ESTELA answer to the "Strategy for long-term EU GHG emissions reductions" consultation

October 9th, 2018
Brussels, Belgium

ESTELA appreciates the possibility to provide the European Commission its comments related to the "Strategy for long-term EU GHG emissions reductions" and would like to draw its attention to the following aspects:

I. **The key role that Solar Thermal Electricity plays in reducing GHG and in the strategy for decarbonising the power system.**

II. **The increasing competitiveness of the technology and the forecasted cost decrease.**

Introduction

Solar Thermal Electricity (STE), also known as Concentrated 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.

Since renewables are no longer a niche market and its penetration in the electricity mix in Europe will continue to increase, the power sector faces new kinds of challenges. In particular, system integration of renewables has been found to be a concern by European transmission system operators. However, due to its storage and its grid-friendly thermal generation unit, **STE is not only easy to integrate to the system, but it can also facilitate the integration of more intermittent renewables**.

Regarding system development models

As a matter of **principle**, we think that the planning models under a least cost approach are no longer appropriate to assess ways and means for the integration of renewables (RES). This is essentially due to the fact that renewable (RES) do have different dispatch profile capabilities and roles to play in the power system of a given country that can be combined and shared at interregional level or even system level.

Furthermore, we are convinced that especially in the wider context of decarbonization, renewables progressively *shall* and *will* ultimately replace all conventional sources due to technological, political/environmental or competitiveness reasons (see below).

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Main comments:

I. The key role that Solar Thermal Electricity (CSP) has in reducing GHG in the power system

a. CO_2-free and flexible renewable energy generation

STE systems can replace the power generated by fossil fuels and reduce the corresponding greenhouse gas emissions which cause climate change. Each square metre of STE concentrator surface, for example, is enough to avoid 200 to 300 kilograms of CO_2 each year, depending on its configuration. Typical STE power plants are made up of hundreds of concentrators arranged in arrays. The life-cycle assessment of the components and the land surface impacts of STE systems indicate that it takes around five months to 'payback' the energy that is used to manufacture and install the equipment. Considering the plants last at least 30 years with minimum performance losses, this is an excellent ratio. In addition, most of the STE solar field components are made from common materials that can be recycled and used again.

Moreover, a recent study performed by Protermosolar, the Spanish association for STE, using real operational records by the Spanish TSO, REE (Red Electrica de España) over a 4-year period, shows that **a further increase of RES penetration towards the decarbonization target is achievable (at least in Spain) with very low backup capacities in fossil fuel plants (replacing coal and nuclear, while minimising natural gas consumption) *and* under *affordable* costs, *i.e. either similar or even lower costs* compared to the least cost models**
(https://www.protermosolar.com/wp-content/uploads/2018/06/Protermosolar-Transition-Report.pdf).

b. Planning priorities should be consistent with political priorities

System planning serving a transition towards a decarbonized electricity system would need to meet three principles jointly, but assessing the various possible answers to these priorities in the right order:

1. Decarbonization
2. Reliability of supply
3. Affordable costs

Conversely, if the lowest cost approach would remain the *first* priority in the planning exercise, the effect on decarbonization level will be much weaker.

