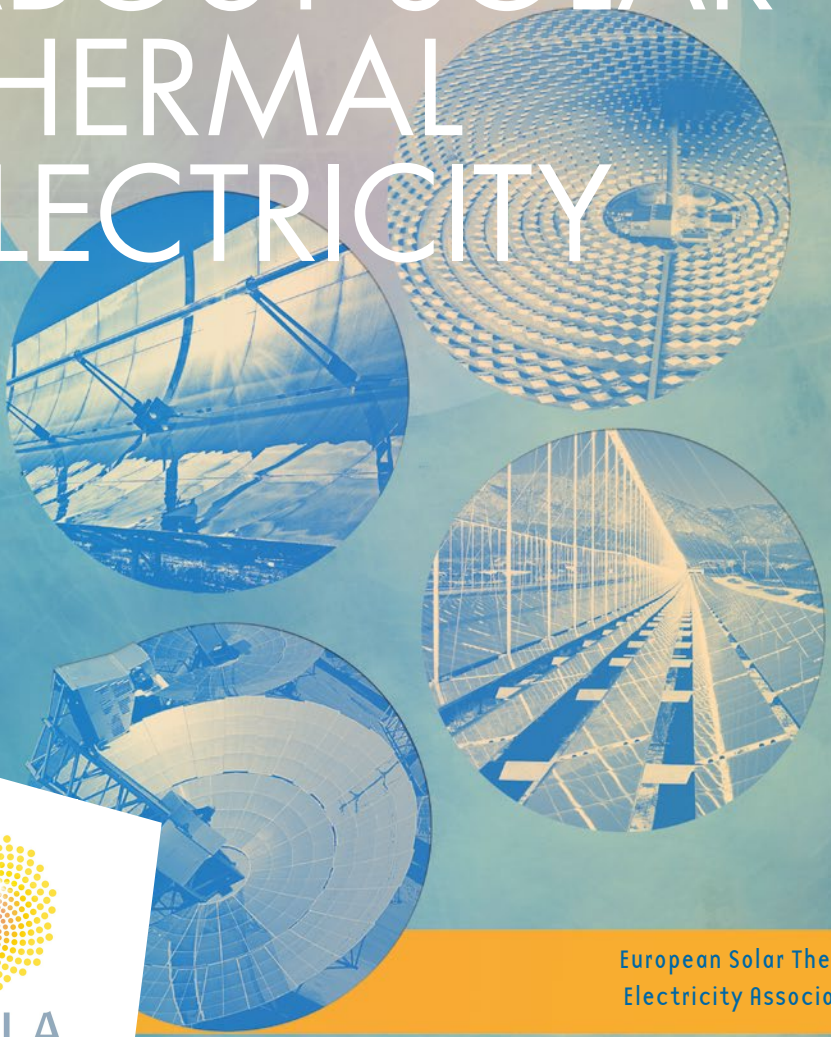
DEBUNKING MYTHS ABOUT SOLAR THERMAL ELECTRICITY



ESTELA

European Solar Thermal Electricity Association

April 2015

MYTH 1

"Solar energy" is just about photovoltaic (PV) technology

Fact is that...

"Solar Energy" is NOT just about PV technology. There are also several other technologies using this free and abundant power of the sun to produce both heat and electricity. Solar Thermal Electricity (STE), also known as Concentrating/Concentrated Solar Power (CSP), is a technology that produces heat by using mirrors or lenses to concentrate sunlight onto a heat receiver, which brings the solar energy to a heat transfer fluid. This heat can be used to generate electricity with a steam turbine or as process heat for industrial application.

Unlike PV that any household can install on its rooftop, STE power plants generate electricity mostly at utility-scale They are connected to the high voltage grid for transport and further delivery to end-users. By storing the thermal energy and/or using hybridization, STE is able to firmly deliver electricity on demand without additional cost – even after sunset. STE is grid-friendly not only due to thermal energy storage, but also due to the use of conventional turbine technology to generate electricity.

