

SESSION 3 | HOW TO GUARANTEE UNINTERRUPTED OPERATION OF SOC SYSTEMS

“Storage and operation modes to enhance SOEC durability & reliability”

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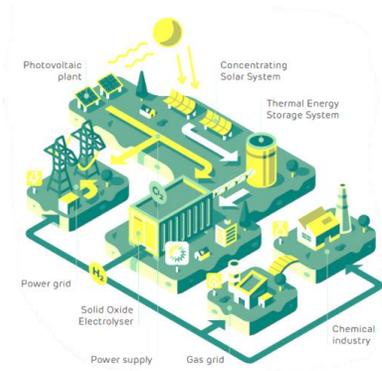
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PROMETEO Project

SOLID OXIDE CELLS: FROM MATERIALS TO SYSTEMS

ONLINE, 19 FEBRUARY 2026





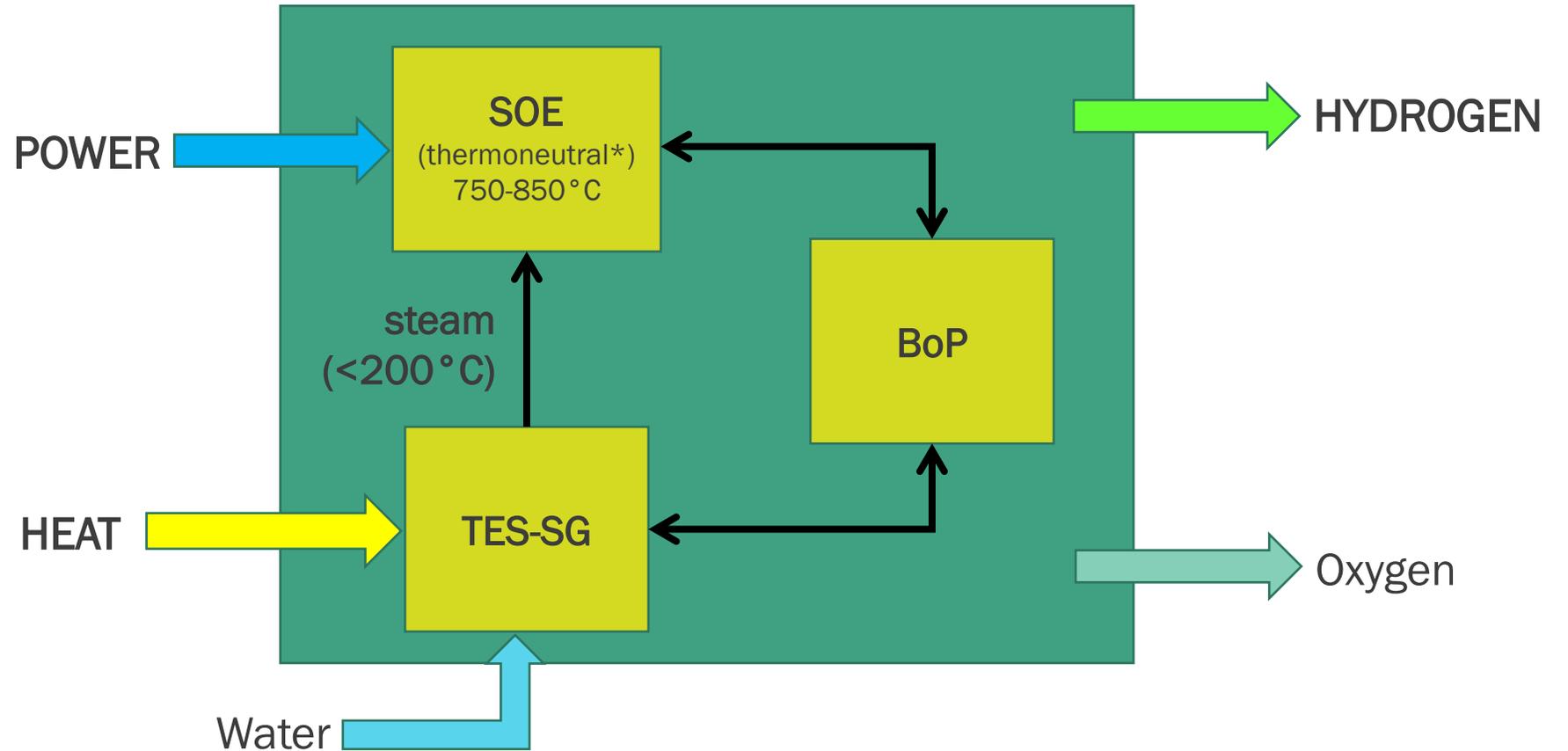


Hydrogen **PRO**duction by **ME**ans
of solar heat and power in high
TEmperature Solid **O**xide Electrolysers