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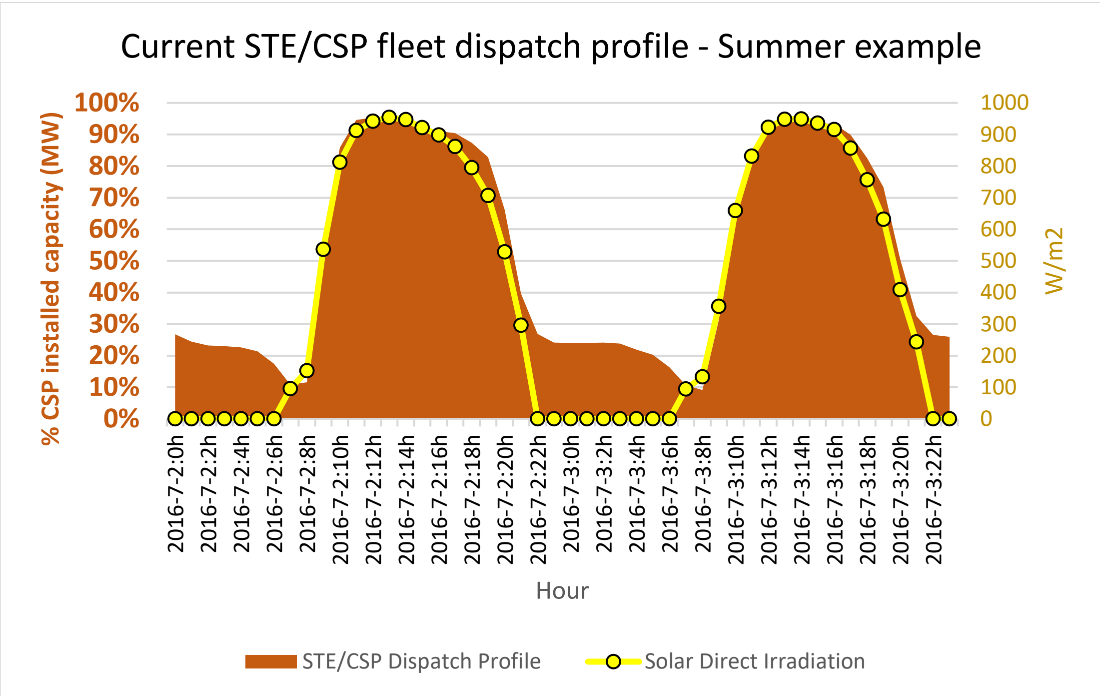
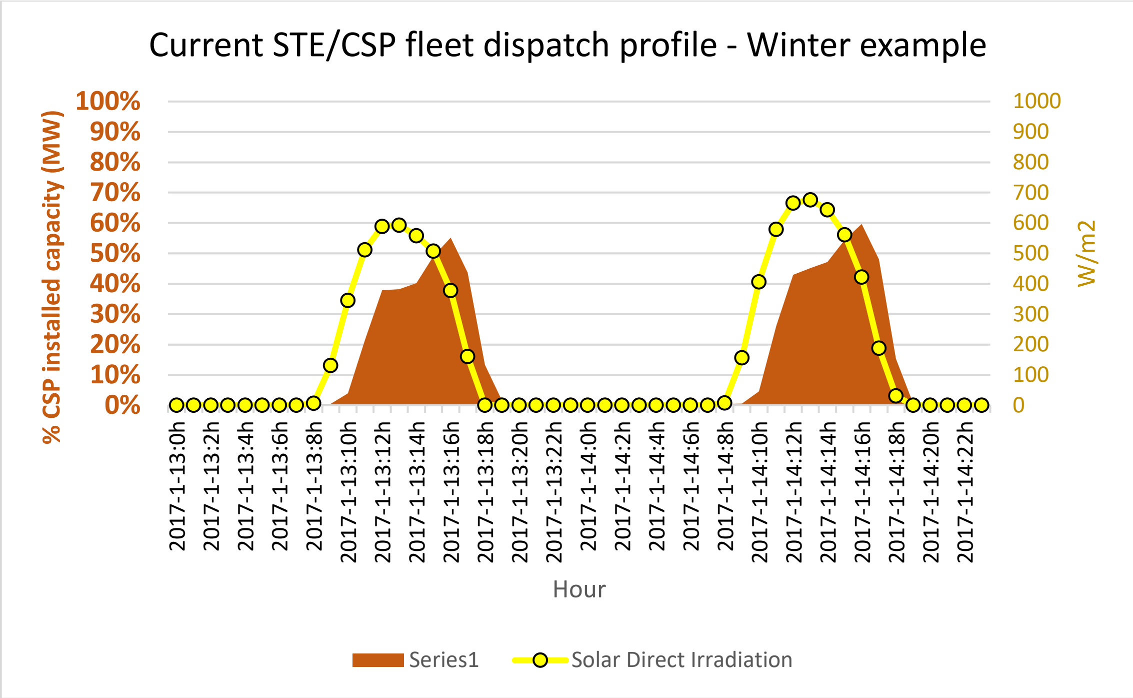
c. Understanding the role of CSP in planning the new capacity

