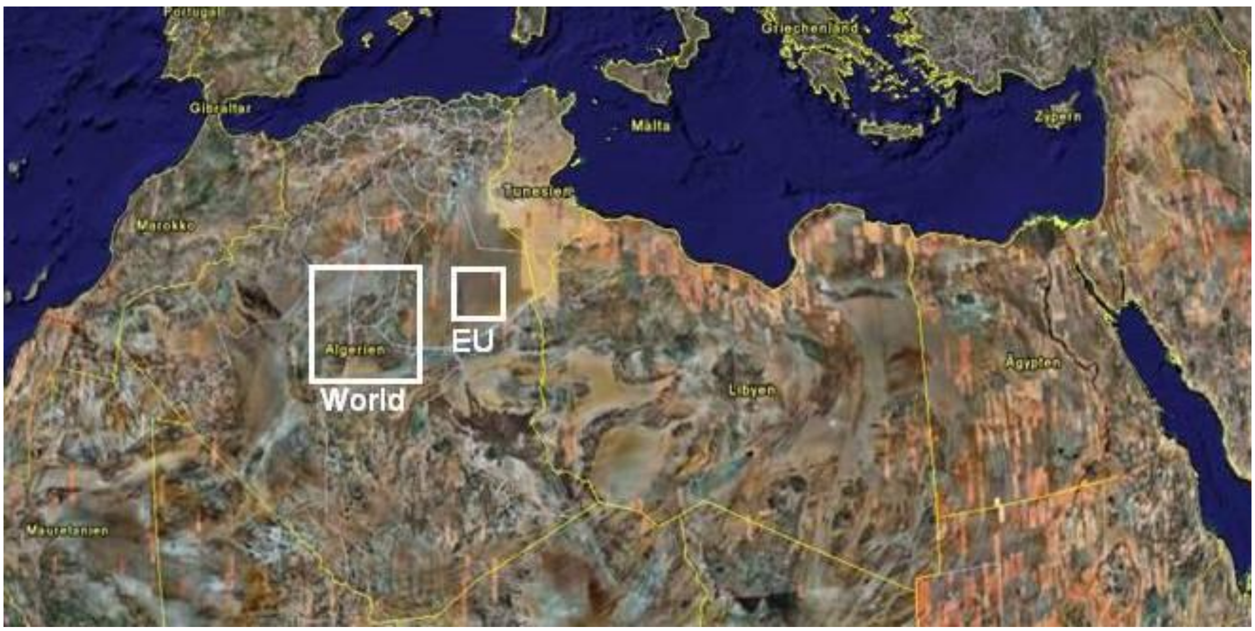
A world-wide long term strategy is needed to build a sustainable low carbon energy system in order to secure the energy supply and to meet the challenges of climate change. For the EU long-term renewable supply regional approaches are of paramount importance (i.e. Baltic Region, East and Central Europe, 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 (2010-202) 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).

1.5 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 MSP (Mediterranean Solar Plan).
As a regional initiative, a MSP, based on STE plants, could contribute to improve the security of the energy supply in the EU countries, as well as to meet the increasing domestic demand from renewable energy sources and to boost economic development in the UfM non-EU countries. This Plan should 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 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 solar power technologies that will allow a faster evolution to reduce costs and improve dispatchability and water consumption, thus leading to a fully competitive kWh cost for plants built by 2021 and beyond. These plants, built with components and engineering mainly produced in Southern Mediterranean countries, will produce electricity at a competitive price to be sold in Europe or locally, depending on price and demand in a fully interconnected environment.

1.6 Cost Estimations of the MSP-STE

ESTELA has elaborated a reasonable implementation plan for the STE initiative in the Northern African 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 Supergrid.

The main goal is to reach by 2020 an amount of 20,000 MW installed power in the desert areas of the NA countries.

The total cost for the STE initiative in NA countries can be estimated at 97.3 billion € (which represents an investment of 81.3 billion € for the plants and of 16 billion € for the transmission lines).

Taking into account the most likely scenario of a continuous increase of the electricity price produced by fossil fuels operated power plants, particularly after the ETS Directive, amended in June 2009, and the Copenhagen agreements, 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 the ones 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 favor the investments by the private industrial sector within the Solar Mediterranean Project.

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 portion of plants.

1.7 Economic and Social Benefits of the MSP-STE

The STE 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. The benefits of developing STE 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.