Solid Oxide Electrolysis (SOE)

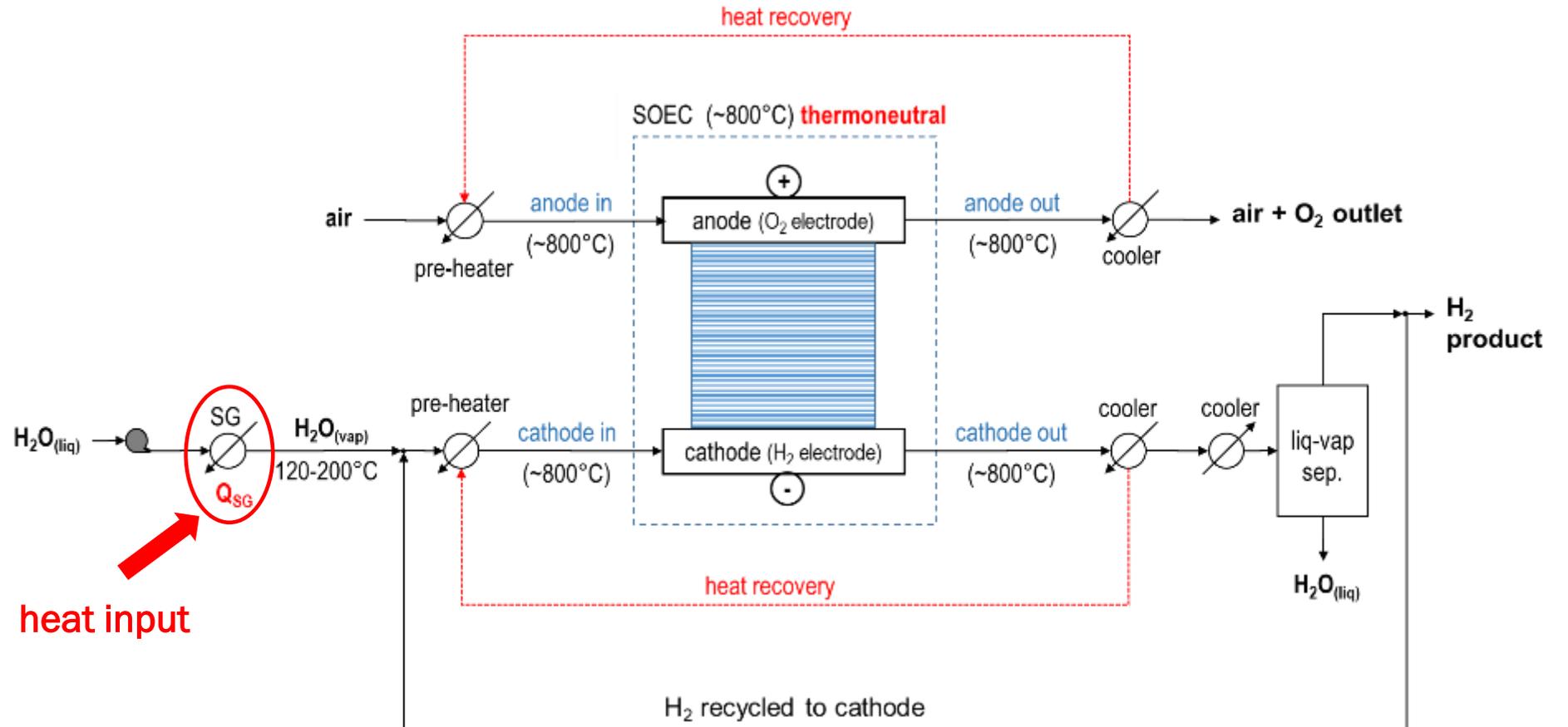
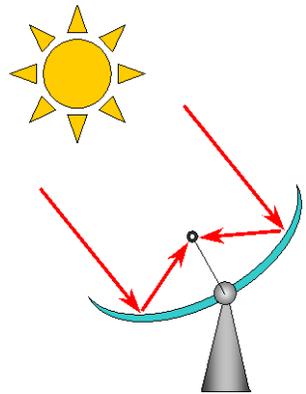
PV
PV & CSP hybrid
Wind
mix (grid)