This is the most distinct feature of STE plants compared to other renewable energies that will allow for integration into the high voltage grids of even more RES sources without jeopardizing grid stability. This specific feature of dispatchability of the STE energy raises the overall value of the energy produced.

MYTH 2

STE is too expensive and it will always be so

Fact is that...

A remarkable cost reduction – around 50% – has been achieved by STE since 2007 with only approximatively 4.5 GW installed worldwide. Compared with the current situation of Wind (350 GW) and PV (130 GW), one can easily figure out the real potential for cost reduction in the next years of STE plants.

Although STE plants are more capital-intensive than traditional fossil-fuel plants, their operating costs – once connected to the grid, are low, essentially because sunshine is free.

However, as of today, the cost of electricity produced by STE plants is lower than the one generated by currently announced new nuclear power plants (notwithstanding the fact that the final costs of nuclear power plants remains vague due to dismantling costs, measures for increased security, etc).

In other words, STE technologies are much more economically feasible compared to fossil-fuel plants over their respective effective operational lifetime (See Myth 9).

Prices for electricity produced by today's STE plants fill the range from 12 to 16 c€/kWh depending on the irradiation level and most importantly on the financing conditions. They will continuously decrease over the coming years due to announced cutting-edge technology developments. The result will be that cost optimisation (also in manufacturing components), economies of scale after deployment of larger plants (i.e. 100-250 MW) are expected to further reduce the cost below 10 c€/kWh before 2020.

This means that solar thermal electricity will be competitive against coal- and gas-fired power before 2020.

MYTH 3

STE plants are like all renewable energy sources an "intermittent" (or "variable") way of generating electricity

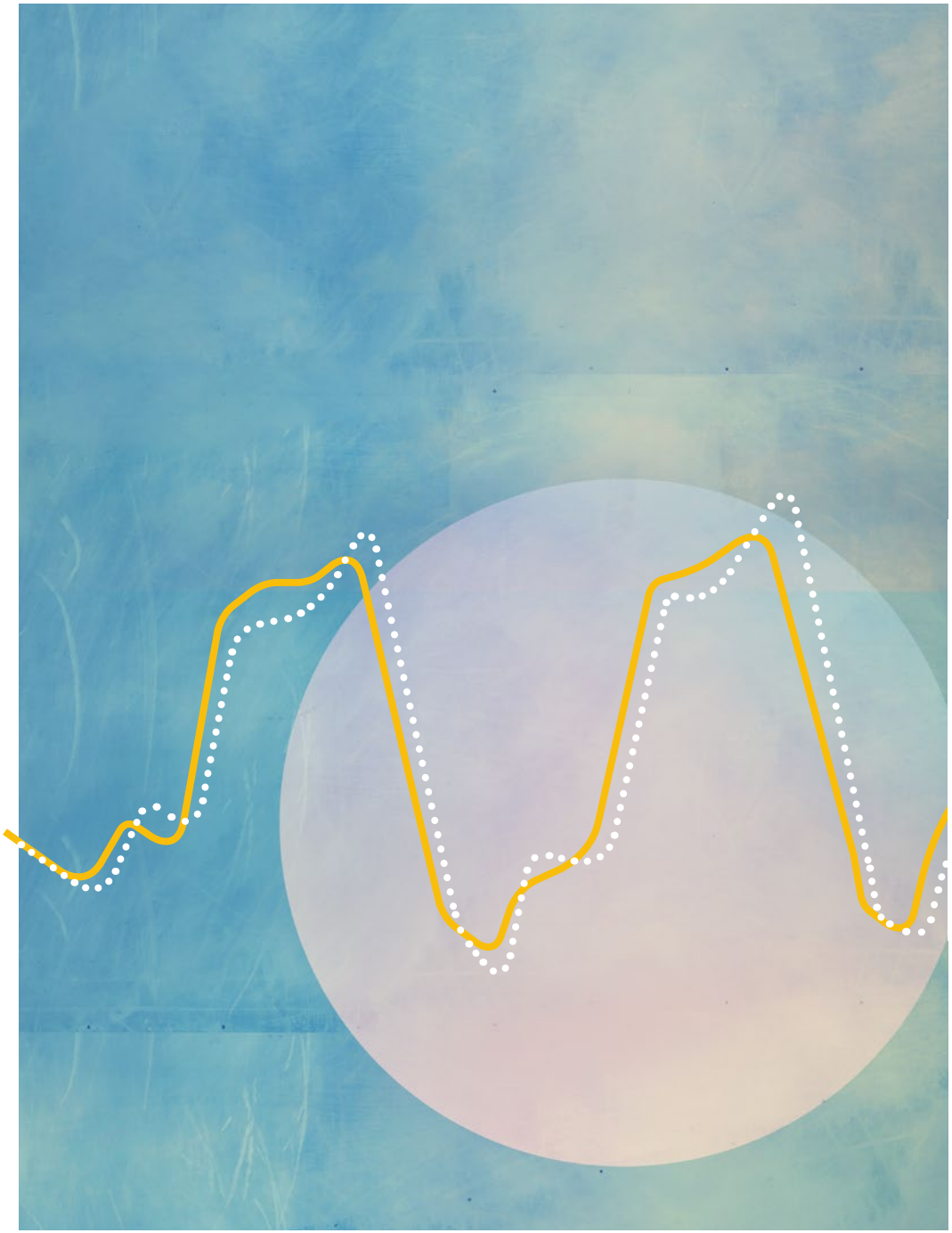
Fact is that...