1.8 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.

1.9 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.
Regarding components manufacturing, 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.

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2 The Research and Demonstration Strategic Agenda for Solar Thermal Electricity

The EU Strategy Energy Technology Plan has been elaborated to align technology development with the main energy policy goals. The European Commission proposes three mechanisms to achieve an effective implementation of the SET plan:

- The European Industrial Initiatives to foster strategic technological alliances.
- The European Energy Research Alliance to strengthen European energy research capacities.
- The Trans-European Energy Networks and Systems of the Future.

The European Commission has clearly defined the basic principles to be developed by the European Industrial Initiatives:

- To boost the research and innovation,
- To accelerate the deployment of technology,
- To deliver progress beyond business-as-usual,
- To define and reach clear targets,
- To contribute to the political goals.

Among the six European Industrial Initiatives currently proposed, one is focused on solar energy. The Solar European Industrial Initiative embraces both the Concentrated Solar Power (CSP) and the Photovoltaic energy (PV) sector. The European Commission expected the European Industrial Initiatives to be built upon the European Technology Platforms (ETPs) works at least in the preparation steps. While for some Renewable sectors as Wind and Photovoltaic, the corresponding ETPs were established in the past years, the Solar Thermal Electricity industry as an emerging industry couldn’t rely on such preparatory works. Thus it becomes necessary to build a strategy that compensates the lack of an ETP.

2.1 Main Research and Demonstration Objectives of the Strategic Agenda for Solar Thermal Electricity

The R&D Strategic Agenda for STE technologies up to 2030 should focus on the following objectives:

- Improve competitiveness of STE, targeting on a fully market cost by 2021 and beyond.
- Develop technological concepts until commercial readiness with respect to cost, reliability and performance
- Improve flexibility of power supply by hybrid concepts, thermal storage and advanced operation concepts.
- Develop scalability of technology to compete in the power market and to reach significant contribution, both large scale and distributed.
- Enhance the environmental profile of the technology (land and water use).
- Wide range of application and develop polygeneration concepts and hybrid combinations with other renewables.
- Coordinate R&D activities with strategic cross-cutting elements like transition strategies for Trans-European grids, hydrogen production, solar resource assessment

2.2 Main Medium- and Long-Term Research and Demonstration Topics

	Research & Development	**Demonstration**
Research and demonstration on improved component reliability and performance	- High temperature joints - Absorber tube - New reflector solutions - Pumps, seals, valves - Power block - Instrumentation	
Storage	- Evolution of molten salt storage technology with respect to cost, reliability performance, flexibility and safety - Develop alternative storage concepts for other molten salts and heat transfer fluids (steam, gas) by material research, heat transfer, process design and operating modes - Phase Change Material (PCM)	- Molten salt: 100 MWh demonstration included in existing plant - Alternative storage: several 100 kWh prototype systems - Several scale-up steps from 1 to 100 MWh storage systems integrated in existing plant
Direct Steam Generation and Molten Salts in Parabolic Troughs	- Development of key components (absorber tube, steam separator, joints) - Integration with storage solutions	- 10 MW demonstration with storage
Innovative Collector Concepts	- Linear Fresnel component optimization	- 10-20 MW demonstration plant
Central Receiver Technology	- Receiver development for different fluids (superheated steam, salt, gas) - Gas turbine combustor chamber for solar hybrid application - Advanced heliostat development	- Several 10 MW demonstration units
Alternative Heat Transfer Media	- Identification, development and assessment of alternative fluids with low environmental impact, low cost, wide operation range	- Collector reference loop demonstration under real operation conditions
Small Scale System	- Automation of operation and maintenance with the objective of unattended operation - Hybrid operation options - Integration of polygeneration concepts (thermal desalination, absorption cooling	- Several 1-5 MW demonstration unit
Hybrid Systems: Combining CSP with other renewable	- Process design and optimization - Optimization of components - Identification of European potentials	- Several 10-20 MW demonstration units

3 The Solar Thermal Electricity European Industrial Initiative (STEII)

The SET-Plan gives the Solar Thermal Electricity Industry an enormous opportunity to develop Solar Thermal Electricity (STE) in Europe. That is why ESTELA is determined to carry out the Solar Industrial Initiative in the field of STE, in order for it to become an outstanding European renewable energy industry.