- Least cost approach should be based on the different dispatch profile capabilities of each specific RES and their respective specific seasonal operational profiles.
- Regarding CSP, it must be underlined that all future CSP plants will be equipped with thermal storage up to 15h at nominal electric capacity.
- This means that CSP does NOT compete with PV plus batteries (since battery technology stores energy at much lower capacity and at higher costs).
- However, it would replace conventional back up such as combines cycles after sunset with the major effect on decarbonization.
- As illustration of the above said, please find below examples of operational profiles on selected sunny days in July and January from different years under review.



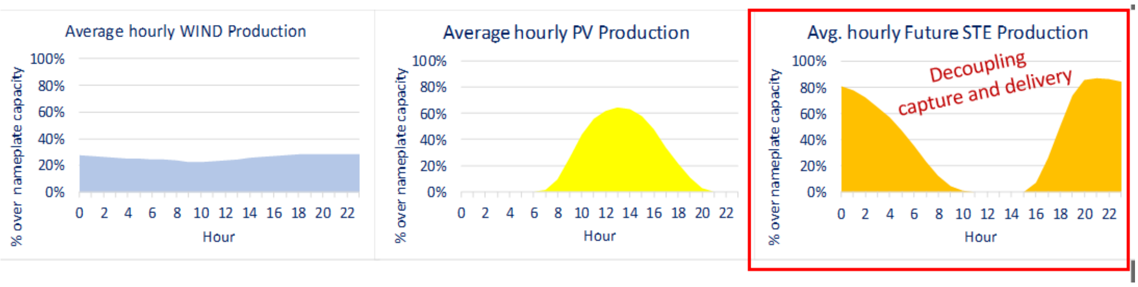
Current

Dispatch profile of CSP Spanish fleet on 2 and 3 July 2016

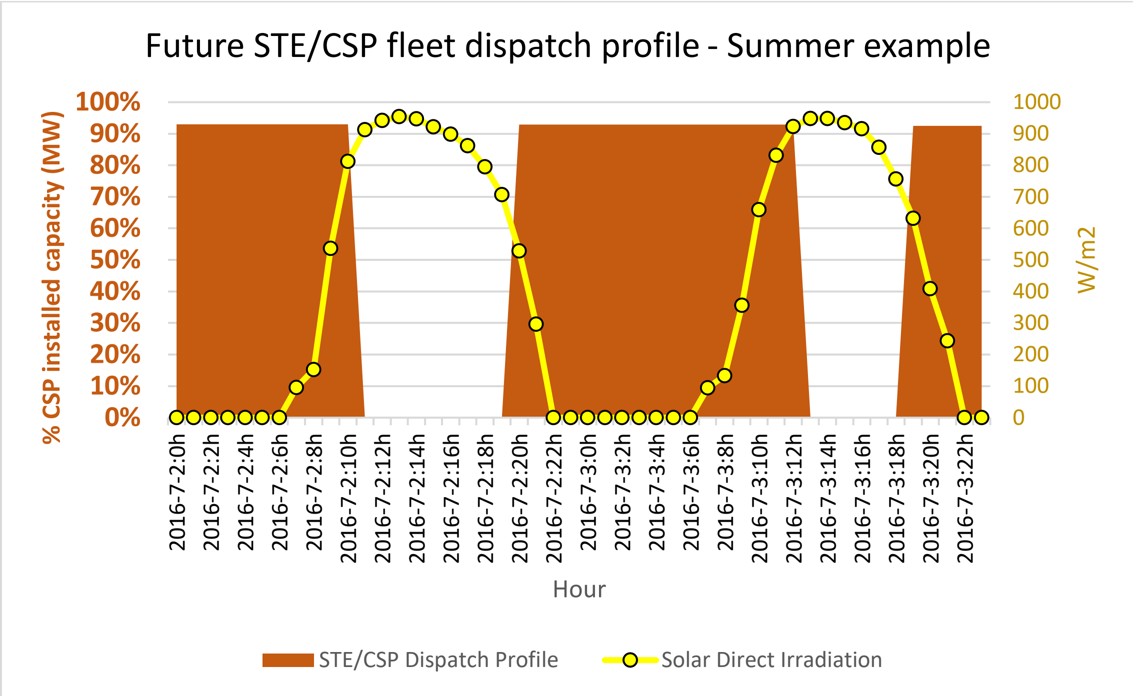


Dispatch profile of CSP Spanish fleet on 13 and 14 January 2017