STE plants are today in most cases equipped with a heat storage system. During sunny hours the collected solar energy is used not only to provide steam to the turbine but also to charge the thermal storage tank. Then, after sunset or during cloudy periods the energy can be drawn from the storage tank to deliver energy – on demand!

Normally the solar fields and the tanks are designed to cover 4 to 7 hours of operation but there is already a reference plant – Gemasolar in Spain – that can produce electricity continuously during the summer season, day and night, just like "base load" nuclear power plants.

From a system perspective, due to its built-in thermal storage capabilities, STE offers significant advantages over other renewable energy sources.

Furthermore, hybridization with biomass natural gas enhances the firmness of the delivery of solar thermal electricity to markets and grid operators.



MYTH 4

STE is not a mainstream energy source in Europe

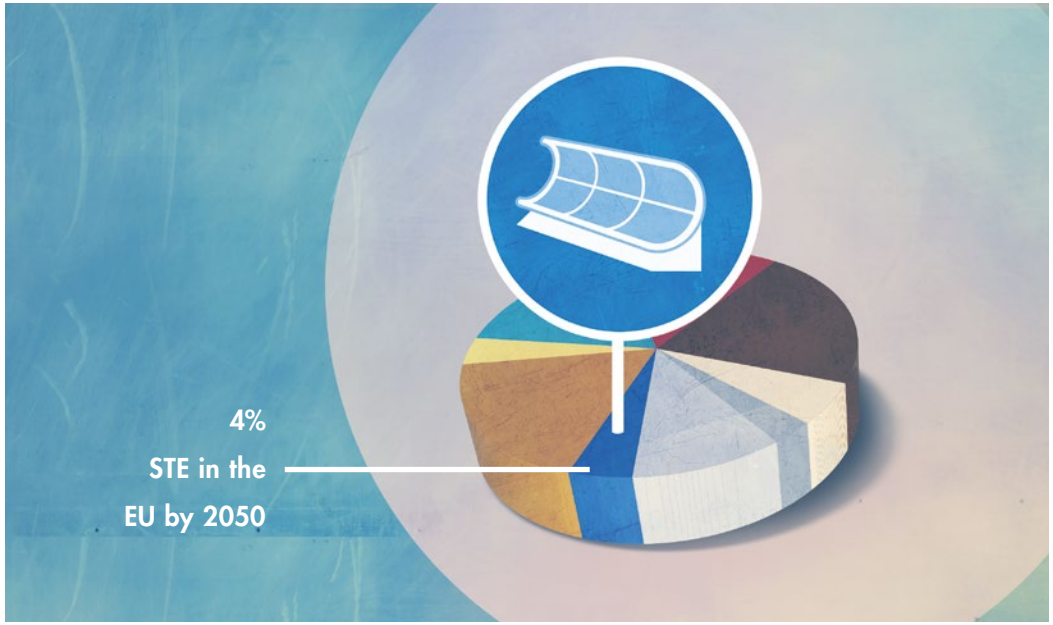
Fact is that...