3.1 STEII Objectives

The proposed STEII has been developed for the purpose of achieving two main goals for the EU:

- **To contribute to achieve the EU 2020 targets** and beyond by implementing large-scale demonstration projects carried out by the industry aimed at increasing the competiveness of the solar thermal electricity sector.
- **To enhance market penetration and to consolidate the European industry global leadership** throughout medium-term research activities aimed at reducing generation and operation costs in solar thermal electricity generation plants.

In order to reach those goals the STEII is structured in 5 main objectives:

1. **Increase Efficiency:** to make STE industry fully competitive by 2020
2. **Reduce Cost:** the competitiveness of STE could be improved by developing technological concepts which would bring costs down
3. **Increase Dispatchability:** the flexibility of power supply would be improved trough hybrid concepts and thermal storage
4. **Reduce Environmental Impact:** R&D would also enhance the environmental profile of the technology, namely regarding the use of land and water
5. **Educational and Training Programs**

3.2 STEII: Implementation Plan

STEII-1 – Increase Efficiency

Objectives:

- Increase the overall efficiency of the plants - Improve the components efficiency - More efficient cycles - Create new design concepts by developing a new generation of parabolic trough collectors

Actions:

Innovative actions aim to develop and test new technological improvements and components with higher efficiency and implement new concepts (i.e. build bigger power blocks, decrease the heat losses, reduce of optical losses and develop more efficient plant configuration and cycles).
Concerning the parabolic troughs technology, increase efficiency may also be possible with the development and use of a new generation of collectors and new technological features, such as improvements in the collectors' assembly methodology.
Regarding tower technology, innovation could address improvements in the control of the power plant and in the control of heliostats.
For instance:

- **Molten salts in tubes (linear technology) and/or receiver (tower technologies).**
- **Pressurized Air Central Receivers for a solar powered combined cycle High Temperature Pressurized Air: with pressurized air receivers, concentrated solar power can be supplied to the gas turbine part of combined cycles and be converted to electricity by highest possible cycle efficiencies close to 60%. (No water cooling needed).**
- **Direct Steam Generation for line concentrating solar collectors: the first major innovation is to increase the direct solar steam temperature to 500°C from today´s 400°C. With 500°C direct solar steam line concentrating collectors, concentrated solar power can be converted in steam cycles at efficiencies up to 42% and dry cooling could be applied efficiently.**
- **High Temperature Steam Generation in Solar Central Receiver Plants: to develop a superheating section to generate steam above 100bar pressure and 540°C. Concentrated solar power can be converted in steam cycles at efficiencies up to 45%.**

Key Performance Indicators	
• **KPI11:** Increase Efficiencies	
• **KPI12**: Increase Heat Collecting Fluid Steam Temperature	
Milestones (compared with the state of the art in commercial plants 2009)	
• **M11:** Increase the overall efficiency up to 30% while today this concept is lower than 20%:	
• **M12:** Increase the direct heat collecting fluid temperature from today´s 400°C up to 550°C	
Budget	
• Investment costs	2,150 M€
• Innovation investment (1/3 average)	720 M€
• Installed capacity	500 MW

STEII-2 – Reduce Costs

Objectives:

- Reduce investment costs - Reduce Operation and Maintenance Cost - Optimize the information and communication technologies - Better use of the installations (better use of land, bigger plants) - Make terms of credit more adequate (lower interest rates, less technical risks)

Actions:

Innovation in Parabolic troughs, Fresnel and Dish Stirling technologies aim to improve new and cheaper components with increased efficiency (i.e. high temperature joints, absorber tubes, new reflector solutions, pumps, seals, valves, power block and instrumentation).
Technological improvements point to the identification, development and assessment of alternative fluids with low cost and wide operation range in order to reduce investment costs.
Implementation of economies of scale, bigger competiveness and manufacturing and construction experience curve would bring costs down.
New technological approaches could be tested to reduce maintenance (cleaning of mirrors, tubes) and operation costs, it would be implemented using optimization of O&M, operation strategy to better accommodate to the grid needs and new simulation models to better predict the system needs to help refining operational strategies.
Innovative approaches would optimize the information and communications technologies for the control and maintenance of parabolic trough power plants and their connectivity to the operations center (including software development).
For instance:

- **Parabolic Trough Power Plants - Improvements on the components (performance and cost reduction): new collector designs, new working fluids and new storage concept might provide substantial investment reduction and/or performance increase to be able to reduce the cost of electricity around 10% in a first step.**

Key Performance Indicators • **KPI21**: Life-time levelized Electricity cost €/MWh • **KPI22**: CO2g/KWh avoided emissions • **KPI23:** O&M cost per MWh produced electricity (€/MWh) • **KPI24:** The numbers of “down-time” hours per year (plant reliability)
Milestones: (compared with the state of the art in commercial plants 2009) • **M21:** Reduction of today´s costs X €/KWh to Y €/KWh • **M22:** % of CO2g/KWh avoided emissions • **M23:** Reduction of KPI23 by 25% for a given plant size • **M24:** Reduction of KPI24 by 20%
Budget: • Investment cost: 2,250 M€ • Innovation investment: 750 M€ • Installed capacity: 370 MW

STEII-3 - Increase Dispatchability

Objectives:

- Improve the thermal energy storage systems (such as filler materials, transfer fluids, changing of phase systems, ultra capacitors) - Hybridization: Develop hybrid plants with other renewables, and use a combination of linear and power systems - Increase the hours of production

Actions:

New concepts and materials for heat storage could be tested in large-scale demonstration plants. In addition, the combination with other renewable sources could be demonstrated, mostly with different forms of biomass, as well as with natural gas, in order to increase the overall system efficiency of the plant. Hybridization could be tested with all four STE technologies.
Parabolic troughs technology could include the development of alternative storage concepts with other molten salts and heat transfer fluid (steam, gas) by material research, heat transfer, process design and operating modes. Linear technologies may store energy thanks to ultra capacitors.
For instance:

- **Hybrid Combined Cycle power plant with biomass and parabolic trough and/or central tower solar field: the gas turbine of the CC will be fed with the biomass allowing high temperature Brayton cycle. The exhaust gases will be used for a steam cycle repowered by the parabolic trough solar field or its enthalpy stored using the plants storage system. Overall efficiency might easily be over 30% while in pure solar plants this figure is lower than 20%.**
- **Cost effective and dual fuelled Stirling Parabolic Dish: the main challenges are to reduce the overall cost and to get dispatchable power using a hybrid Stirling engine. Significant level of innovation is required to make Dish technology well suited to storage and hybridization.**

Key Performance Indicators • **KPI31:** Investment cost of storage, €/MWht of stored energy • **KPI32**: Efficiency of the storage, %, as well as time dependency • **KPI33:** Size of storage, m3/MWht • **KPI34**: the number of equivalent operating hours, based on maximum storage capacity • **KPI35:** the cost of the produced energy as compared with a similar plant without storage
Milestones (compared with the state of the art in commercial plants 2009) • **M31:** the decrease of cost of storage by 20% • **M32:** the increase of storage efficiency by 10% • **M33:** the decrease of size by 20% • **M34:** 50% increase in operating hours • **M35:** 20% decrease of cost of produced electricity due to hybridization
Budget: • Investment costs: 1,700 M€ • Innovation investment (1/3 average): 570 M€ • Installed capacity: 330 MW

STEII-4 – Improve Environmental Profile

Objectives:

- Develop new cooling systems with lower water needs (steam cycles) - Develop dry cooling systems - Better use of land and materials - Desalination and purification of water

Actions:

Innovative actions (parabolic trough technology) could test new approaches to reduce water consumption (innovative use of Organic Rankine Cycle (ORC) coupled with a conventional steam cycle, development of an advanced water saving system).
Dry cooling systems could be applied to projects using the tower technology, the Fresnel technology and the Dish Stirling technology.
Other innovative actions aim at the identification, development and assessment of alternative fluids with low environmental impact as well as the integration of others low-polluting materials. New plant design may be developed in order to better use of land.
One of the main actions in order to improve the environmental profile could be done by searching how to use the residual heat in order to produce other valuable products (i.e. desalinated water, heat process, etc.), thus simultaneously reducing the cooling water needs (where suitable).

