DESIGNING AN ENERGY-EFFICIENT GREEN METHANOL PRODUCTION PROCESS USING A SOLAR-REDOX CYCLE AND CAPTURED CO_2 FROM THE CEMENT INDUSTRY

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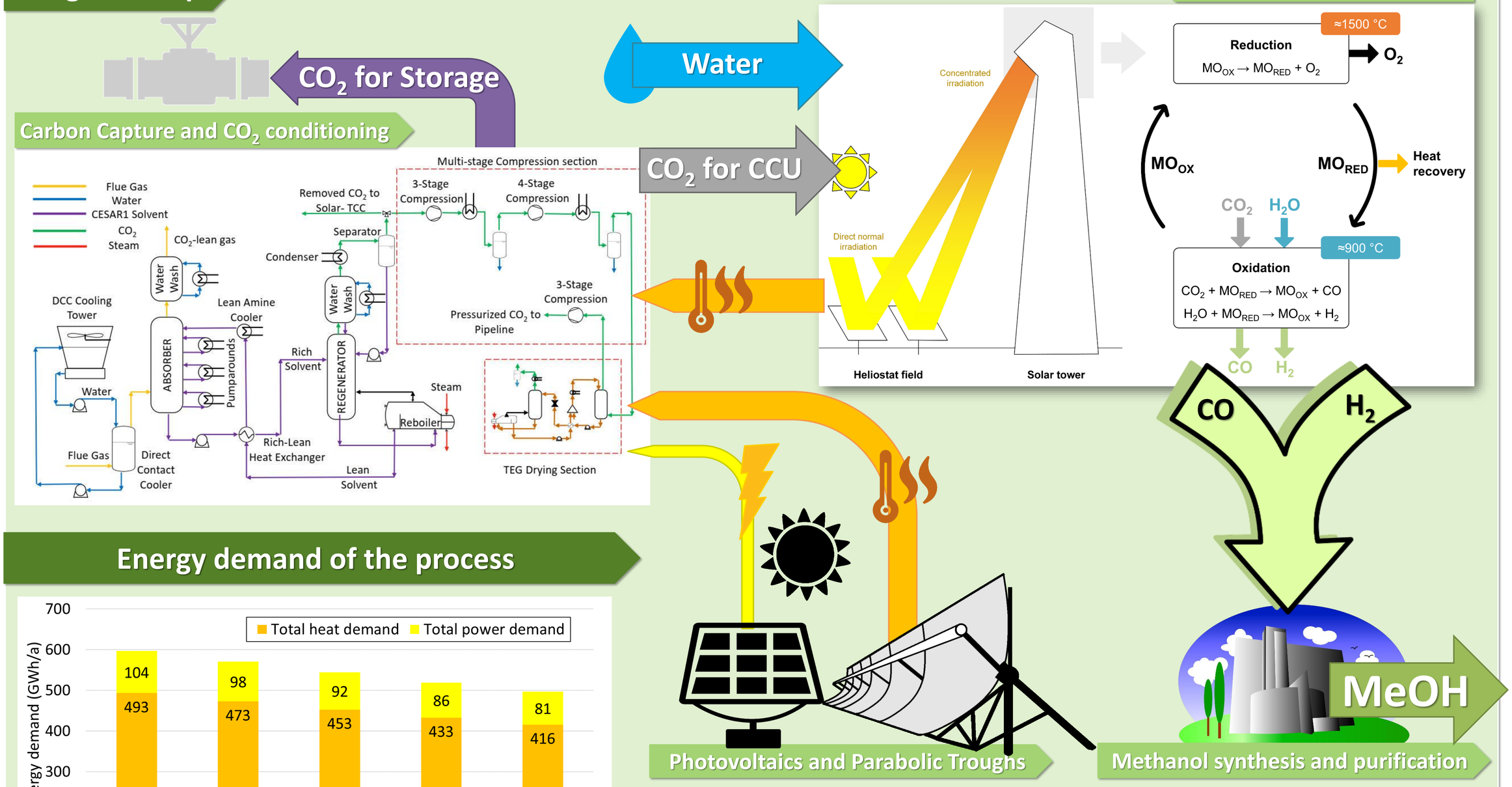
Summary

The chemical industry's future relies heavily on methanol as a crucial commodity. We propose a renewable alternative route to produce syngas using ***solar thermochemical cycles (TCC)*** for water and CO_2 splitting. The design concept tests the synergy between an **intermittent** solar TCC and a **continuous** carbon capture (CC) process. The designed CC unit utilizes a novel amine solvent (CESAR 1) to capture CO_2 from the direct emissions of the cement industry. ***Capture and conditioning*** for utilization (CCU) and storage (CCS) were modeled using Aspen Plus®. The solar-TCC process is optimized using an *in-house* Python model, which also estimates the energy requirements, employing parallel systems in a 2:1 ratio for the simultaneous production of H_2 and CO. This configuration enables efficient and scalable syngas production, which is then converted into ***sustainable methanol***. By leveraging solar energy and captured CO_2, our proposed system offers a promising pathway towards a more sustainable chemical industry.

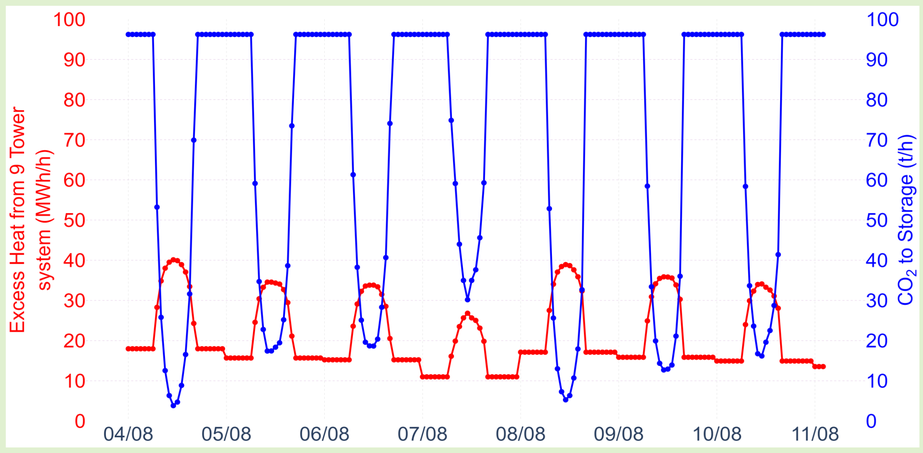
Location

Design Concept



Energy demand of the process

Hourly excess heat and CO_2 sequestration



Key points & outlook

- Application of novel EU-backed amine solution for CO_2 capture.
- Combined valorization and storage of unavoidable CO_2 emissions can enable cost-effective **deep decarbonization of the cement industry**.
  - Captured CO_2 utilization rates between 9 % and 32%
- Green *syngas* production using ***solar-TCC*** technology.
- Green methanol production via traditional pathway.
- Preliminary results show potential for **energy integration**.
- Provision of **solar power** for the supplementation of extra energy requirements.
- **Future work:** updating current solar-TCC models to *state-of-the-art*, improving integration and overall system efficiency.
- **Future work:** Techno-economic assessment of the optimized system to assess the costs of the integrated system.

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