CSH
CSP co-generation

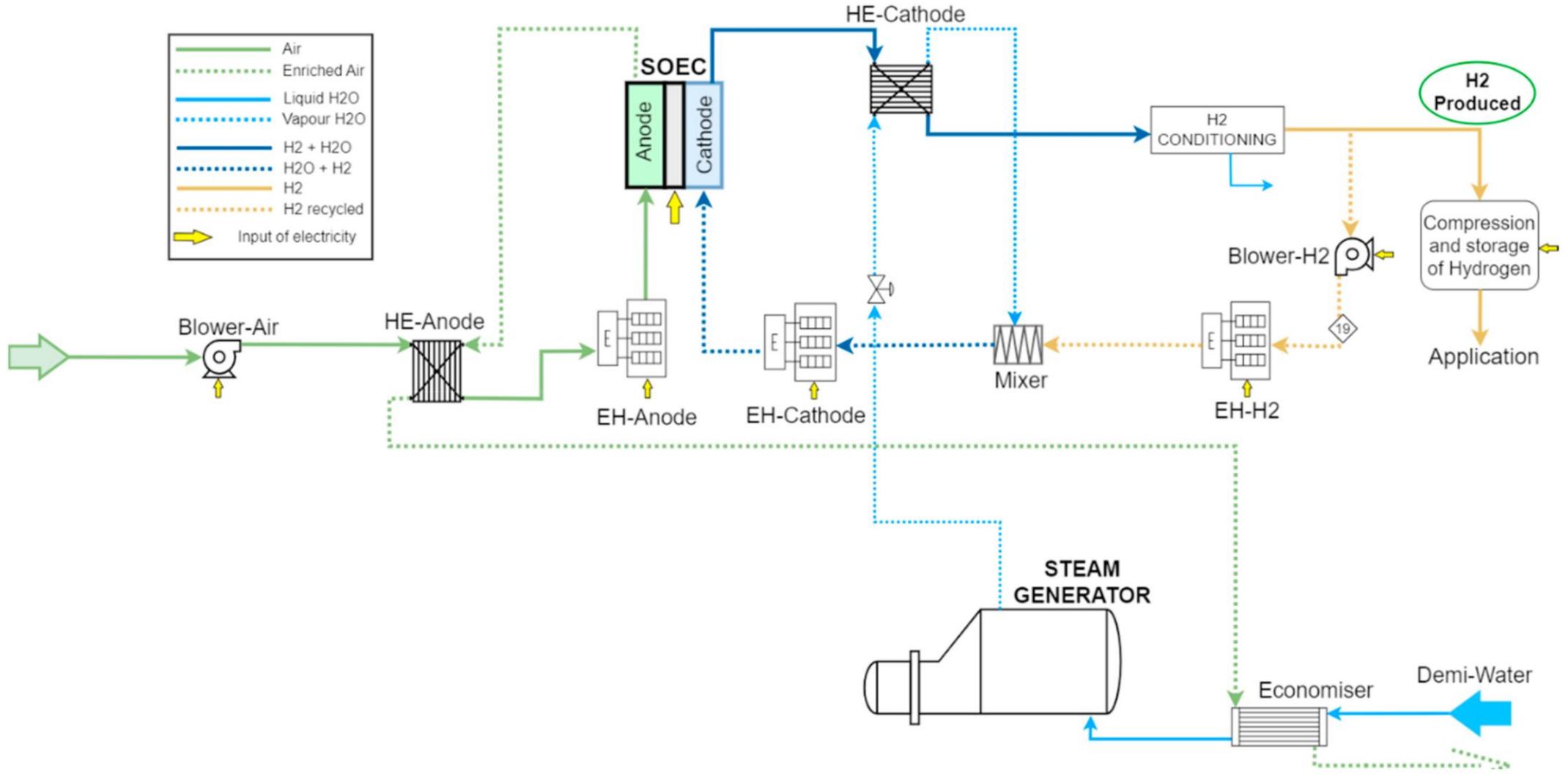


J. González-Aguilar et al., *SolarPACES 2023 Conference, Sydney (Australia), 10-13 October 2023*
G. Barreto et al. *SolarPACES2024 Conference, Rome (Italy), 8-11 October 2024.*

* the heat demand ($Q=T\Delta S$) equals the heat released by the joule heating (ohmic losses) → high electrical efficiency



