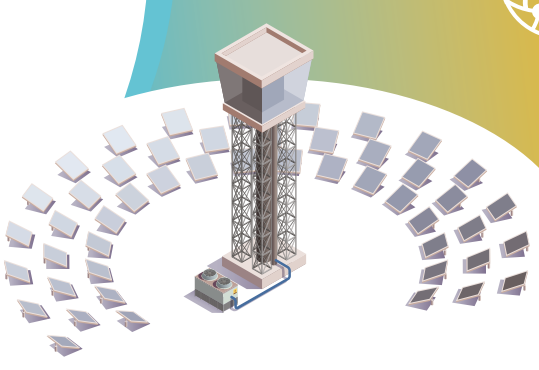
Solar Thermal Electricity (STE)

THE FUTURE OF SOLAR ELECTRICITY ON DEMAND



HORIZON STE

HOW STE WORKS

Example of a CSP Tower Power Plant

Solar thermal electricity (STE) technologies, also known as concentrated solar power (CSP), use mirrors to concentrate the sun's heat onto a receiver for either, driving traditional steam turbines or engines that produce electrical power, or using it (the heat) directly for industrial processes.

1. HELIOSTATS

Large mirrors track the sun and concentrate sunlight onto a receiver.

2. RECEIVER (TOWER)

Inside the receiver, the reflected energy is absorbed to heat up a heat transfer fluid, such as molten salts, to around 600°C. Molten salts also serve as a sensible-heat storage medium.

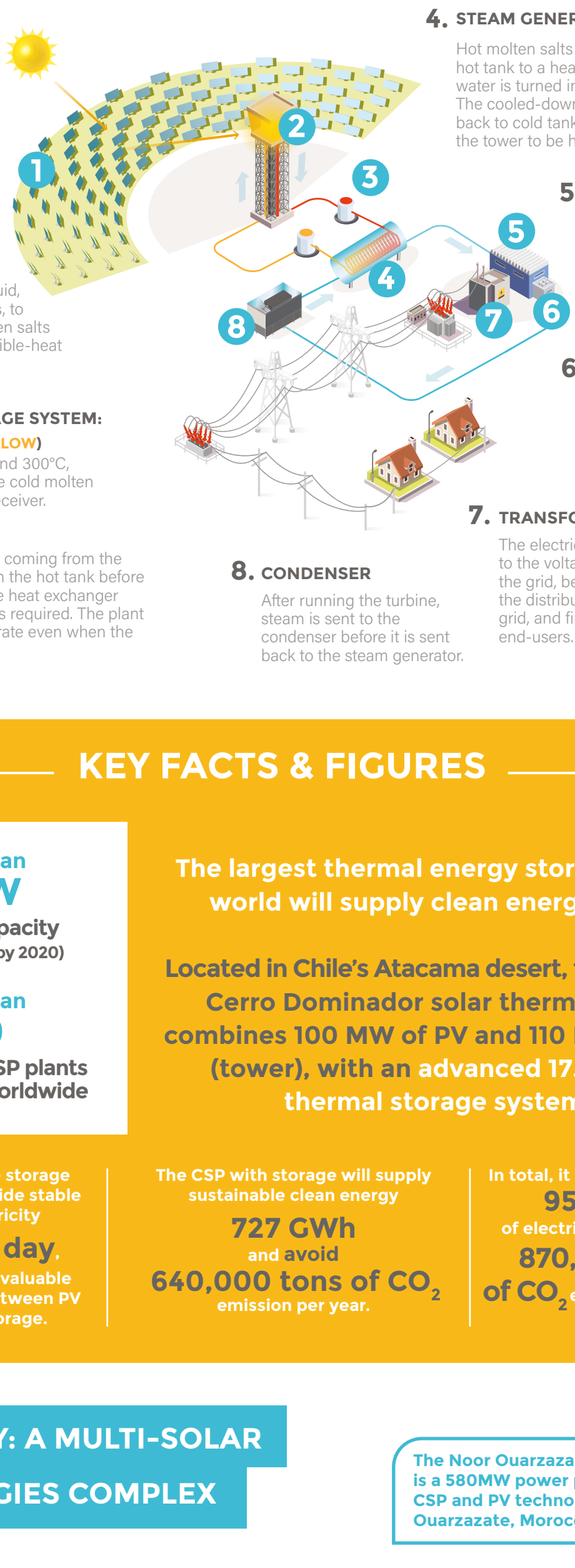
3. THERMAL STORAGE SYSTEM:

A. COLD TANK (YELLOW)

Molten salts, at around 300°C, are pumped from the cold molten salt tank up to the receiver.

