

Is Heat Storage Relevant to Support Industrial Decarbonization?

Optimal multi-energy system sizing for heat supply

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In Europe, **process heating** constitutes more than **40% of the total energy demand** and is responsible for **three-quarters of total industrial emissions** (Agora, 2024). **Electrification** with heat pumps and boilers is a crucial strategy for decarbonization, especially for temperatures below 180°C, relevant for sectors such as paper, food, and chemical industries. Integrating **heat storage solutions** can bring flexibility to the electric system while **leveraging low-carbon and cost-effective electricity**.

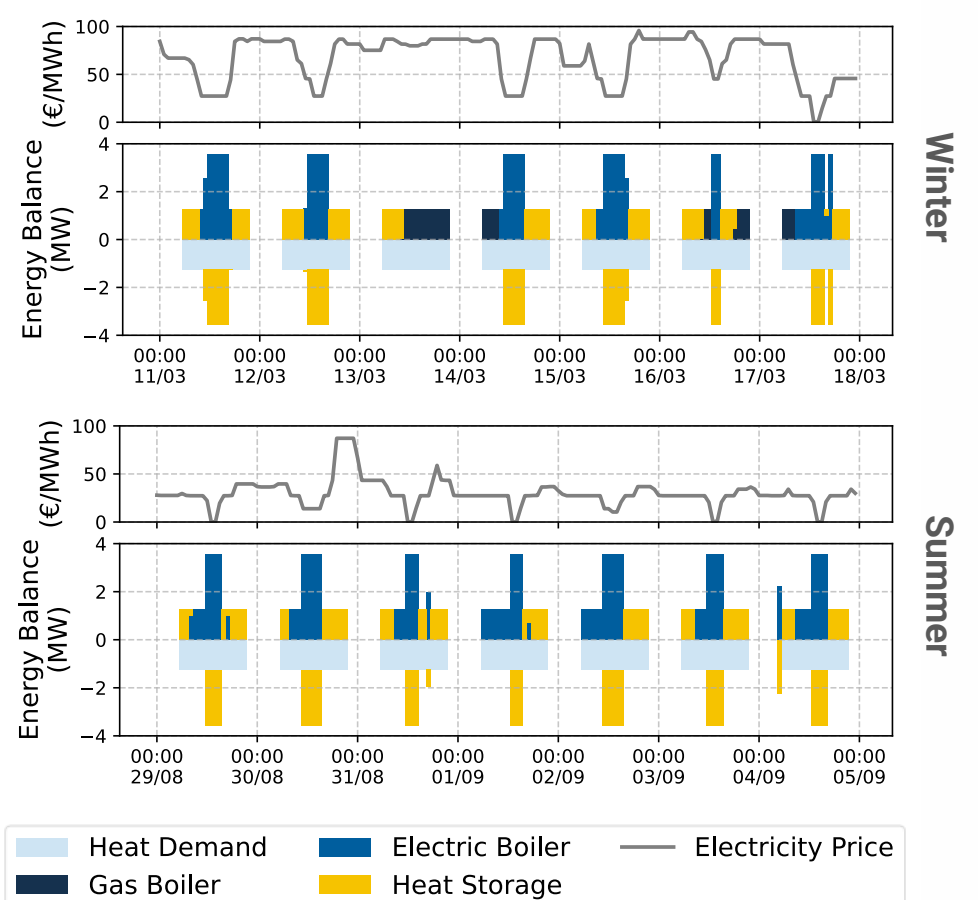
Use case

- A chemical industry with a **two-shift constant heat demand** of 1,26MW at 180°C is considered.
- The site has an existing **gas boiler** and can invest in an **electric boiler** and **thermal storage** capacity.
- Gas and electricity prices and carbon contents are taken from TYNDP 2024 National Trends scenario for **France in 2030**.

Methodology

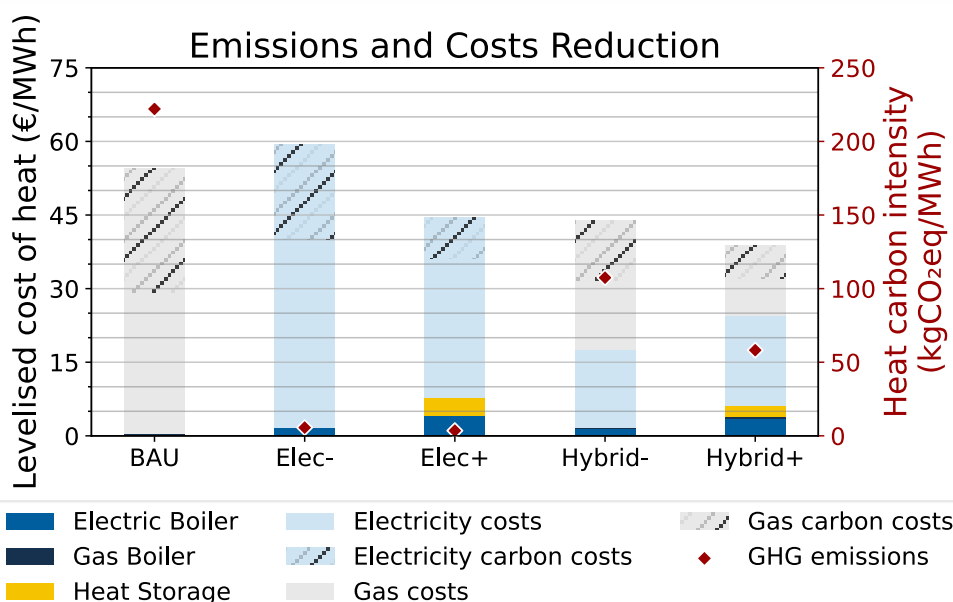
- The system is modelled as a **linear optimization problem** of the capacity expansion class.
- The objective function to **minimize is the annualised total costs**: CAPEX, variable and fixed OPEX and carbon costs.
- Five scenarios are considered: business as usual (**BAU**), electrification with without storage (**Elec+** and **Elec-**) and hybrid electrification with the existing gas boiler with and without storage (**Hybrid+** and **Hybrid-**).

Typical Weeks of Operation in scenario Hybrid+



Conclusion

- Electrification with heat storage** is the most cost-effective sizing of the system with annual **emissions lowered by 70% to 95%** compared to business-as-usual scenarios.
- Hybridization** between gas and electric boiler is more flexible and **cost-effective** than storage to handle high electricity price periods, leading however to a **higher heat supply carbon intensity**.
- Storage** follows the **daily pattern** of the electricity price.
- The **electric boiler is oversized** by a factor **three** to capture low electricity price windows.



References

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