Thermal integration of the SOE

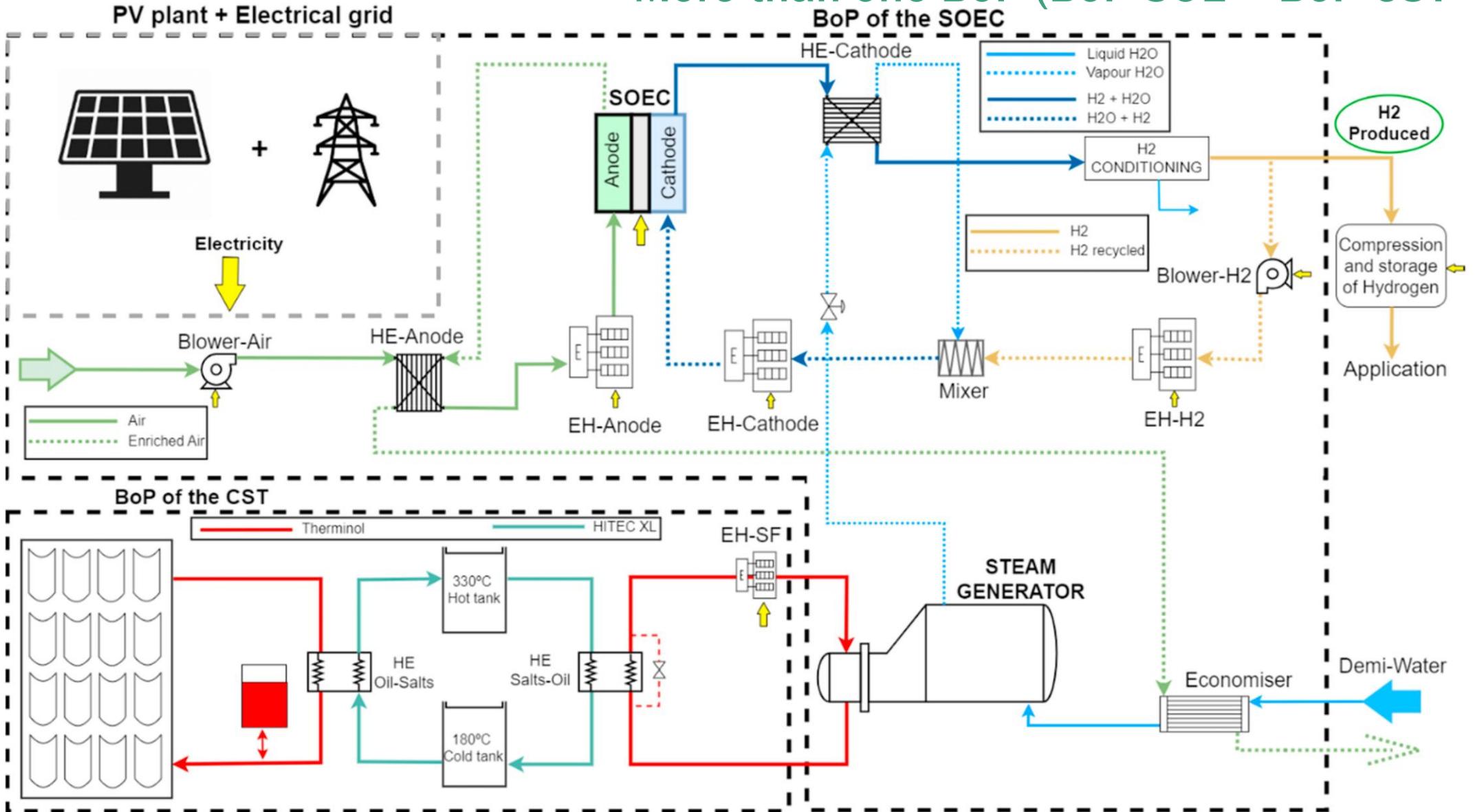




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GREEN HYDROGEN FROM SUNSHINE

Integrating with solar

More than one BoP (BoP SOE + BoP CST + SG)



