Energy flows and heat recovery in a Norwegian CO_2 dairy utility system

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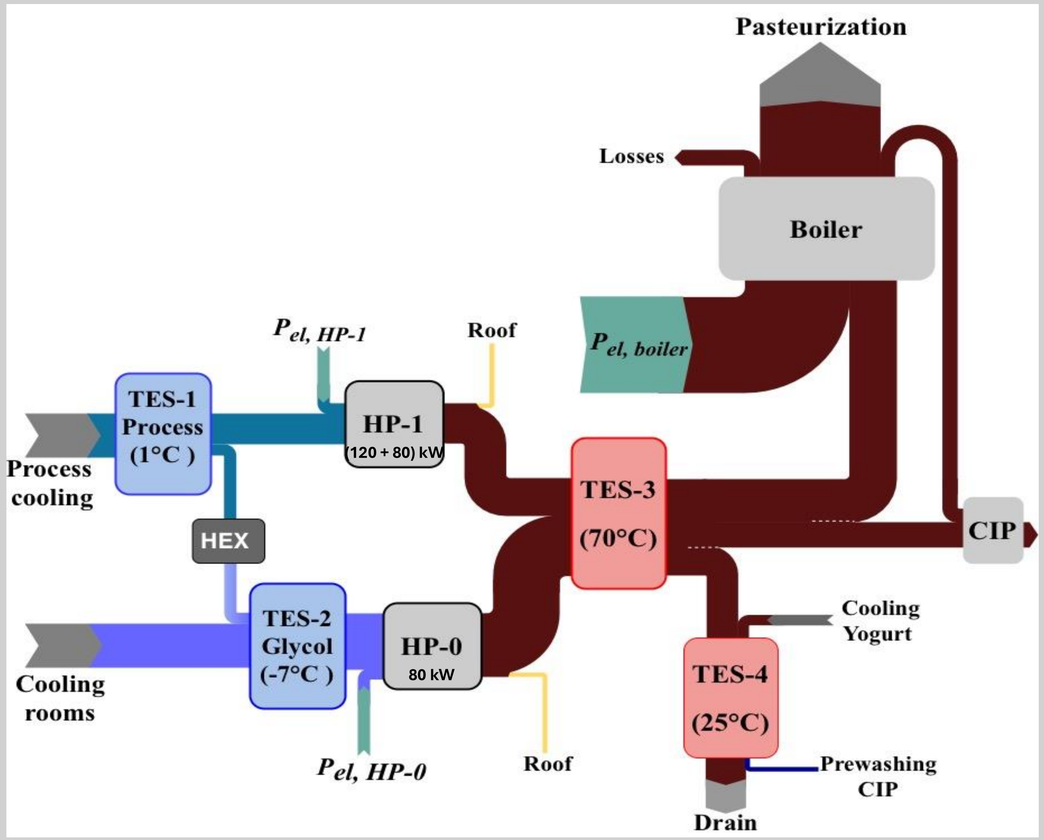


Overview of the thermal system

- Integrated CO_2 refrigeration and heat recovery system (simultaneous heating & cooling).
- CO_2 heat pumps (HP-0 & HP-1) upgrade recovered heat from the cold side to the hot-water network.
- Two cooling levels: process cooling (~1 °C) and cold rooms/glycol (~–7 °C).
- Hot-water network with thermal energy storage (TES-3) for buffering and peak shaving.
- Heat recovery charges hot-water storage (~70 °C) for CIP and hot-water users.
- Electric boiler provides high-temperature heat for pasteurization (~98 °C).
- Excess heat is rejected to ambient (roof) when sink demand or storage capacity is limited.

Background

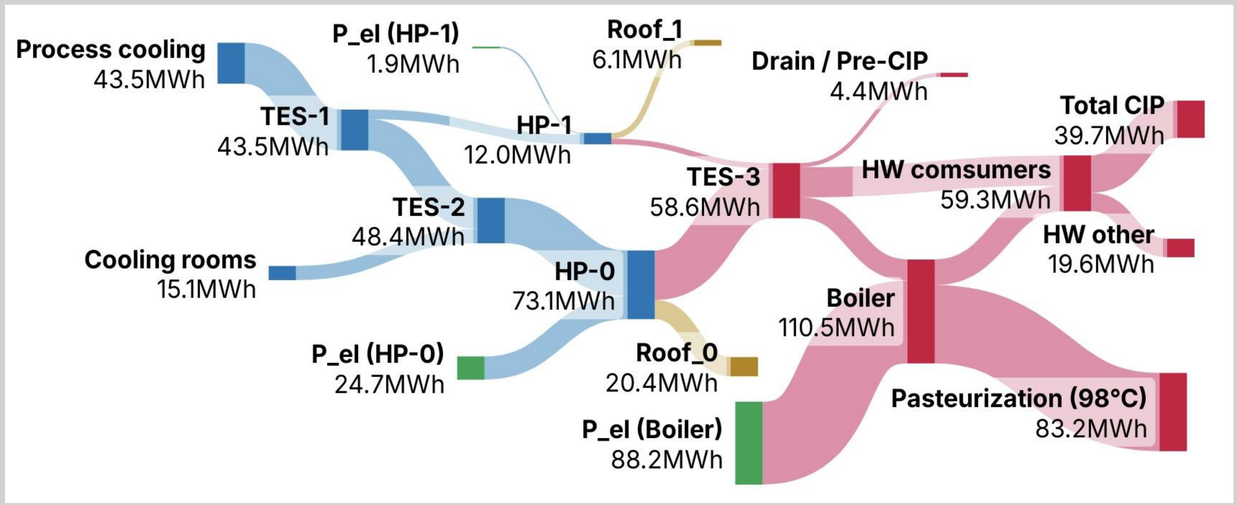
As part of the ENOUGH2020 project, Rørosmeieriet is working with SINTEF Ocean and NTNU to improve energy efficiency and reduce emissions in dairy utility systems. Rørosmeieriet operates an integrated CO_2 refrigeration and heat recovery system with multiple temperature levels for dairy processing. Production and cleaning-in-place (CIP) create strongly time-dependent heating and cooling demands, where short peaks can drive capacity and electricity demand. This project establishes a time-resolved baseline of loads and internal energy flows to identify dominant energy drivers, waste-heat utilization and rejection, and to provide a foundation for future improvement concepts such as high-temperature heat pump (HTHP) integration and cold thermal storage (CTES).

Future case – Master's thesis

- Integrate a cascade HTHP to deliver upgraded heat to the hot-water network, with aim to reduce the electric boiler operation.
- Primary heat source: CIP wastewater (drain) and other suitable low/medium-temperature returns.
- Introduce CTES for further peak shaving and load shifting.
- Assess ice slurry as a CTES solution for process cooling.
- Develop a dynamic simulation model of the utility system, including the HTHP concept and CTES.

Monthly energy flows (January 2025)

- Based on 1-minute operational measurements from the utility system (flows, temperatures, and electrical power/energy signals)
- The electric boiler dominates electricity use, driven by high-temperature duties.



MSc student in Energy and Process Engineering (NTNU), focusing on energy efficiency in industrial thermal systems.

Currently working on energy analysis and heat recovery in a Norwegian dairy.

Research interests:
- *High-temperature heat pumps (HTHP)*
- *Thermal energy storage (TES / CTES)*
- *Wastewater heat recovery*