Key Performance Indicators

- **KPI41:** the amount of cooling water needed per MWh produced electricity
- **KPI42:** the cost of water saving system (€/m3 saved) per MWh
- **KPI43:** For dry cooling, the loss of total efficiency of the plant (as compared with normal water cooling)

Milestones: (compared with the state of the art in commercial plants 2009)

- **M41:** reduction of cooling water needs, KPI42, by 80%
- **M42:** 20% reduction of the cost of the water saving system per MWh
- **M43:** less the 2% loss of efficiency

Budget:

Investment costs:	800 M€
Innovation investment:	270 M€
Installed capacity:	200 MW

STEII-5 – Educational and training programs

Objectives:

- Raise awareness of solar thermal electricity technologies in engineering (mechanics, energy thermodynamics), in sciences (physics and other fields), as well as in information technologies (management of solar fields, etc).
- Cooperation with South Mediterranean countries Universities, and Engineering Schools participating in the Educational/Universities programme, that as the Mediterranean Solar Plan, have been established in the framework of the Union of the Mediterranean.

Actions:

- **Erasmus grants – Dissemination of information about Universities that have Solar Thermal Electricity Technologies in their programs (PhD and Master level)**
- **Marie-Curie grants – Specific grants for STE**
- **Practice internship in operating STE Plants**

Budget: It is partially included in the EU programs (Erasmus, Marie Curie, Leonardo World, etc).

- Training programs (4 per year over 5 years, 2M€ each) 40 M€

The STE sector is widely rich, with four different technologies to generate solar power in various geographical contexts and for various demand constraints. Some technologies are better suited for massive centralized power generation, others for decentralized applications, the possibilities are vast to better adequate to each necessity. Long-term trends are not easily predictable as new generations of power plants are recent and long-term research will have to rely on the results of these second generation plants (the first generation being the plants built in the 80's).

3.3 STEII: Funding and Financial Support

To successfully implement the STEII, i.e. in the framework of the EC/Industry Implementing Agreement, it is essential to get full endorsement from the EU and MS in terms of eligibility to grants and/or other support mechanisms for the European Solar Thermal Electricity Industry Initiative.
The EU financial support granted to each project should be equal to 50% of the capital cost of eligible items (the innovative systems or components which are being demonstrated). The eligible items should at the minimum be the components procurement and the installation costs.
The projects might also benefit from additional local incentives and support schemes. Grants, loans without recourse to shareholders and guarantees to obtain private banks loans are also envisioned as part of the support mechanisms.
One of the greatest barriers for the deployment of innovative technologies, already proven at the small-scale (laboratory or pilot plant), is the difficulty to set up commercial projects (30-50 MWe) due to the lack of bankability criteria caused by inherent risks related to innovations.
This aspect is particularly obvious now, when the financial resources are limited due to the economical crisis and the financial institutions are increasing the warranty requirements for their investments.
Whilst the normal FP7 R&D and demonstration programs are quite efficient in the development of new components, concepts and technology approaches, they are not the appropriate accelerating tool to bridge the gap between the demo size (up to few MWe) and the real commercial size (greater than 20 MWe in some technologies and more than 50 MWe in others).
A complementary/additional funding mechanism, which could effectively help in the achievement of the objectives of the SET PLAN and in the short-term contribution of the European political goals, could be a sort of warranty mechanism (i.e. risk sharing facilities) to be issued by the European Investment Bank to the funding institutes which will finance large innovative STE plants.
This action aimed to partially cover the financial risks could be very effective and could rapidly support the diffusion of innovation and to deliver progress beyond business-as-usual scenario.

In addition the real total financial exposure would be relatively small because we can expect just few of the proposed projects will fail and hence the intervention of the EIB will only be required for those projects.
A similar approach has been adopted in the USA by the US Department of Energy (Loan Guarantee Program of October 29th, 2008), in which 80% of the project's CAPEX is guaranteed by the US Government against technological risks.

Objectives of the STEII	**MW**	**Investment Cost (M€)**	**Support to Innovation Investment: 1/3 average**
STEII-1 - Increase Efficiency	500	2,150	720
STEII-2 – Reduce Investment Costs	370	2,250	750
STEII-3 - Increase Dispatchability	330	1,700	570
STEII-4 – Improve Environmental Profile	200	800	270
STEII-5 – Educational and Training		40	
Total	**1,400**	**6,940**	**2310**

3.4 STEII: The Projects

The initial step of the Solar Thermal Electricity Industrial Initiative on Solar Thermal Electricity will be the implementation of projects focused on commercial and technical demonstration, large-scale projects concerning parabolic troughs and central receiver plants in order to reduce costs beyond the business-as-usual scenario. Concerning the reliability and feasibility of other STE technologies, like Dish-Stirling or Fresnel medium-size scale projects are also proposed.
Results will be widely shared, intellectual property (IP) will be respected, in order to place the STEII as an active catalyst for further international competitiveness and implementation of these technologies.
Specific financial support instruments for large-scale innovative and demonstration STE projects should be mobilised, involving the EIB and other EU institutions, in order to produce or share the required guarantees for the usual "project financing" schemes.

