ABENGOA
Energy

Retrofitting of CSP Plants. Short-term solutions to store and integrate VarRES

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1 Who are we?

Who **are we?**

Abengoa (MCE: ABG.B) is an international company that applies innovative technology solutions for **sustainable development** in the infrastructure, energy and water sectors.

Constructing energy infrastructures

- Generating conventional and renewable energy.
- Transporting and distributing energy.

Providing solutions for the integrated water cycle

- Developing desalination and water treatment processes.
- Constructing hydraulic infrastructures.

Being a reference in the transmission and distribution sector

- Developing transmission lines, electric distribution and railway electrification projects.
- Constructing installations and infrastructures for all types of plants and buildings.

Obtaining results in the services area

- Providing operation and maintenance services for plants optimization.
- Managing private assets efficiently.

Furthering new horizons for development and innovation

- Our 280 accumulated awarded patents since 2008 position us as technological leaders in sectors such as solar thermal technology.
- Renewable energy storage and our bet for energy efficiency and water consumption (water-energy nexus).

Track record

Abengoa is a **world leader** in **solar thermal technology** and an **international reference** in the construction of **conventional** and **renewable energy generation plants**.

Concentrated Solar Power	**Solar thermal tower and solar thermal parabolic trough collectors technology. Solar process heat.**	More than 80 MW in operation in tower technology. More than 1,600 MW in operation in parabolic trough collectors technology
Conventional generation	**Combined cycles, cogeneration, open cycle.**	More than 9 GW of installed capacity.
Photovoltaic and Wind	**Photovoltaic plants, onshore wind farms.**	More than 500 MWp built in photovoltaic. More than 480 MW built in wind.
Storage	**Electrochemical batteries, hydrogen, thermal storage in salts.**	More than 6.000 MWht in commercial operation.
Biofuel	**Biofuel production plants (bioethanol, biodiesel and jetfuel).**	More than 2.500 Ml/year of biofuel.
Waste and Biomass	**Electric and thermal energy production plants.**	More than 50 completed projects.
Hydrogen	**Production of hydrogen and generation of energy.**	More than 20 developed projects.

Hybridization of technologies

2 CSP Technology

World leader in CSP

Abengoa has its own **solar thermal technology** and has become a world leader in the construction of solar thermal plants, with **35% of the installed capacity worldwide**.

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CSP technologies

Abengoa is carrying out turnkey projects encompassing **the entire value-chain**, from the early development stage until final O&M

Parabolic Trough Collector Technology

Central Tower Technology

Solar Heat for Industrial Processes

Energy solutions provided

Smart Solar Plant : hybridization

Why CSP+ TES?

- CSP with TES currently is the **cheapest and most reliable solution to grant dispatchability and capacity factors**.
- TES integration allows **baseload generation** profile and **peak demand**
- Increases investment but with large SM, you can even get **24/7 generation**

Why PV?

- Dramatic reduction of PV technology **costs** in the past years
- PV only covers approx. 30% of daily demand → **oversizing and store** to generate out of the day
- For larger PV capacities, the **energy dumped** becomes relevant

Why BESS?

- **Investment costs of batteries are still high for applications of large electricity storage**, however, technical analysis also showed the potential that BESS system can provide in terms of **higher capacity factors** (less dumped energy) and **fast response** to help grid regulation.

3 Hybridization. Decarbonization challenge.

Energy transition in the world

Why **CSP** is a key driver for a **sustainable Energy Transition**?

- **Storage is a crucial challenge in Energy Transition**, especially in those regions with a high penetration of intermittent renewables (VarRES).
- Penetration levels of **VarRES above 30%** may run into a non-controllable growth issue with severe consequences in terms of sustainability
- Large-scale storage solutions have to be implemented to accommodate such penetration of VarRES.
- **CSP technology** is, nowadays, the only and **the most reliable solution to equip the system with that large-scale storage**. However, there is still a dramatic lack of knowledge about all the benefits this technology may provide and its role in the necessary Energy Transition.
- **Hybrid systems**, combining the storage ability of CSP with the low price of PV and Wind, may help policy makers to finally consider CSP technology to play a key role in the upcoming energy green deals.

What does CSP offer today?

CSP offers essential distinctive features to allow a sharp drop of the energy prices after sunset

Referring to **ESTELA four commandments** in the last COP25 event, CSP technology provides the following features to the energy market:

1. **Bring flexibility to intermittent RES** and allows for delivery firmness making CSP already competitive against fossil-based solutions in sunny countries in the timeframe sunset-sunrise
2. **Industrial maturity**. Instead of hoped-for technological and quantitative development for any 'new-promising' technologies. CSP is already today available at industrial scale.
3. **CSP energy on demand** can be transferred to other countries via the network wherever needed. This clearly contributes to a more efficient use of the given natural resources across a region or continent.
4. **It allows various uses of its thermal storage** technologies for process heat in the industry, contributing to mitigate hot economic-social issues since those applications are equally important for achieving a substantial reduction of CO_2 emissions in the world.

