

DECALOGUE FOR ADVANCING CONCENTRATING SOLAR THERMAL ENERGY IN SPAIN

Introduction

Concentrated solar thermal (CST) is a mature, dispatchable renewable technology that can be fully integrated into the power system. Its thermal storage capability, synchronous generation, and direct contribution to grid stability make it a unique solution among renewable energy technologies. Spain benefits from internationally recognized industrial, technological, and scientific leadership, as well as an exceptional solar resource, positioning CST as a strategic asset for the country. Ignoring this strategic asset would mean relinquishing a unique competitive advantage.

These characteristics make CST particularly essential in the new scenario facing the power system: a grid with a high penetration of variable renewables and increasing electrification of demand, which will require not only generation capacity but also firmness, flexibility, stability, and resilience. In this context, technological complementarity is no longer optional; it becomes a necessary condition. A balanced energy mix, capable of integrating dispatchable renewable generation and providing system services, will be critical to ensuring security of supply, economic efficiency, and long-term sustainability.

1. CST ensure stability in the power system

Unlike intermittent renewables, CST plants generate synchronous electricity through turbines and generators, providing natural inertia to the system, as conventional fossil fuel and nuclear technologies do. In this way, they contribute to frequency and voltage regulation, provide spinning reserves, and strengthen the system's dynamic stability and resilience. In a highly electrified system dependent on intermittent renewables, these capabilities are essential to avoid imbalances and prevent blackouts.

2. CST is dispatchable and flexible

CST differs from other renewable energy technologies by naturally integrating thermal storage, enabling electricity generation on demand, even at night or on cloudy days. It effectively brings daytime sunlight into the night. An example of flagship is Gemasolar (Seville), which has demonstrated continuous 24-hour generation at full capacity.

Thermal storage has proven to be efficient, economically viable, flexible, and sustainable, offering key advantages over electrochemical storage, which faces scalability limitations and cannot provide inertia to the power system.

3. CST is the most competitive renewable technology when real system costs are considered

CST becomes more cost-effective than alternative renewable technologies when flexible renewable generation is required and when the analysis goes beyond the direct cost per kWh. While other renewables require additional investments in storage, conventional backup, and grid reinforcements, CST integrates storage and synchronous generation within a single infrastructure. In markets such as China, when firm renewable capacity is required, CST-based solutions have consistently been the preferred option.

CST also has extraordinary cost-reduction potential. With 7 GW installed, it has already reached price levels comparable to, or even lower than, those of other technologies at similar stages of development. Large-scale deployment would enable further substantial cost reductions, as demonstrated by other renewable technologies.

4. Spain has unique leadership and human capital

Spain is a global reference in CST, in industry, technology, and research. Spanish companies have participated in the construction of more than 86% of commercial plants currently in operation worldwide. The technical expertise developed has positioned Spanish professionals among the most highly regarded globally. Investing in this technology will strengthen Spain's strategic position and enhance economic and industrial competitiveness.

5. CST generates local wealth and high-quality employment

CST creates stable jobs across a wide range of roles. In 2019, Spanish CST plants employed more than 6,000 people. In addition, their operation and maintenance require skilled labor throughout their entire lifetime.

CST energizes Spain's industrial fabric, creating skilled jobs, strengthening the value chain, and driving strategic sectors such as engineering, manufacturing, construction, and the operation and maintenance of high-tech facilities.

More than 80% of the economic value of a CST plant, including construction, operation, and maintenance over 25 years, remains in Spain. CST maximizes economic impact and wealth creation within the territory, strengthening local economies and contributing to national GDP.

6. CST enables efficient industrial decarbonization

Between 60% and 70% of final energy consumed by industry is used for thermal processes. CST can directly supply heat, reducing the need to electrify industrial processes and preventing additional strain on the electricity grid. This makes it a high-value solution for the efficient decarbonization of industrial sectors, as well as for the production of solar fuels and the supply of heat to district heating networks.

7. CST supports large-scale integration of renewables

In addition to contributing to grid stability, CST plants can store their own thermal energy and utilize surplus photovoltaic or wind energy to generate electricity during sunless periods. This avoids curtailment of renewable energy at zero marginal cost and maximizes the use of clean resources. In this way, CST acts as a backbone of the power system, enabling higher penetration of variable renewable energy, reducing the need for fossil backup, and stabilizing system prices.

8. CST is clean, sustainable, and inexhaustible

CST is a 100% renewable technology. It directly harnesses solar radiation (an inexhaustible, free, and sustainable energy source) eliminating dependence on fossil fuels to maintain grid stability.

It produces no greenhouse gas emissions and generates no hazardous waste, contributing to climate change mitigation without the impacts associated with conventional technologies. Its fuel is the sun, and Spain is one of the best-positioned countries in the world to harness it.

It also avoids challenges related to the recycling of large volumes of photovoltaic modules, wind turbines, nuclear waste, or batteries based on critical and highly polluting materials.

9. CST ensures energy sovereignty

As a local, distributed, and well-established technology, CST reduces dependence on imported fuels and international interconnections, thereby strengthening Spain's energy sovereignty.

It does not rely on scarce or critical materials, nor on delocalized supply chains, reducing both environmental impact and exposure to geopolitical risks, and reinforcing its strategic role in the transition toward a more autonomous and environmentally responsible energy system.

10. CST is a mature and proven technology

CST is a tested and reliable technology, with more than 7 GWe in operation in countries such as Spain, the United States, China, Morocco, and the United Arab Emirates.

In Spain, between 2007 and 2013, 49 CSP plants were built with a total installed capacity of 2.3 GWe, of which more than 1 GWe includes thermal storage systems of up to eight hours at nominal power. Operational data have demonstrated high reliability and virtually no degradation. This accumulated experience provides a solid foundation for a new phase of large-scale deployment.

Conclusion

Spain faces a strategic decision: to consolidate its global leadership in CST, leveraging unique expertise and solar resources, or to allow an irreversible loss of its energy and technological sovereignty.

Supporting CST in Spain is a necessary condition for a renewable, stable, and competitive power system. Abandoning it would mean higher costs, greater external dependence, and reduced system resilience.

Now is the time to promote this technology to ensure decarbonization, attract and retain national talent, and build an energy model aligned with long-term decarbonization and security objectives, while enabling Spain to become a leading exporter of solar energy.