3.5 STEII: Monitoring

The relevant parameters to be monitored will be both technical and economic, according to the main objectives detailed in Chapter 3.1 and to the selection criteria detailed in Chapter 5.2 and to the specific monitoring parameters of projects.
However, as far as one of the main objectives of commercial demonstration is to reduce generation costs, the economic parameters are of paramount importance. Expertise in new plants built in Europe will provide with the initial parameters for monitoring.
The Strategic Energy Technology Information System (SETIS) that is being elaborated by the Joint Research Center (JRC) will be the instrument for sharing monitoring schemes.

4 STEII: EC/Industry Implementing Agreement as an example of Public/Private Partnership

In order to implement the STEII the European Commission proposed for those technologies with a sufficient industrial base across Europe a kind of "public-private partnership", while for other technologies which are prioritised by a few countries, a kind of "joint programming" by coalitions of those Member States could be suitable.
For the purposes of this document ESTELA takes the option of an Implementing Agreement between the EU Commission and ESTELA could be signed detailing all the procedures and managerial aspects of the STEII.

It should be highlighted that STE Technologies, Industry and Markets evolve steadily and that future trends have to be predicted according to real progress on current and new markets. It is why there is a need to build the right structure to implement and manage the STEII and the Public/Private Partnership.

4.1 STEII Partnership: The role of Member States

The Member States direct support to demonstration and innovation in the sector of STE is crucial for an EU-wide development of these technologies in order to maintain the leading position of the European Solar Thermal Industry.
In fact, more than in other sectors, the EU-wide dimension is evident in research and demonstration. Geographical constraints are only for the plants location and don't apply for developing and manufacturing components and equipment, measuring instruments, electronics, etc.
In the medium-term solar power can generate electricity for the whole EU, produced in the South and conveyed through a Euro-Mediterranean Supergrid.
The 'joint programming' to build coalitions as proposed in the SET-Plan by the European Commission should be implemented from the very beginning in order to allow companies from the largest number of MS to participate in the Solar European Industrial Initiative. Examples exist that can be further developed.
However, the main role of MS should be the adoption of a legal and stable framework promoting the production of electricity from renewable energy sources and more precisely by STE plants – i.e. introducing feed-in tariffs support schemes – which will encourage the construction of STE plants in Europe and in Southern Mediterranean countries, thus contributing to meet their targets of Renewable Electricity with a share of dispatchable green electricity.

4.2 STEII Partnership: Promoters and Stakeholders

The promoters and other stakeholders involved in the STEII include among others:

- The STE and their Associations, the European Solar Thermal Association (ESTELA), the Spanish Solar Thermal Electricity Association (Protermosolar), together representing 90% of the European industry.
- Research Institutes, most of them already being Associate Members of ESTELA.
- The Academic Community, including its networks.
- Public Authorities, including Energy Agencies.
- Other Energy, Electricity, Industry and Environmental organisations.

The areas covered by the STEII are the European Union and can be extended to the non-EU countries partners in the Union for the Mediterranean and taking part in The Mediterranean Solar Plan.
The funding of the STEII, as public/private partnerships, will mainly be provided by the Industry, the EC support mechanisms, including the European Investment Bank, the National support schemes, the multilateral Banks and other institutions, regional or local.

4.3 STEII Partnership: Structure

Members of the STEII could be all the promoters and stakeholders that will participate in the works and decisions.
The structure of the STEII could be as follows.

The STEII Steering Committee of 9 members:
The STEII Steering Committee will represent the promoters and stakeholders and will ensure a large and open debate on the objectives, outcomes and priorities of the Solar Thermal Electricity Industry needs in the field of innovation.

The STEII Steering Committee will be composed of:

- 5 members of the Solar Thermal Electricity industry (among which the President and Vice-president)
- 4 representatives of public entities (among which representatives of the European Commission, DGs TREN and RTD, the EIB)
- The Secretariat could be taken in charge by the European Solar Thermal Electricity Association, ESTELA.