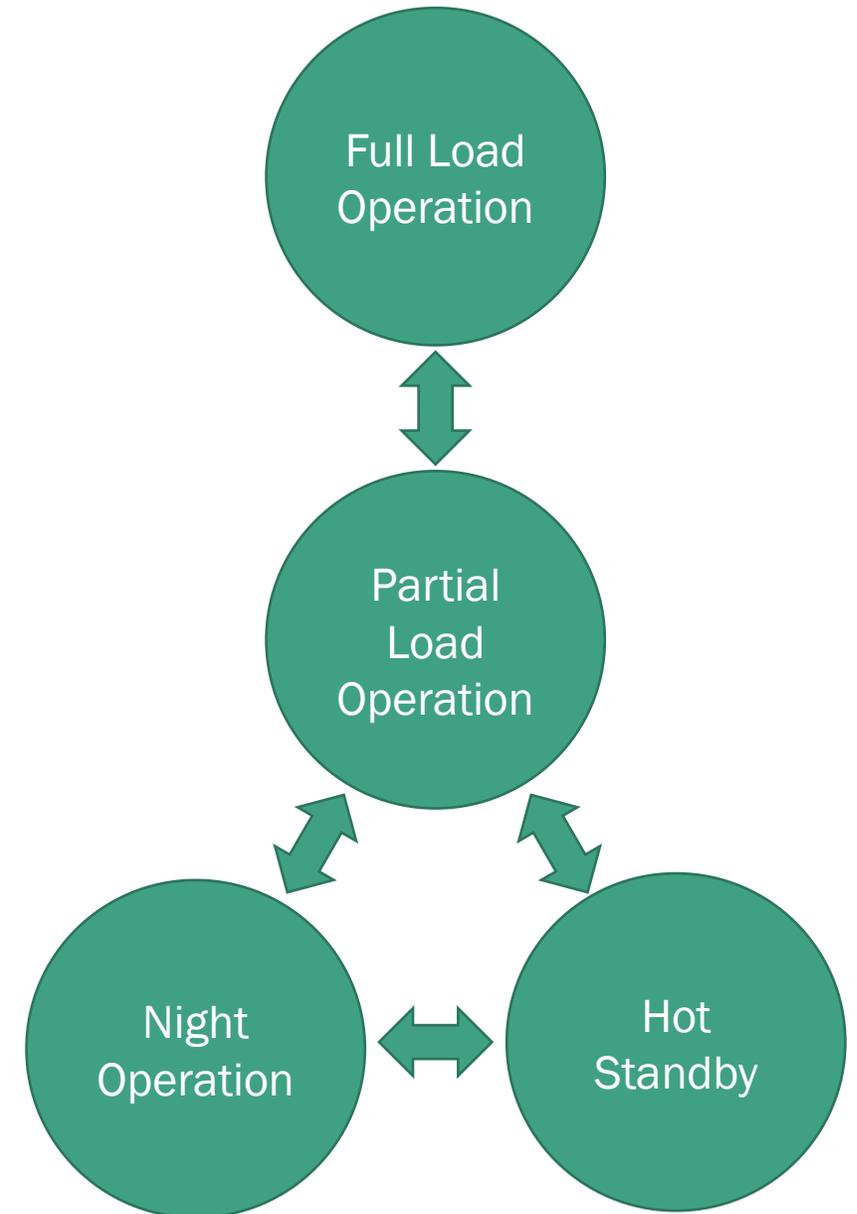
SOE operation modes

Hydrogen production

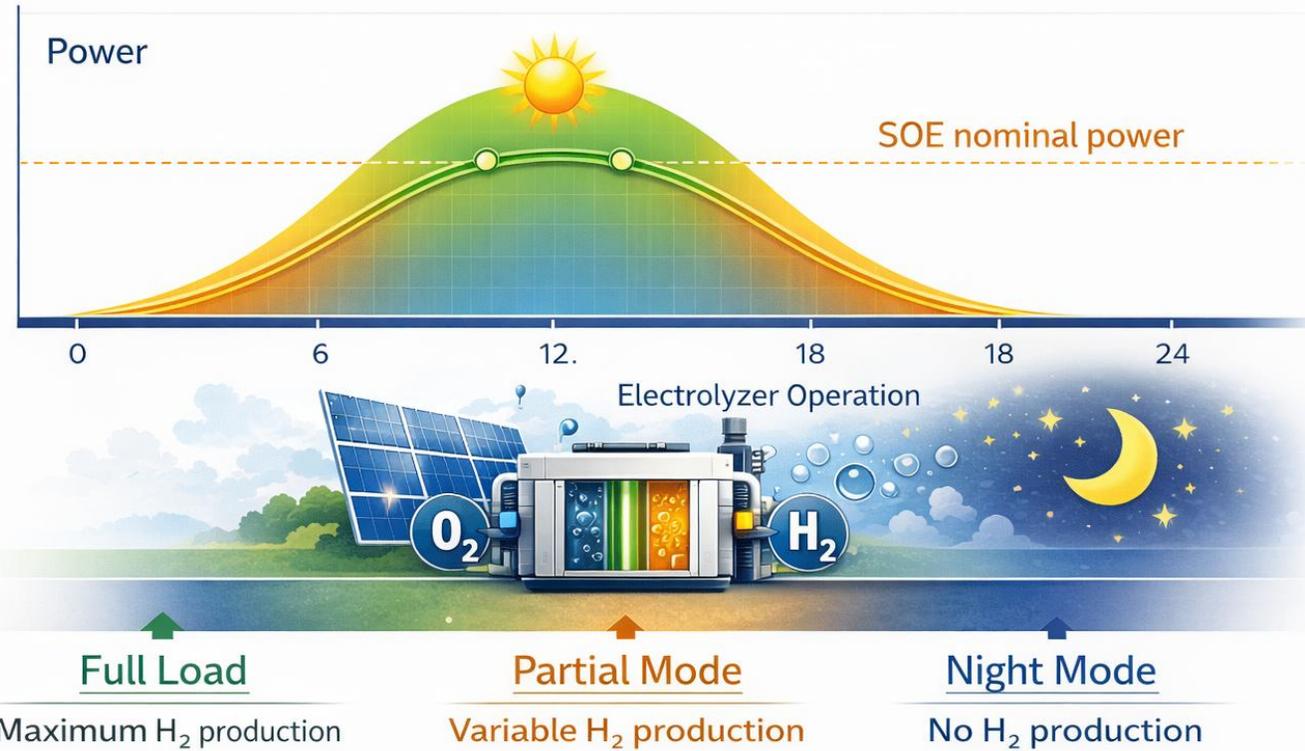
- **Full load operation** – Max. H₂ production
- **Partial load operation**

