SMB/6202/SBP

STRATEGIC BUSINESS PLAN (SBP)

IEC/TC or SC:	Secretariat:	Date:
117	**SPAIN**	**2017-06-29**

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A. State title and scope of TC

TC 117- Solar Thermal Electric Plants

Scope: To prepare international standards for systems of Solar Thermal Electric (STE) plants for the conversion of solar thermal energy into electrical energy and for all the elements (including all sub-systems and components) in the entire STE energy system.

The standards would cover all of the current different types of systems in the STE field, as follows:

- Parabolic trough
- Solar tower
- Linear Fresnel
- Dish
- Thermal storage

The standards would define terminology, design and installation requirements, performance measurement techniques and test methods, safety requirements, "power quality" issues for each of the above systems.

The standards would also address issues of connectivity and interoperability with the power grid related to connections, bi-directional communicates and centralized control (Smart Grid) and environmental aspects.

B. Management Structure of the TC

TC 117 is currently structured into Projects Teams according to the approved NWIP and taking into account the different types of technology in the STE field:

- General topics
- Thermal energy storage systems
- Parabolic trough systems
- Central receivers systems
- Linear Fresnel systems
- Parabolic dish systems

C. Business Environment

With the global increasing demand for energy, along with the growing commitment of many countries to sustainability, Energy is becoming one of the most world's precious resources. Energy in general, and especially renewable energies, have already been identified as strategic issues and stand at the top of the agenda of the world's leaders.

- At the moment, solar energy is the largest energy resource available to us; one hour's worth of sun radiation exceeds what all 6,8 billion people on earth consume in a year.

- The Union for the Mediterranean (UfM) together with the industry representatives have developed the Mediterranean Solar Plan. 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
  - The objective in terms of installed capacity is to reach more than 150 GW in 2030 between plants in the South of Europe and the North of Africa.

- The Desertec idea, carried by several initiatives in the last years, is based on a study for MENA proposing up to 470 GWatts of electricity by 2050, according to research done by the German Aerospace Centre. The project entails installing a massive solar thermal array in the North African desert to provide most of the growing additional energy needs for North Africa, the Middle East and Europe combined. Although the idea has received some criticism and has to be modified due to the commercial success of PV the basic idea of transnational grids interchange of renewable electricity is still valid.

- At today's level of global energy consumption — 18 000 terawatt-hours per year — we would need to cover just 3/1000th (0,003) of Earth's desert regions, about 90 000 square kilometers, to meet the demand.

Renewable energies are expected to play an increasing role in the final energy consumption structure (2020 and beyond) in Europe, US, South America, Africa ,Middle East , India and China, Australia and additional locations worldwide.

Renewable energies are the only sustainable alternative to the increasing energy demand providing security of supply, avoiding CO_2 emissions and preventing the uncontrolled impact of the fossil fuel price increases on the economies of the different countries. Within the whole range of Renewable Energies, Solar technologies show the largest potential. Within the solar field, Thermo Solar technology would play a leading role.

Moreover, concentrating solar thermal technologies could provide the basis for dispatch-able electricity generation, as well as for other purposes (chemicals, water desalination, industrial steam processes, etc.)

Solar thermal electric plants around the world - either in operation or under advanced construction - have an overall power close to 5.5 GW. Though Spain has a large share of the solar market, there are more than 500 MW under construction over the world and more important, great efforts on R&D are being carried out by many countries all over the world.

Additionally, there are ambitious plans for additional capacity in USA, Middle East and North African countries, as well as in other regions like China, India, South Africa, South America, and Australia.

Technological development is mainly led by the industry, which is highly motivated by cost reduction.

After more than 20 years of successful operations, STE is now in a commercial ramp-up phase with several large scale projects typically above 100 MWe around the world. The growing motivation for this energy source includes increasing demand for Renewable Energy Sources, especially when taking into account the unique added value when comparing STE with other energy sources:

- Predictability and reliability of production
- High-quality electricity supplied to the grid
- Dispatchability due to proven, highly efficient and cost effective storage and potential plant integrated back up firing
- Cost competitiveness compared to other renewable energy sources
- Large scale deployment and energy on demand
- Grid stability due to the inertial features of STE power blocks
- Inherent backing option with no need for additional fossil power plant
- Long-term supply security and independence from oil and gas prices
- High share of local content
- For most of the locations Electricity production and peak demand overlap most of the time during the day

Nevertheless, there are huge scientific challenges to be undertaken by research bodies and by the Industry to contribute to this real need of reducing costs, increasing efficiency and enhancing reliability of solar concentrating technologies and to the real need for standards in this field.