With only approximatively 4.5 GW installed worldwide, STE technology is relatively new compared to other energy technologies. However, STE has a considerable potential in terms of electricity generation. A small part of the North African (MENA) territory could meet the electricity demands of Europe, the Middle East and North Africa all together. The same also applies to the potential of STE plants in Southern Europe. For instance in Spain, 50 plants with a total 2300 MW are currently connected to the grid providing more than 4 TWh/year. STE represents already a share of more than 3% of the Spanish electricity generation mix during a significant part of a year.

With the recently adopted binding targets of at least 27% of renewable energy used and of 15% interconnection capacity at EU level, renewables are no longer a niche market and will contribute 45-60% to the electricity mix in Europe by 2030. Hence, STE will play an important role in the future energy mix due to its storage and its system-friendly thermal generation unit – STE can not only easily integrate but also facilitate the integration of more intermittent renewables.

Assuming an important capital cost reduction and the contribution of energy storage, the International Energy Agency (IEA) suggests that STE could become economically competitive for intermediate and peak loads within the current decade, due to reduced STE costs and increasing prices of fossil fuels and CO_2. According to the 2014 edition of IEA's Technology Roadmap for STE, the estimated production of STE reach about 1000 TWh by 2030 and 4380 TWh by 2050, thus providing 4% of the electricity mix in Europe and 11% of global electricity mix. In other words, this will be a significant share in the energy mix.

In the future generation mix, dispatchable STE electricity from the Southern European countries combined with off-shore wind from the North See could complement seasonally each other and provide the bulk of the demand of Europe by 2050. Large hydropower along with other technologies such as on-shore wind or solar PV could also have a significant share. According to the study, adding STE to PV, solar power could provide up to 27% of global electricity by 2050 and become the leading source of electricity globally as early as 2040. All together they can achieve the goal of a practically carbon-free electrical system in the future.



MYTH 5

Support programmes for STE deployment are expensive and inefficient for the economy of the countries

Fact is that...

Investments in STE plants bring high macro-economic benefits to countries that go for it. Due to its high local economic content, therefore STE industry brings great contribution to the country GDP, during both the construction and the operation of the plants. In terms of direct job creation, the STE industry has created jobs from manufacturing and engineering to construction works throughout Europe and will continue doing so as the global STE market is set to reach up to €130 bn. per year, according to the IEA technology roadmap for STE. Based on IEA's estimates, €39-57 bn. will be invested on average every year between 2015 and 2030, creating 275,000 to 520,000 jobs worldwide. Up to 150,000 qualified jobs are at stake alone in Europe through these 15 years covering a wide spectrum of direct activities related to:

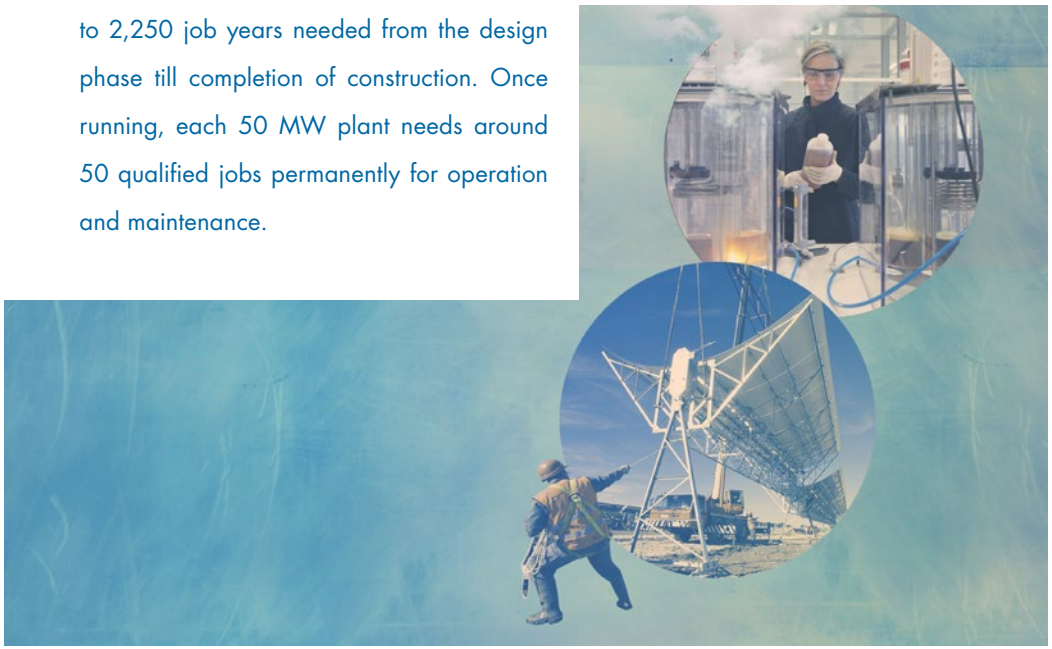
- Engineering, development and financing
- Manufacturing of components: reflectors, receivers, etc.
- Construction, civil, installation and commissioning works
- Operation and maintenance (O&M)

In addition to such direct activities, the European STE industry will in this case also create numerous indirect jobs: research, training, transport, information and communication (ICT) activities, general maintenance services, etc. The returns of all kinds of tax incomes, avoided unemployment subsidies, avoided fuel imports, avoided CO_2 emission rights – are in any contemplated timeframe along the lifetime of the plant higher than the still necessary, but decreasing premiums to fill the initial gap with the current electricity prices.

In Spain, as an example, each 50 MW plant with thermal storage installed is equivalent to 2,250 job years needed from the design phase till completion of construction. Once running, each 50 MW plant needs around 50 qualified jobs permanently for operation and maintenance.

A report from the National Renewable Energy Laboratory (NREL, U.S.) estimates that investing in 100 MW of STE generates 4,000 (direct and indirect) job years plus 94 permanent jobs and $628 million in economic output – compared to 330 job/years plus 13 permanent jobs and $47 million economic output for an identical investment in natural gas-fueled power plant.

This means that STE investment creates more than 10 times more employment (and social wealth) per MW than the same investments in fossil-fuel power generation.



MYTH 6

STE plants disrupt landscape

Fact is that...

STE power plants tend to be located at abandoned industrial sites, on rural land and in deserts to lower the impact of land use and land disturbance. But "beauty is in the eye of the beholder". For someone, a STE power plant may look like a giant art project, and we in the industry do feel it indeed so …

Others may not think the same. All this is at the end largely a matter either of opinion, interest or taste.

More objectively, parabolic trough plants are difficult to be perceived as visually disruptive on landscapes since the collectors are not high and spread over a large area.

The tower in STE tower plants can be seen from far away, a little similar to a lighthouse. When in operation the view of sun rays concentrating in the receiver is appreciated by most people.

MYTH 7

STE power plants need too much land

Fact is that...

The electricity yield of solar technologies per unit of land is in the order of magnitude of other technologies.

Moreover, STE makes great use of the desert's abundant solar resource.

