TECHNISCHE UNIVERSITÄT WIEN

Dispatchable solar power - Comparing cost and performance of CSP and PV with thermal or battery storage

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joint work with

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Comparing solar power with storage

- Which system is better for dispatchable solar power?
- High-level techno-economic analysis: evaluates the impact of
  - required **storage time** &
  - **technology cost** development

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Making the sun shine at night: comparing the cost of dispatchable concentrating solar power and photovoltaics with storage

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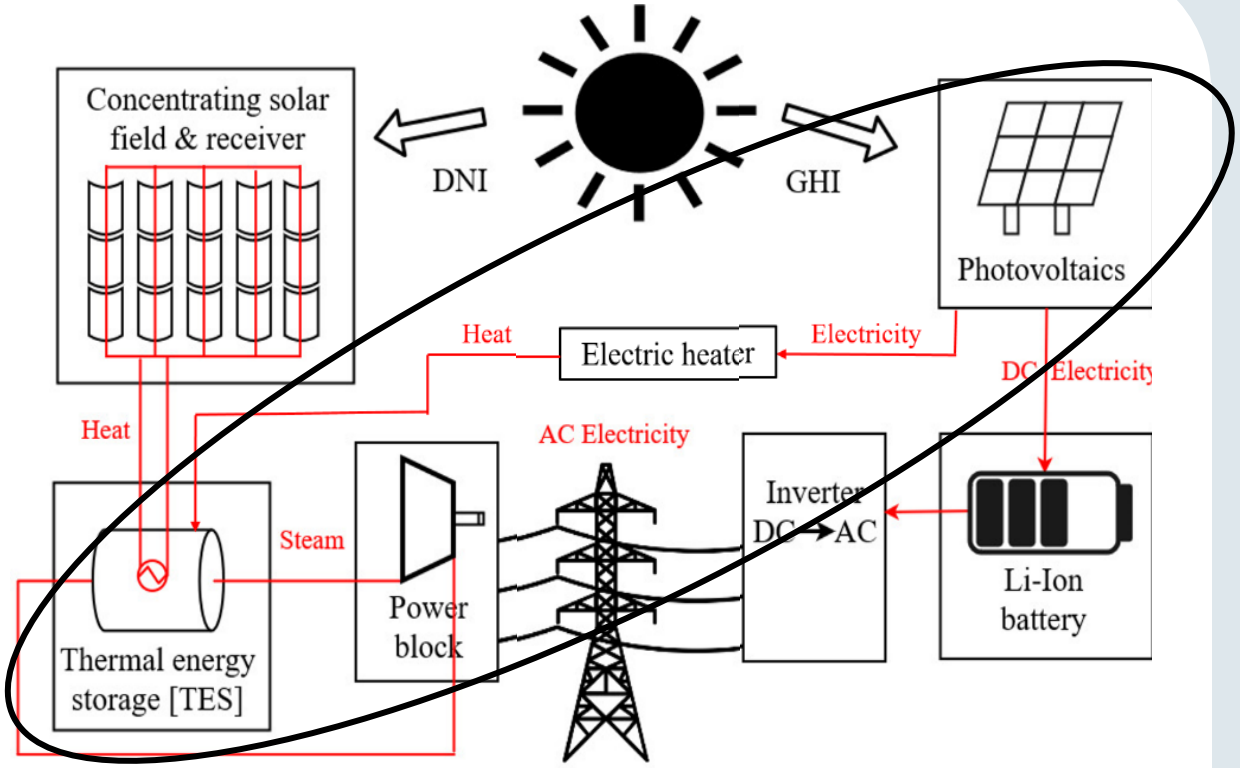
MUSTEC
Market Uptake of Solar Thermal Electricity

Conceptualization of the analysis

- High-level comparison of **three solar technology options**
  - CSP + thermal energy storage (TES, molten salt)
  - PV + utility-scale lithium-ion battery (BESS)
  - PV + TES

- Stylized setting: hourly resolution of one year
  - Solar radiation for a **specific site (Spain)**
  - During the day: charging of storage
  - After sunset: discharging a **continuous electricity load from storage** for a certain time span (1-24 hours)

- Three **cost scenarios** (literature review on cost projections): Current/medium/low costs



- Output: investment and O&M costs of
  - **electricity generation capacities** (solar field and power block for CSP, and PV panels + inverter)
  - **storage capacities** (Li-Ion battery and TES)