D. **MARKET DEMAND**

The plans for deployment of STE plants are very ambitious in many regions of the world. Different estimations for 2020 and 2030 forecast 23 000 MW in 2015 and 261 GW in 2030.

The current figures are as follows:

- Spain: 2 304 MW connected to the grid. 5,100 MW announced for 2020.
- Other European Countries: National Action Plans with 1,500 MW announced for 2020.
- USA: 1 900 MW connected to the grid.
- Australia: The ISCoalPlant in Kogan Creek (44 MW Fresnel) is near to completion.
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- Morocco: The PPA for the two recently awarded STE plants in Morocco, Noor 2: 200 MW Parabolic trough & Noor 3: 150 MW Tower with molten salts, were $160/MWh, which is a significant cost reduction in comparison with the of the first power plant awarded in the program three years ago, Noor 1 awarded in 2013.
- India: There are three power plants in operation, Godawari, a 50 MW Parabolic Trough power plant and Reliance, a 100 MW using Fresnel technology & Megha, 50 MW Parabolic trough. There has created solar power plants using the approved feed in tariff for 500 MW (First phase of National Solar Mission) and started Phase Two tendering with further plans for 10 000 MW in 2022.
- China has launched several tender procedures for the commercial plant with huge expectations for the coming years. There is a 50 MW parabolic trough under construction in Delingha.
- Latin America: Huge potential although no detailed policy plans have been announced. In Chile STE may be competitive against conventional power generation even without subsidies. A 110 MW STE plant with 17,5 hours of storage, partly hybridized with PV, was recently selected with a PPA of $110/MWh, in competition with all other generation technologies including Gas Combined Cycle.
- South Africa:There is already a 100 MW parabolic trough plant in operation and more than 500 MW under construction. The tariff for the “Expedited round” (3x150 MW) in South Africa are close to 20% less than the ones for Round 3. These plants will be awarded beginning 2016.
  Announcement of the Minister of Energy of a specific 1.500 MW Solar Action in Northern Cape (mainly STE) and expectations regarding enlargement of the current goals for the whole country. .
- Israel: There are two power plants under construction.
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E. Trends in Technology and in the Market

There are currently 4 main technologies in the market:

- Parabolic Trough plants collect the solar energy in parabolic trough concentrators with a linear absorber tube. The heat transfer fluid is normally synthetic oil which circulates through the tubes at inlet outlet/temperatures of 300/400 ºC. Higher outlet temperatures can increase the overall efficiency of the plants but the oil presently used can't reach higher temperatures. That is why other HTF such as water with direct steam generation and molten salts are being considered.

  The typical system size in Spain is 50 MW due to regulatory incentives; nevertheless this is not the optimal size. Depending on the sun irradiation, the optimal size of a parabolic trough plant is around 120 – 250 MW. Lower size leads to higher LCOE (Levelised Cost Of Electricity).

  Typical storage technology in Spain using molten salt is 7-8 hours at nominal power.

- Tower plants reflect the solar energy concentrated by the heliostat field on a central receiver mounted at the top of the tower. There have been several alternative heat transfer fluids which have been successfully tested until now: saturated steam, superheated steam, molten salt and pressurized atmospheric air. The largest storage size which is nowadays in operation is with 17h of storage in a 19 MW plant.. The largest tower in operation with 133 MW nominal power has been started in the US.

- Fresnel plants use linear, modular, flat mirrors to focus the sun rays onto a fixed absorber tube or a bundle of tubes, quite similar to the parabolic trough plants. The concentrated sunlight heats a heat transfer fluid. Different heat transfer fluids are feasible. The heat transfer fluid as of today's state of the art is usually water, generating in the collector directly saturated and – in some plants – superheated solar steam for the use in power generation or in industrial steam applications, but molten salts are being considered.The largest commercial plant which is in operation has a nominal electric power of 100 MW in India but projects can go up to the range of approximately 500 MW.

- Dish- with Stirling engine or gas turbine plants are a suitable solution for decentralized applications. The main advantage is that no water is required for cooling purposes in the conversion cycle. The Stirling version are non dispatch-able plants and the production ceases when clouds pass. Some research with respect to advanced storage and hybridization systems is being conducted. The largest current installation has a total power of 1,5 MW. Several 10 MW- projects have been approved under the current feed-in-tariff system in Spain; nevertheless there is a lot of development in different type of power generation and sizes. Dish with pressurized air volumetric receiver connected to a Brayton Hybrid dispatchable, or solar only Microturbine has been developed. Dish system that transfers the heated pressurized air to a central Heat Exchanger generating high temperature superheated steam is currently under development and demonstrations.