- In Spain, only 1/3 of the total installed 2,3 GW capacity in CSP plants has storage facilities (7,5h) due to historical, legal regulatory constraints. This means that 2/3 of the CSP fleet in Spain generates electricity only during sunny hours. Those plants equipped with storage facilities are in fact reducing their capacity at night so to avoid stopping the turbine until sunrise on the next day.
- **However, from now on**, CSP plants will find their place in system development models **if their most important feature (the possibility to uncouple solar energy capture and electricity generation) is integrated in the models' algorithms.**



- This means that future CSP/STE plants are well able to deliver the following dispatch profiles:

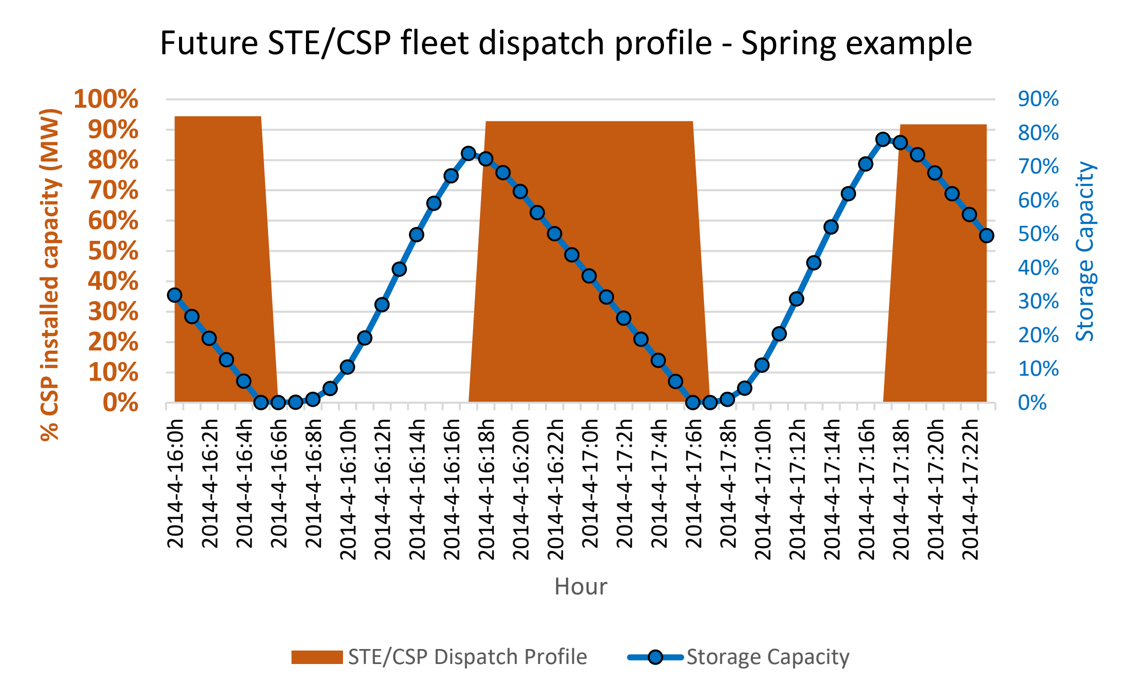


Target dispatch profile of new CSP Spanish fleet on the same July 2 and 3, 2016

- The complementarity of given natural resources across the system shall be duly addressed in assessing the future electricity mix.