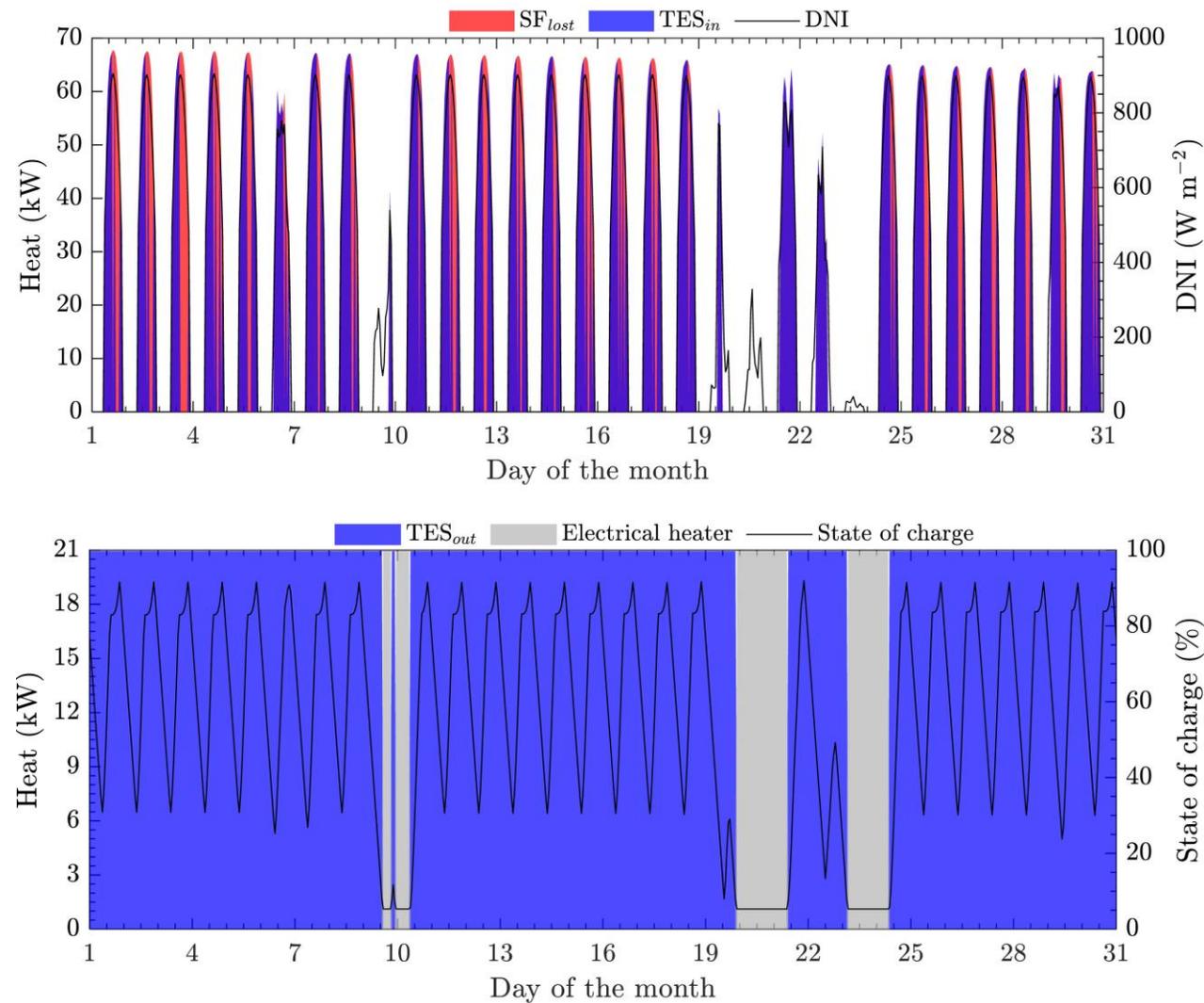
No hydrogen production

- Lack of low-cost renewable power, and the system should be kept hot and ready to start.
- Short periods (lower than 1 h) >>> **Hot standby**
- Longer periods (from 1 to 16 h) >>> **Night operation** modes
- Fast transition to full or partial loads and avoid frequent shutdowns of the SOEC system