B. HOT TANK (RED)

The hot molten salts coming from the receiver are stored in the hot tank before being pumped to the heat exchanger (steam generator), as required. The plant can continue to operate even when the storage is full.



4. STEAM GENERATOR

Hot molten salts are pumped from the hot tank to a heat exchanger, where water is turned into high pressure steam. The cooled-down molten salts are sent back to cold tank, ready to be sent up the tower to be heated again.

5. TURBINE

Like in other thermal power plants (coal-fired or nuclear), the steam is used to drive a turbine in a power block.

6. ELECTRIC GENERATOR

The turbine drives the generator, producing electricity.

7. TRANSFORMER

The electricity is then adjusted to the voltage level required by the grid, before it is injected into the distribution or transmission grid, and finally sent to household end-users.

8. CONDENSER

After running the turbine, steam is sent to the condenser before it is sent back to the steam generator.

KEY FACTS & FIGURES

More than
6 GW
installed capacity worldwide (by 2020)

More than
100
commercial CSP plants in operation worldwide

The largest thermal energy storage in the world will supply clean energy 24x7.

Located in Chile's Atacama desert, the 210 MW Cerro Dominador solar thermal plant combines 100 MW of PV and 110 MW of CSP (tower), with an advanced 17.5-hour thermal storage system.

Thanks to the large storage capacity, it will provide stable and clean electricity
24 hours a day,
demonstrating the valuable complementarity between PV and CSP with storage.

The CSP with storage will supply sustainable clean energy
727 GWh
and avoid
640,000 tons of CO_2
emission per year.

In total, it will produce up to
950 GWh
of electricity and off-set
870,000 tons
of CO_2 emissions annually.

CASE STUDY: A MULTI-SOLAR TECHNOLOGIES COMPLEX

The Noor Ouarzazate Solar Complex is a 580MW power plant combining CSP and PV technologies located in Ouarzazate, Morocco.

NOORo I	NOORo II	NOORo III	NOORo IV
			
CSP Trough Technology	**CSP Trough** Technology	**CSP Tower** Technology	**PV** Technology
160 MW Capacity	**200MW** Capacity	**150 MW** Capacity	**70 MW** Capacity
3 hours Storage	**>7 hours** Storage	**>7 hours** Storage	-
~ 280 000 tCO_2 emissions avoided per year	**~ 380 000 tCO_2** emissions avoided per year	**~ 250 000 tCO_2** emissions avoided per year (in initial phase)	**~ 87 000 tCO_2** emissions avoided per year
34% Industrial integration	**40.6%** Industrial integration	**42%** Industrial integration	**24%** Industrial integration

With these thermal storages, the solar power station can store solar energy in the form of heated molten salt, allowing for production of electricity after sunset and at night.

More than 35% of the project costs are sourced locally, which aids in developing Morocco's industrial base and create jobs. NOORo I created approx. 2000 construction jobs and 100 permanent jobs during the operation and maintenance phase. NOORo II and III employed around 5000 people during construction phase and created more than 100 jobs during operation.

Together, the NOORo I, NOORo II and NOORo III plants can offset more than 900,000 tons of CO_2 emissions/ year and provide renewable electricity when it is most needed.

Source: MASEN (Moroccan Agency for Sustainable Energy)

THERMAL ENERGY STORAGE (TES) WHAT'S NEXT?

Mature thermal energy storage technologies have continued to develop, and new ones have come to light, extending their operational hours, their versatility and demonstrating improved new concepts. This enables more and more potential uses of TES across different sectors and industries, including:

Electricity generation

CSP plus TES power plants (standalone or even hybridized with PV or Biomass) in countries with good solar resources

Modular storage for various sources of energy (e.g. PV, wind) with integrated generation

Retrofitting existing fossil-fuelled power plants **with TES** (avoiding curtailed electricity from PV or wind via heat pumps)

Heat applications

Process heat for industry

Heating & cooling

Auxiliary in production of green hydrogen (and other gases)

WHY STE?

How can STE contribute to the energy transition?

1/ **Avoiding greenhouse gas emissions** - accelerating the decarbonisation of the power system

2/ **Bringing high flexibility** and **dispatchability** in the energy system

3/ **Increasing the stability** of the power system (synchronous generation)

4/ **Generating positive impact** on local economies

5/ **Strengthening energy security**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 838514.