- Future CSP plants (e.g. in Spain) shall be designed for approximatively 3.500 equivalent operation hours, corresponding to approximatively a 40%-capacity factor. This appears today feasible or could even be surpassed by current CSP projects. This suggested capacity factor matches perfectly any strategy taking advantage from the complementary between CSP and PV.

- Storage tanks would be charged during the day hours. This dispatch profile leads to an almost 100%- firm synchronous power delivery for the day-ahead market (i.e. with minimal deviations from the contracted values).



Example of Storage tanks behaviour in April 16th & 17th 2014 (New Dispatch profile)

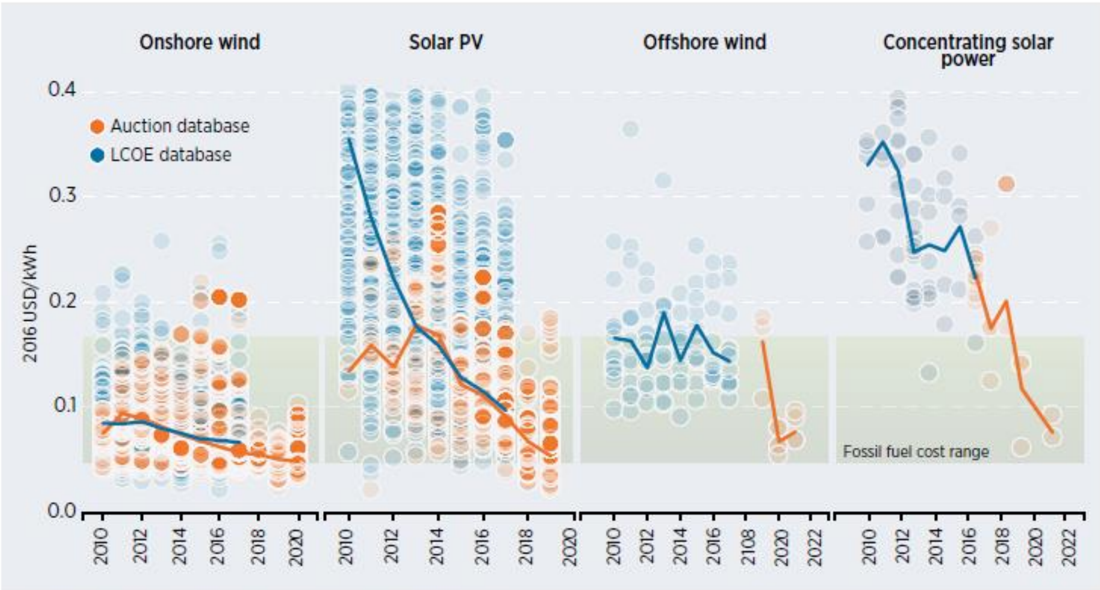
II. The increasing competitiveness of the technology and the forecasted cost decrease

According to IRENA – Renewable Power Generation Costs in 2017, the CSP cost forecasts can be summarized as follows (corresponding to the figure below):

- "Recently, very low bids for CSP projects have been announced. Examples include the USD 0.073/kWh (± 0.061 €/kWh) bid announced by the Dubai Electricity and Water Authority (DEWA) for a 700 MW plant at the Mohammed bin Rashid Al Maktoum Solar Park (DEWA, 2017) and the Port Augusta CSP project in Australia, at around USD 0.06/kWh (± 0.049 €/kWh). If the auction results for Dubai and South Australia are factored in, then for the period 2010-2022 the learning rate could reach 30%"
- Learning rates for technologies are the average percentage cost or price reduction that occurs for every doubling in cumulative installed capacity of that technology