The STEII Scientific Committee of 9 members:
The STEII Scientific and Technical Committee will give the necessary expertise and ensure the excellence in advising the Steering Committee about priorities, performance indicators and other aspects of the STEII development.

- The STEII Scientific Committee will be composed of:
- 5 representatives of Engineering, Procurement and Construction (EPC) companies, members of European and National Solar Thermal Electricity Associations.
- 4 representatives of R&D Institutions and the Academia
- The Secretariat could be taken in charge by the European Solar Thermal Electricity Association, ESTELA.

The STEII Partnership: Committees Activities
The activities of the STEII will at the minimum consist in:

- Regular STEII Steering Committee meetings
- Regular STEII Scientific Committee meetings
- Workshops
- Annual Conference

5 STEII Partnership: Implementing Projects

In order to start action in the framework of the STEII, a consensus has been reached by the industry on the first large-scale demonstration projects that could be proposed for implementation.

5.1 General Requirements

The projects will be located in the Southern European countries, this area being proposed by the consortia on the basis of its specific advantages. Some of the projects might also be located in non-EU countries of the Union for the Mediterranean which are taking part in the Mediterranean Solar Plan.
All the projects must be completed within a reference period of three years after the final investment decision has been taken

5.2 Eligibility Criteria

Demonstration Projects should be large-scale, economically viable with a large innovative demonstration component. However, technological risks linked to innovative systems or components, or the innovative way of combining existing technologies, should obviously be taken into account.
Demonstration Projects should present major technological improvements leading to cover at least one of the objectives of the STEII (Solar Thermal Electricity Industrial Initiative).

Projects presented should have a clear definition of:

- Location, land availability and adequacy (topology, environmental constraints, power evacuation, acceptance by local authorities, etc.).
- Technical concept describing the innovation which will be included.
- Tentative timeframe for their development.
- Total capital expenditure (CAPEX) expected and gross breakdown.
- Type of finance envisaged for the project, including a Preliminary Business Plan, and description of the type and amounts of support expected, as well as their justification in the light of the business plan and financing scheme.
- Identification of the promoters, builders and main technological partners of the project, showing their joint technical and financial capacity to successfully carry out the project.

5.3 Evaluation Parameters

Parameters to be taken into account for the evaluation:

- Innovation
  - Project's outcomes in conformity with the SET-Plan STEII objectives, priorities and performance indicators.
  - How much the innovation contributes to any of the objectives: Share of performance improvements, share of water savings?
  - Risk taking and risk allocation
  - Brief description of the technical innovation involved, compared with "state of the art".
  - Why and to which extent the innovation means a risk for the project's feasibility/profitability. Worst case scenario and actions to be taken in that case.
  - What is the risk of the project, and how the promoter proposes to share the risk with the European Commission?
  - Kind and amount of support required to implement the project.
  - General schedule of the project after confirmation of the support requested.
  - Relevance between the innovative value and the amounts requested.
- Implementation of specific training programs for design, construction, operation and maintenance stages, including local training programs meant to develop cooperation according to the local requirements in the Mediterranean Partner Countries.

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.