What is needed to re-launch CSP market?

Specially in those geographies with an extensive RES culture

- More efficient and sustainable **procurement practices** for renewables.
  - Global auctions focusing on the value of flexibility and firmness in the power generation system.
  - Legislation to balance the energy price.
- **Specific policies about CO_2 emissions reduction tar**gets ('green footprint certificate') for both, the power generation market and the large-scale industries.
- **Incentives program** to equip the energy market with green capacity, making more attractive the investment on retrofitting existing plants, providing a 'second life' of those facilities and lowering the energy cost.
- An '**education campaign**' to be conducted from all entities/parties involved in the CSP market to deeply explain the capabilities of this technology and to step out of the comparison with VarRES.

Which should be the strategic approach of CSP?

Three main lines of activities have been detected by Abengoa with a

1. **Hybridizing CSP with other renewable technologies** to get a 24/7 solution with a net-zero emissions footprint.
2. **Hybridizing CSP with any other technology**, including conventional, to get a lower LCOE for a 24/7 solution and partially reducing CO2 emissions.
3. **Retrofitting already existing plants** by introducing storage solutions based on CSP together with/without other dispatchable technologies.

Hybridization for PNIEC

PNIEC targets

1. **74% RES-Electricity (mainly PV and wind) and 42% RES in energy market by 2030**
2. **Storage strategy: 11GW of additional storage (6GW of storage+5GW CSP) by 2030**

   +3.5GW stational storage

   +2.5GW daily storage with high capacity

   +5GW in CSP plants with TES (>8 hours)
3. **Back-up capacity**

   Closure of 3GW of nuclear

   Closure of all 9GW of coal (c.4GW after 2020)

New storage capacity with the retrofitting of the existing CSP plants

How to apply the CSP strategy for PNIEC in Spain?

49 CSP plants: 2,300 MW
Storage capacity: 6,850 MWh
(22 plants)

- 50 MW Parabolic trough technology (96%)
- Storage (45%)
  - New storage capacity in existing CSP plants: storage, capacity, flexibility, inertia, voltage control

How to apply the CSP strategy for PNIEC in Spain?

49 CSP plants: 2,300 MW
Storage capacity: 6,850 MWh
(22 plants)

- 50 MW Parabolic trough technology (96%)
- Storage (45%)
  - New storage capacity in existing CSP plants: storage, capacity, flexibility, inertia, voltage control

49 CSP plants: 2300 MW
New Storage capacity:
17,800 MWhe (+adding 8h TES)

Spain Case of Study – PTC 50MW

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Spain Case of Study – PTC 50MW

Retrofitting of operating CSP plants with TES system: Modular TES solution to "firm capacity"

Retrofitting

Retrofitting operating CSP plants with PV/Wind: power to heat to power.
Design with resistances can guarantee 100% firm capacity

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Retrofitting

Spain Case of Study – PTC 50MW

Retrofitting operating CSP plants with TES Plant and Solar Field

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Retrofitting

Spain Case of Study – PNIEC: Comparative of solutions

- Addition of TES
- to replace the PV production every day after sunset
- Firm supply
- Strategic reserve
- Minimum additional investment
- Fast solution

- 50 MW, new TES of 8 h, 35% cycle
- Indirect TES cost
- Permits?
- Construction time?

35-50 M€

- Addition of electric heater
- Use of PV and Wind surplus
- Use of grid surplus
- Firm supply 100%
- Extension of production

- Heater cost depends on energy coming from VarRES/Grid/CSP(*)

+ 50-65(*) M€

- Addition of Solar Field and TES
- Expanding the renewable energy portion of total electricity generation

- Impact in the HT system
- Land requirement
- Solar Filed cost depends on SM
- (**) MS:2

+ 75-100(**) M€

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Conclusions

- The services that thermal storage of CSP plants can provide to the system (strategic reserve, curtailments collection, price arbitrage) constitute additional relevant reasons to push the deployment of CSP plants with TES.
- The two molten salt tank storage system are being commercially used since 2008 with proven reliability and performances.
- TES can be already installed in existing CSP plant to increase storage capacity demanded in high penetration of RES energy system.
- TES with electrical heater can use PV and Wind surplus achieving full firmness and grid flexibility

However, specific incentives for the retrofitting of CSP plants with storage are needed.

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Innovative technology solutions
for sustainability

Thank you .