A relatively modest amount of desert land would be enough to supply our planet with energy, according to a study performed in 2003, 2,400,000 TWh per year using 1% of each of the world's deserts!

MYTH 8

STE power plants need much water

Fact is that...

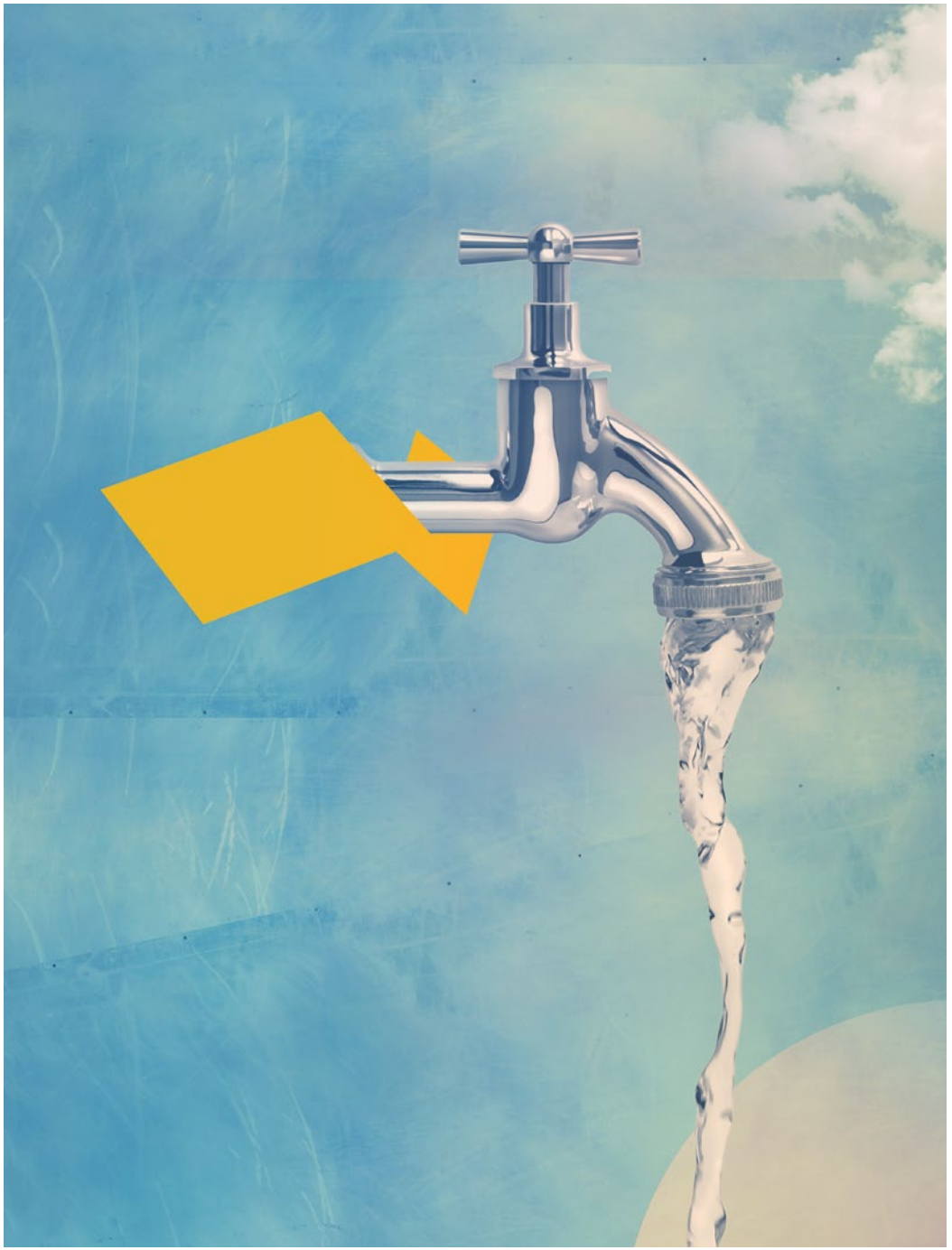
Compared with conventional fossil or nuclear technologies, this statement does not hold true.