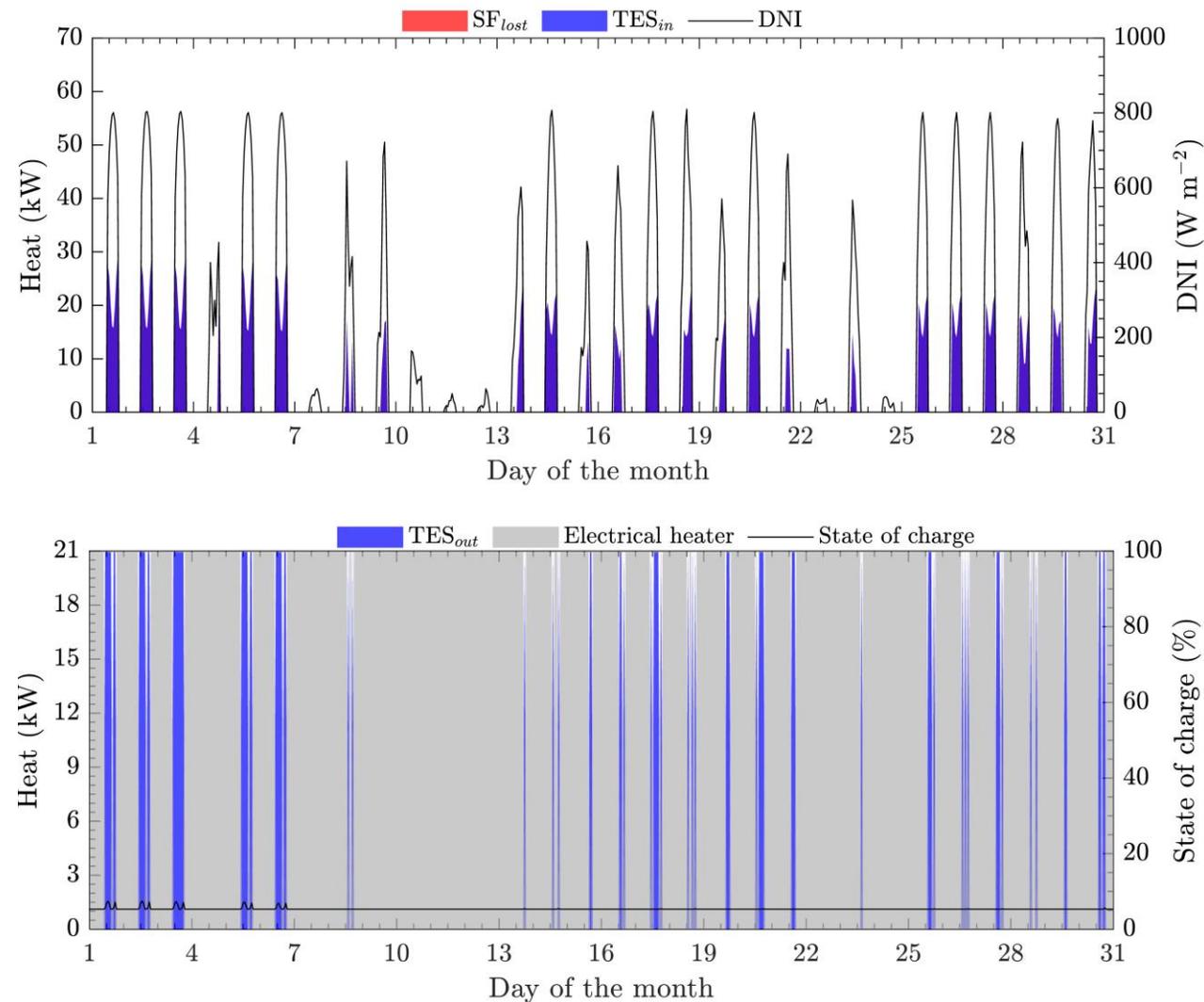


Daily Operating Curve: Off-Grid Electrolyzer Coupled with Solar Energy

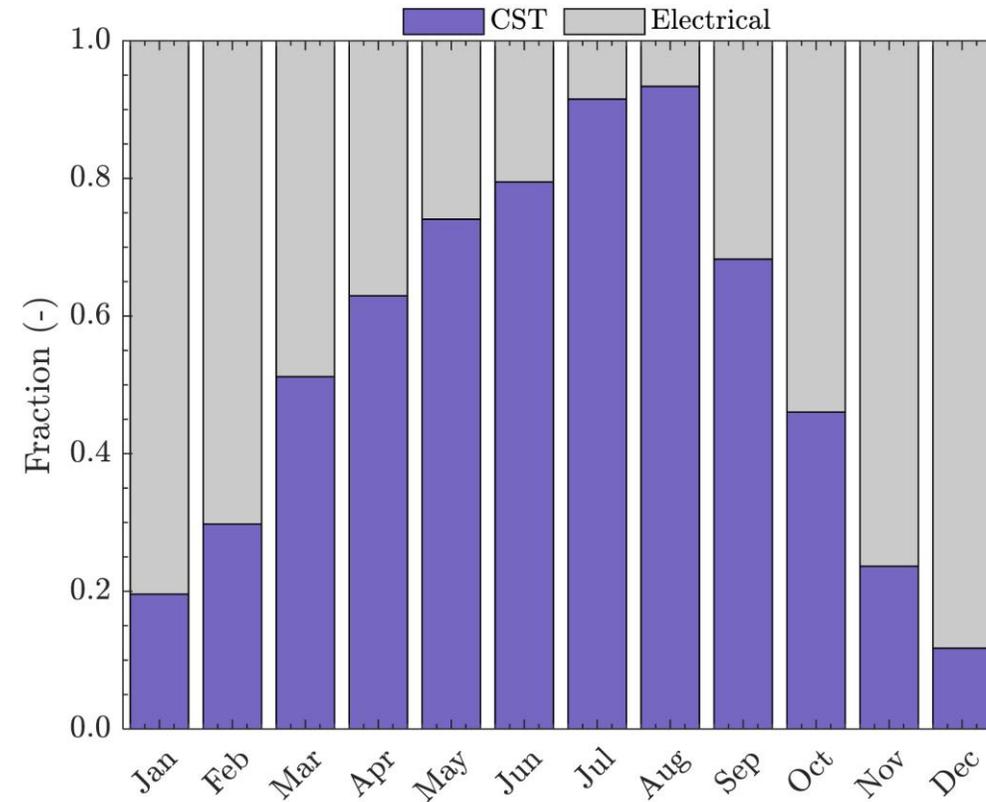




Energy balance in the CST system in July. (Top) From solar field to the thermal storage (TES_{in}), recirculation losses of the solar field (SF_{lost}) and DNI (dark line: right vertical axis). (Bottom) From thermal storage to evaporator (TES_{out}), electrical heater of the solar field and state of charge of the thermal storage system.



Energy balance in the CST system in December. (Top) From solar field to the thermal storage (TES_{in}), recirculation losses of the solar field (SF_{lost}) and DNI (dark line: right vertical axis). (Bottom) From thermal storage to evaporator (TES_{out}), electrical heater of the solar field and state of charge of the thermal storage system.



Monthly fraction contribution of the CST system and the electrical heater (HE-SF) for steady state continuous operation of the steam generator.

Key Performance (KPI)		Definition	Target	Calculated
ID	Definition			
H ₂ kg/day	Maximum measured instantaneous hydrogen production rate at full-load	H _{2-prod} (kg/h)*24(h/day)	≥ 60 kgH ₂ /day	65.52
Eff %	Power-to-hydrogen energy conversion efficiency of the heat- integrated SOE system (LHV basis)	$\eta_{SOE} = \frac{\dot{m}_{H_2-prod} LHV_{H_2}}{P_{SOE} + P_{EH-an} + P_{EH-cath}}$	≥ 85%	86.2%