Different niches for different technology options

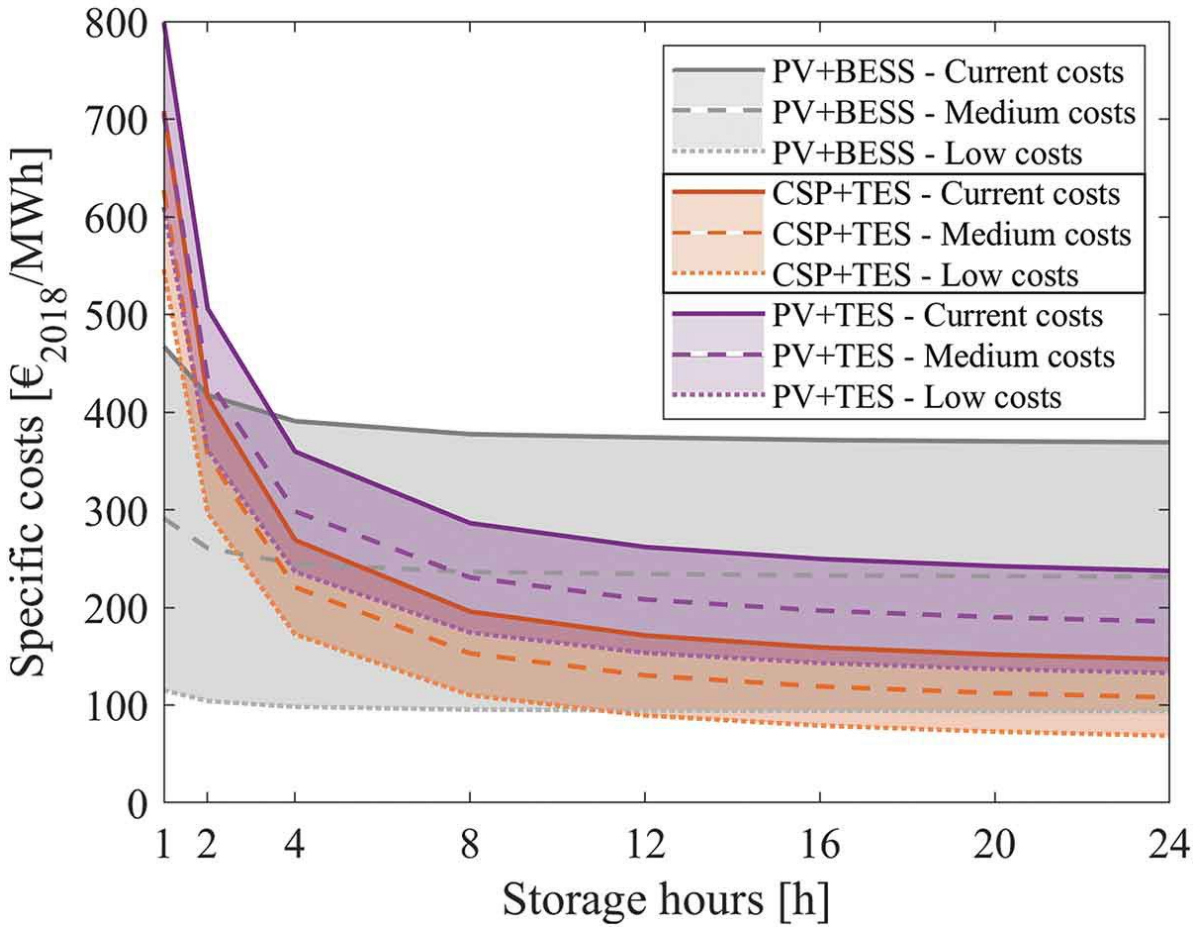
- **PV+BESS** is **cheaper** than CSP+TES for **short storage durations**: 2-3 h (current costs), 4 h (medium costs), and 10 h (low costs)

- **CSP+TES** is more **economic for longer storage hours** unless there is much stronger learning for PV+BESS than for CSP+TES.