STE plants require also less water per hectare (ha) than agricultural activities as this was assessed in the south of Spain so that transforming agricultural land into STE application would not increase but reduce the water needs of such a region.

It is true that water resources are often scarce in the Sun Belt regions where dry cooling towers can be used for cooling the condenser of the steam cycle. Solar fields can be also integrated in existing thermal power plants – coal or gas – reducing immediately gas consumption, emissions with reduced water needs.

Moreover, STE for sea water desalination is possible and makes sense on many sites (especially on islands). Solar fields can be designed besides electricity generation also to produce high-temperature heat to be used for industrial heating, production of synthetic fuels (e.g. syngas), enhanced oil recovery and refineries.

The combined production of electricity, heat and desalinated water is of particular interest in arid regions where STE can provide electricity for reverse-osmosis or heat for water desalination.



MYTH 9

STE is a not-yet mature technology and thus not reliable

Fact is that...

STE plants have proven their reliability since the 1980s as the first commercial-scale application, the Solar Energy Generating System (SEGS) with 9 separate sites continues to operate and produce 350 MW of installed capacity – enough to power nearly a quarter of a million homes at peak production. In other words, STE plants have a lifetime of more than 30 years with minimum performance losses.

2,300 MW have been installed in Spain since 2007 in 50 plants at different locations. They provide reliable electricity which match perfectly the demand curve. The maturity and reliability of the huge two-tank molten salt storage technology is since 2008 a matter of evidence with daily charging and discharging processes without any incident.

On many days during summer 2014, STE plants supplied more than 10% of the demand and many days of summer 2014 the total daily contribution was over 5% of the demand in Spain with the same reliability as any other conventional source.

Taking into account the great potential, the macroeconomic benefits and the contribution to RES integration, STE as the sole dispatchable technology deserves further support in the coming years.

MYTH 10

STE industry is falling

Fact is that...

STE industry is rather booming worldwide. Since 2010, generation of solar thermal electricity from STE plants has grown strongly worldwide.

Due to financial and economic crisis in Spain, retroactive legislative changes on renewable energy in the last 2 years have been applied and thus the growth became more slowly than expected. Despite of the sudden cut in renewable energy incentives in Spain, new markets are emerging on most world regions and countries with continents where the sun is strong and skies clear enough, including the U.S., Australia, China, India, Turkey, the Middle East, North Africa and South Africa with ambitious and far-seeing development plans for STE.

More specifically, the Middle East is ramping up its plans to install STE based projects and as a part of the Plan, Shams-I has been installed in Abu Dhabi. There are ambitious plans in Saudi Arabia and in several Arab Emirates. A further 1.5 GW in STE plants are under construction in the U.S. and contracts signed for at least another 6.2 GW.

According to International Energy Agency (IEA), the prospects for the development of STE plants are extremely high. The forecast of STE production could reach about 1000 TWh by 2030 and almost 4500 TWh by 2050 at world level, thus providing 4% of the electricity mix in Europe and 11% of global electricity mix.

MYTH 11

STE is more complex technology than PV or wind

Fact is that...

STE power plant is not that complex, although STE plants are like mechanical watches with many parts and components to be optimized.

This being said, let us note that the electrical part of STE plants uses common, simple conventional power generation parts and devices – just the solar field is specific.

Unlike solar PV panels, which require large amounts of scarce materials such as silicon, copper indium selenide, or cadmium telluride, STE plants electrical components are manufactured at large scales and thus at low-cost from durable, common materials such as steel, glass, mirrors and piping.

MYTH 12

STE plants endanger wildlife.

Fact is that...