- **This cost decrease is consistent with the ESTELA cost forecasts.**

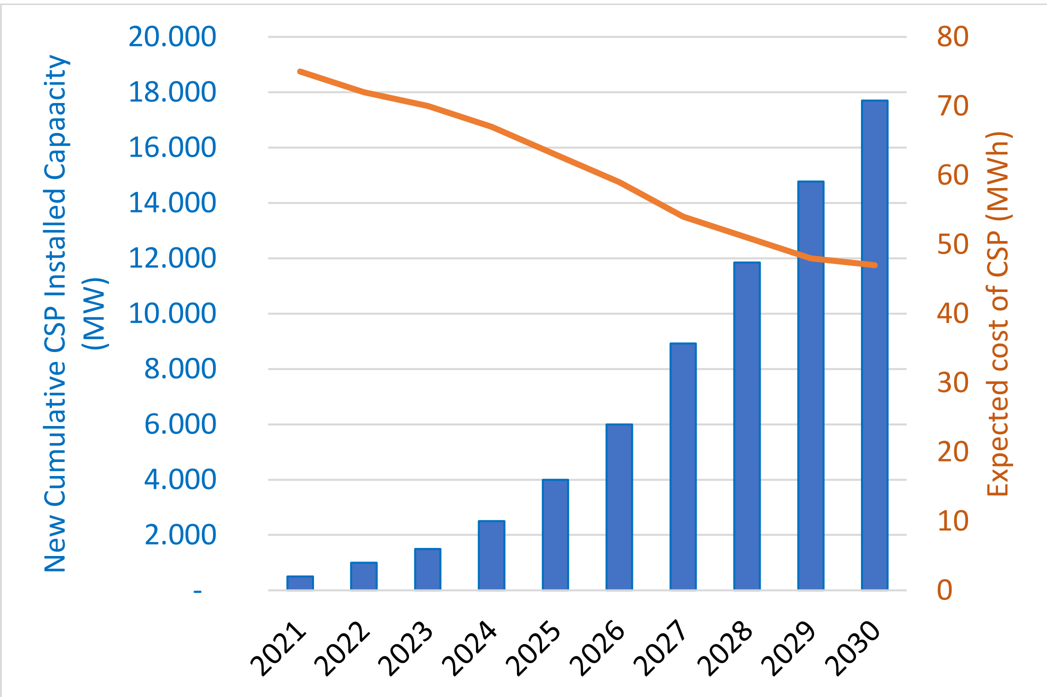
Figure ES.2 The levelised cost of electricity for projects and global weighted average values for CSP, solar PV, onshore and offshore wind, 2010-2022



Source: IRENA Renewable Cost Database and Auctions Database.

Note: Each circle represents an individual project or an auction result where there was a single clearing price at auction. The centre of the circle is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE, or auction values, by year. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.

In addition, the graph below shows the estimated cost evolution curve for new installed CSP capacity in Spain according to the a.m. Protermosolar's transition report.



	STE / CSP		Solar PV	
	€/MWh	New Inst. Capacity (MW)	€/MWh	New Inst. Capacity (MW)
2021	75	500	40	2.700
2022	72	500	38	2.700
2023	70	500	37	2.700
2024	67	1.000	35	2.000
2025	63	1.500	32	1.500
2026	59	2.000	31	1.000
2027	54	2.925	30	701
2028	51	2.925	29	701
2029	48	2.925	28	701
2030	47	2.925	27	701
Weighted average by Technology in 2025	**67**		**37**	
Weighted average by Technology in 2030	**55**		**35**	

The cost reduction curve is based not only on the new capacity in CSP to be added in Spain but on the impact on costs of the ongoing CSP deployment worldwide.

As of today, CSP worldwide installed capacity is approximatively 5 GW which means almost 100 times less than PV. Therefore, the potential room for performance improvements and further cost reductions is very high. There are 1.35 GW under construction/development in China and it's also expected that China will release a second batch of CSP projects in a range between 3,5 GW and 5 GW).

Moreover, Kuwait may include in the phase 3 of its "Shagaya RES Plan" additional CSP capacity on top of the recently commissioned. Besides, Morocco is set to announce in the coming weeks cost figures for the Midelt Project (including a CSP capacity between 300 – 390 MW), which are expected to be in line with the forecasted reductions.