The STE industry is committed to technological improvement initiatives, focused on increasing plant efficiency and reducing deployment and operating costs. Besides the improvement of current technologies, new technologies might therefore be developed in the future to achieve the target of competitiveness for power production. Standardization can play an essential role in achieving this goal.

Despite entering a commercial ramp-up phase, STE technology is still in a development stage, displaying high potential for technical improvements. The industry is already focused on research and development of the next stage of technology improvements, which should have great impact on costs and efficiency of STE plants. These improvements, which can be either technology specific or common to most technologies, are focused on three levels:

- Increasing power generation efficiency, mainly through the rise of the operating temperature leading to higher turbine efficiency, and also through improvements in reflecting facets and receivers.
- Reducing solar field costs by minimizing components costs and through design optimizations that can lead to more cost effective solar fields deployment.
- Reducing internal resources consumption through reduction of needed water and auxiliary parasitic consumption.

The other emerging technologies –Fresnel, DSG (Direct Steam Generation), Stirling, or gas turbines and modular-small-towers - might also have probability for some other specific applications rather than bulk electricity production alone. Fresnel could also find an additional niche market in industrial heat production while Dish-Stirling could be used in decentralized generation systems or in remote areas with scarce water availability, provided its cost per kWh would be lower than the one for PV systems. All systems can play a very important role in water desalination, which becomes a major problem in all developed and undeveloped countries.

IEA has published the Roadmap 2014 for Concentrated Solar Power showing a significant contribution of these technologies to the power supply until 2050, as follows:

- STE would grow from less than 4 GigaWatt (GW) installed capacity today to nearly thousand GWs by 2050
- STE requires excellent direct normal isolation from the Sun, mostly met in the 15° to 35° latitude bands. High-voltage direct-current lines may be used to send solar electricity from locations with excellent resource (e.g. southwestern USA, North Africa, etc.) to large consumption centers (e.g. other areas in the US, Europe, etc.)
- Most STE plants are based on commercial trough technology, but tower and linear Fresnel installations are increasing.
- Thermal storage and back-up from fuels (whether fossil or from biomass) allow STE to provide for firm and dispatch-able electricity. Few-hour storage allows for extending power production to late night peak or shoulder loads. Larger storage permits base load power. The value of dispatchability is seen as a major advantage of STE compared to fluctuating renewables
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- Lowering the costs of STE requires significant research and development efforts with respect to mirrors, heliostats, linear or point focus receivers, and power blocks. Many innovations are expected to be seen in the coming years 2018 until 2025 e.g. molten salt technology in linear systems or supercritical steam turbines in STE plants.
- Solar fuels could be produced in large concentrated solar plants and mixed with more conventional resources in gas networks and liquid fuels. Together with STE, solar fuels would thus increase the solar share in the global energy mix. However, large-scale production of solar fuels still requires several years of research and development efforts

It is important to point out the homogeneous geographic distribution around the world which has been foreseen. STE technologies should not be designed/ planned to meet the needs of industrialized countries alone, but should also take into account the great advantages of developing countries in terms of dispatch-ability and grid stability.

The markets are supposed to accelerate slowly along with the learning curve and cost reduction of these technologies. Expectations for 2020 are 11 GW of CSP plants worldwide. However for 2030 electricity production is estimated to reach 900 TWh (which is equivalent to 260 GW installed), and this figure increases up to 4,200 TWh in 2050 (equivalent to 980 GW installed).

F. System approach aspects (Reference - AC/33/2013)

A close contact and active relationship with the agents of the whole value chain of a STE plant will be maintained in order to respond to their standardization needs.

The customer of the products of this TC can be easily identified. The feedback on the TC publications will be regularly checked.

The work program should be detail defined along with the main milestones and the planned deliverables. The TC Secretary should keep the momentum and the effectiveness of the working groups/project teams.

Liaisons with three TC are confirmed:

- ISO TC 180 Solar Energy
- ISO TC 192 Gas Turbines
- IEA SolarPaces (Liaison A)

Further liaisons with other committees will be also considered:

- IEC/TC 1 Terminology

G. Conformity Assessment

For the moment, no IEC Conformity Assessment System is being considered in the development of the basic standards for TC 117. However, IECRE could be of interest in the future.

H. 3-5 Year Projected Strategic Objectives, Actions, Target Dates

Strategic Objectives 3-5 years	Actions to support the strategic objectives	Target Date(s) to complete the actions
To have a set of normative documents that addresses both general aspects common to all technologies as individuals of each.	Try to stabilize the PT leadership	2019
	Keep on holding regular PT meetings to finish the development of the first set of standards	2019
Increase the participation of experts from new countries	Promote the TC 117 activity taking advantage of the liaison with SolarPACES	2018
Note: The progress on the actions should be reported in the RSMB.		