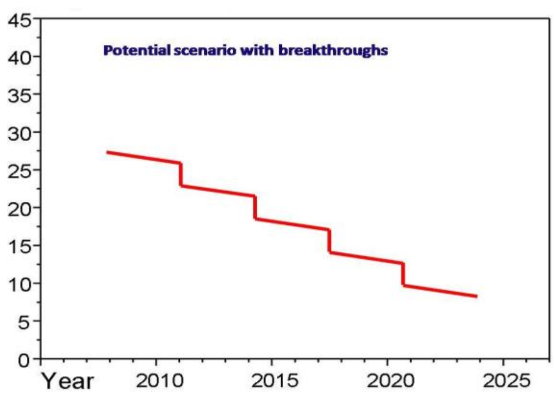
The Present Situation of STE

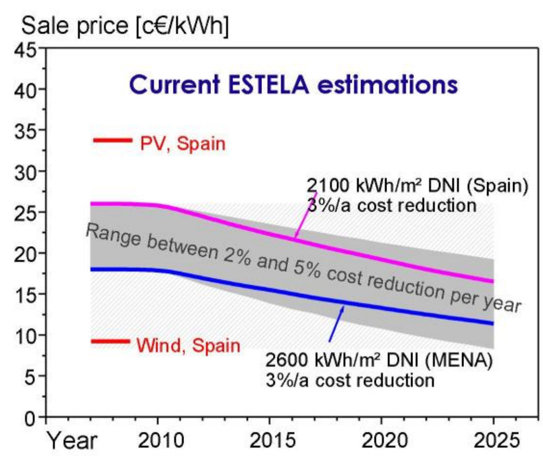
The following facts demonstrate the involvement and the amount of financial risk on solar thermoelectric projects which is being assumed at an international level by the private sector.
By June 2009, 25 plants of 50 MW each (parabolic trough collector type) and an additional one of 17 MW (central receiver 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





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 100m² 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.

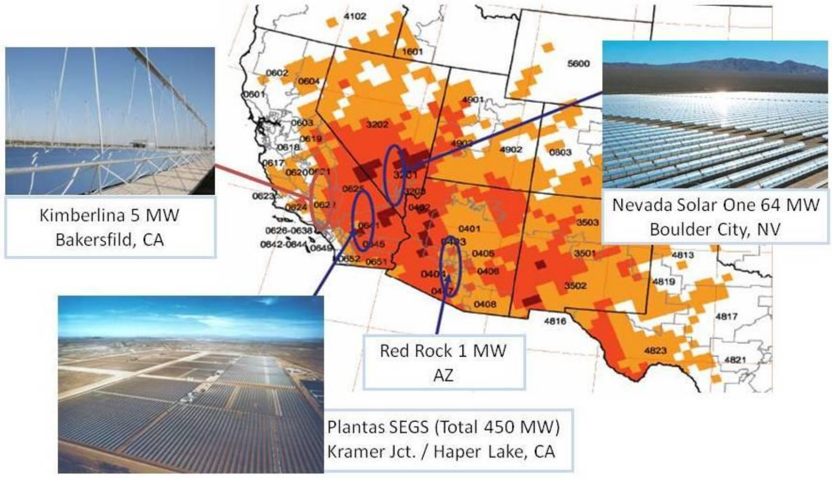
STE Plants in the World

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

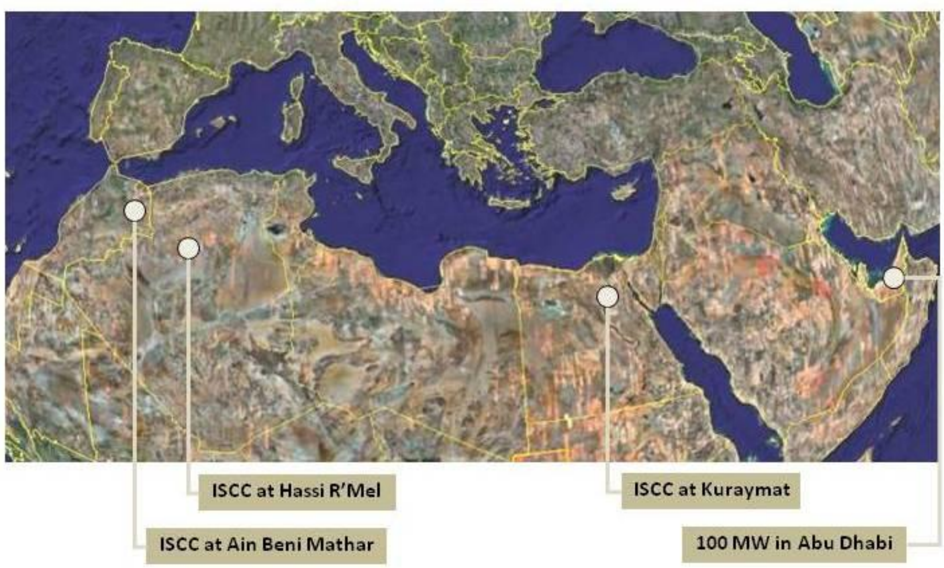
Most of the plants are located in Spain, pilot plants already exist in Italy, France and Germany. In Spain, an area of 3,000 km2 (see the orange square on the map below) devoted to CSP plants (75 GW) could produce 250 TWh/Year, almost the equivalent of the annual electricity of the whole peninsula.

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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