The a.m. examples show that the solar resource can be more efficiently captured for electricity generation purposes. Doing so, a smart combination of CSP (3.500 equivalent hours) and PV (1.800 equivalent hours) avoids the overlapping of production during the central hours of the day in Spain. This is what should be from now on considered in the system development models, since the resulting average costs for 2030 (S. above) – and even before – would be attractive for sunny European countries and CSP more competitive than gas combined cycles after sunset.

We underline that this cost forecast is rather conservative, since costs outside EU in 2017 (DEWA, 73 $/MWh) are already lower than the assumed cost in 2021 in Spain - even if the available solar resource in Spain is better than in the UAE. This also means that other countries outside the EU are benefiting from a technology in which the EU is today the current leader and are recognising its value, while the EU is stopping its strategic inclusion in the strategies for decarbonisation.

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Unfortunately, the previous inputs provided by ESTELA to the "Stakeholders' review of technology assumptions for decarbonisation scenarios within the PRIMES model" (attached), were not taken into consideration. **Therefore, ESTELA requests to the Commission the reconsideration of this input since the figures currently considered are not only not valid anymore but *de facto* erase STE from the strategic roadmap (with the corresponding consequences of it) for being too high.**

Additional comments - Questioning Least Cost System Development Models (so far known to us)

- They clearly do not target decarbonization as the primary objective – discarding the overall political objectives in Europe and worldwide (Paris Agreement)
- A very high penetration in the system of intermittent RES does not appear compatible with a marginal cost model since:
    - potential investors would EITHER not find any motivation for further investments above a given penetration level where market prices are diving according to the amount of unmanageable RES in the same timeframe;
    - OR the prices of backup units (that would able to match the demand) would sharply increase up to levels corresponding to their reduced operational hours, driving the market into extremely volatile areas. Overall, this would result in an increase of the supply costs at various times of the day.
- The input data on the models regarding CAPEX and OPEX and capacity factors used until now in most cases do not correspond to the current PPAs resulting from the competitive tendering and auction processes. The impact of this input on the results is high and correspondently the conclusions of the model very doubtful.
- The cost of the gas backup does not seem to be consistent with the reduced number of hours that combined cycles will achieve as a result of a massive penetration of renewable technologies
- The increase of balancing costs also resulting from the high renewable penetration does not seem to be properly considered. Expert studies already pointed out that the dysfunctionalities of the resulting generation mix will have consequences that must be paid by the system.

So far the least cost system development models would be further used in ENTSOE (and ENTSO-G) three essential points should be taken into account:

- Introducing specific hourly dispatch profile with seasonal differences
- Using updated costs (incl cost forecasts) for CSP plants, i.e. tracking the auction and tendering processes which are currently going on in different countries, with due considerations regarding DNI and other local specific circumstances.
- Prioritizing decarbonization requires considering 'from scratch' dispatchable renewables (CSP, geothermal, hydro, biomass) instead of gas combined cycles. For this exercise, projecting hourly data using real past years data provides a much more

accurate techno-economical approach allowing to assess the amount of gas backup that may possibly still be needed.

Conclusions

1. STE can produce CO_2-free renewable energy, contributing to the avoidance of GHG in power generation.
2. STE is complementary to variable sources such as solar PV and wind, and contributes not only to reducing the need for fossil-fuelled back-up in the system, but it also helps to integrate a bigger amount of variable RES system without compromising the security of supply.
3. Thanks to its integrated Thermal Energy Storage System (TES), plants can provide firm and flexible energy (and fully dispatchable if hybridized with complementary technologies), operating up to 24 hours a day, providing baseload or peak power as required.
4. Costs are lower (and expected to continue decreasing) than those considered by the PRIMES model, as mentioned by IRENA.
5. The value of the technology is today being recognised in countries outside Europe (even with worse solar resources) with strong investment development programs, which among others, will take over the current European technological leadership and market, with the associated consequences.

Therefore, ESTELA requests to the Commission to reconsider the role of STE in the decarbonisation strategies and its input towards the development of scenarios based on the modelling of the different technology alternatives with the use of PRIMES.

In addition, ESTELA would be glad to provide more information regarding the aspects addressed in this comment.

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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