Eff-w	Power-to-hydrogen conversion efficiency of the heat-integrated SOE system	$\eta_w = \frac{P_{SOE} + P_{EH-an} + P_{EH-cath}}{\dot{m}_{H_2-prod}}$	< 39 kWh _e /kgH ₂	38.7
Sol-%	Solar-to-Hydrogen energy conversion efficiency: from solar radiation* to H ₂ energy (LHV basis)	$\eta_{sun} = \frac{\dot{m}_{H_2-prod} LHV_{H_2}}{\dot{Q}_{evap} / \eta_{CST} + (P_{SOE} + P_{EH-an} + P_{EH-cath}) / \eta_{pv}}$	≥ 10%	13.9%
F-TES	Hours in which the SOE has been driven with heat directly discharged from the TES vs. total hours	$F_{TES} = \frac{\sum_1^{8760} \dot{Q}_{TES-out}}{\sum_1^{8760} \dot{Q}_{evap}}$	≥ 50%	53.2%
Eff-TES	Heat-to-TES-to-Heat conversion efficiency of the TES system on charge/discharge cycles	Q _{TES_out} /Q _{TES_in}	≥ 85%	97.0%

^[1] The KPIs are for Sevilla and a North – South mounting of the parabolic through. The values will change for a different location and mounting orientation.

^[2] The amount of power in blower and electrical heater of the hydrogen can be neglected. Electrical consumptions related to solar operation of PV, CST and TES, not included.



Thank you for your attention



The project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under Grant Agreement n° 101007194. The JU receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe Research.