In Europe, there is no case about endangering wildlife at all. However, recently there seems to be some misleading and exaggerated news in the U.S. about bird deaths associated with STE plants, especially the story about a new solar project in California killing up to 28,000 birds per year by reflected sunlight, which is based on a number of uncertain assumptions. In fact, the power plant reported 321 total avian fatalities between Jan and June 2014, of which 133 were related to reflected sunlight, thus falling far short of the 'estimates' in those criticises, according to NRG Energy. In reality, the impact of STE or other renewable energy resources in power generation on bird deaths has been largely overblown.

So what do these numbers mean compared to other sources of bird deaths ?

For example, every year cats kill between 1.4 and 3.7 billion birds; windows nearly 1 billion; cars some 60 million; the mining and burning of coal nearly 8 million, etc.

If killing birds had to be avoided at all costs, then windows, pet cats and roads should all be first prohibited, commented by IEA's recent study. Moreover, this may happen only to tower technology, which is less than 10% of the installed STE power in the world.

In reality, government agencies and all relevant stakeholders work closely to optimise the clean energy contributions from STE plants while minimising any environmental impact. Environmental analyses are performed before acting on the site and preventive measures are taken in case of any potential threat to the protected species.

MYTH 13

Countries may be better off starting a CSP program later (after 2020 or so...)

Fact is that...

There is an erroneous perception by some policy-makers that it would be better to wait until STE become competitive before considering deploying STE plants in their own countries.

On the contrary, as a matter of fact, a support programme for STE will provide immediate positive returns to the economy of any given country – in terms of GDP increase, employment and taxes – right from the starting up of the construction phase, while the first premiums will be paid some years later. ESTELA has performed simulations for different countries which show that the returns to the economy will be always greater than the corresponding premiums. The "golden era" has also to be taken into consideration - the golden era is the time when the support program ends and the costs of the electricity produced will be the O&M costs only – without necessity of re-powering the unit.

Besides this, the local content delivered during the construction of the plants will be increasing with the time and widening STE programs. Therefore an ambitious country can reach a point where new STE plants can be deployed without any further country support. This means that the country that started its support program earlier will be in a position for grasping further benefits by building the plants with a local content delivery close to 80% while others may start later their STE program, but with most of the supplies still coming from abroad.

Additionally such countries with an ambitious STE program will no doubt enjoy an additional "first-mover advantage" in their region and become an exporter to the neighbouring countries.

MYTH 14

STE companies – along the whole value chain – are making huge profits due to incentive measures (feed-in-tariffs or feed-in-premiums)

Fact is that...

On the contrary the companies took high risks associated to large investments either for building up manufacturing units for specific STE components or for the construction of the plants.

In Spain, the profit and loss accounts of the plants' holders show very small positive results until they had to face aggressive retroactive cuts in their income putting the owners of the plants at threat, revealing thus severe shortcomings of current national and European legislation related to investments/investors protection.

As the STE plants have high CAPEX, most of them were financed with a high leverage, so that the banks are the entities that currently make most profit from the STE deployment.

ABOUT STE

Solar Thermal Electricity (STE), also known as Concentrating Solar Power (CSP), is a technology that produces heat by concentrating solar irradiation. This heat can be used to generate electricity with a steam turbine or as process heat for industrial applications. By storing the thermal energy and/or using hybridization, STE is able to firmly deliver electricity on demand without additional cost – even after sunset. STE is grid-friendly not only due to thermal energy storage, but also due to the use of conventional turbine technology to generate electricity.

ABOUT ESTELA

ESTELA, the European Solar Thermal Electricity Association, is the voice of the European STE/CSP industry. From its office in Brussels, ESTELA provides a single point of contact to stakeholders dealing with energy policy for all matters related to STE.

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Sources

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Design & Illustrations
www.paulgrabowski.de

ESTELA a.s.b.l.
European Solar Thermal Electricity Association
Rue de l'Industrie 10
B-1000 Brussels
T: +32 (0) 2 893 25 96
E: contact@estelasolar.org
http://www.estelasolar.org