  → **high value of storage** for currently installed CSP **in power systems** with high shares of wind & PV

- Very **much learning potential in BESS** compared to the other technology components

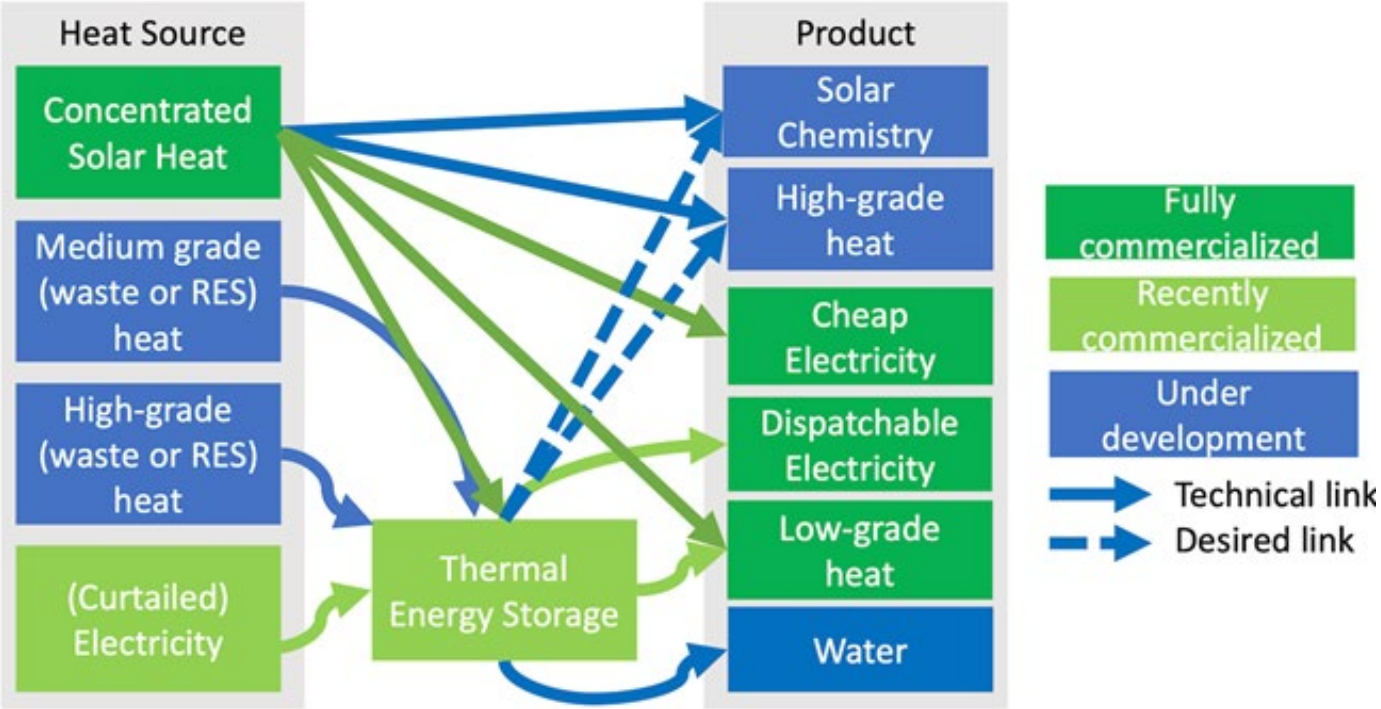
  → **high range of uncertainty** regarding the competitiveness of PV+BESS



Cross sectoral deployment can change the picture…

- Power is only one product among many
- Manufacturing & industry **decarbonization** will create new **opportunities & spillovers**
- A **cross-sectoral perspective** offers new revenue streams and changes the economics
- **Co-benefits** of thermal storage with other industrial processes, e.g.
    - Different grades of industry heat, e.g. for thermochemical processes
    - heating and cooling
    - use of waste heat
    - solar water treatment: desalination, detoxification
    - Sustainable energy carriers/renewable fuels

Several inputs and outputs can be combined in one plant:



Thonig, R. & Lilliestam, J. (in press). Concentrating Solar Technology Policy Should Encourage High Temperatures and Modularity to Enable Spillovers, in: *AIP Conference Proceedings SolarPACES 2021, Preprint available from: https://www.researchgate.net/publication/355154844*

Conclusions

1. Competitiveness of CSP combined with TES in comparison to PV + storage in future fully decarbonized electricity systems is **highly dependent on the required storage size.**

2. There are **niches for CSP+TES** as well as **PV+BESS**: different technologies allow us to take advantage of optimal solutions for different demand profiles and can contribute to minimizing the overall system costs.

3. Consideration of **cross-sectoral co-benefits** in **industrial processes** can increase competitiveness of thermal energy storage and applications.

Thank you!

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