Highly Efficient Super Critical ZERO eMission Energy System

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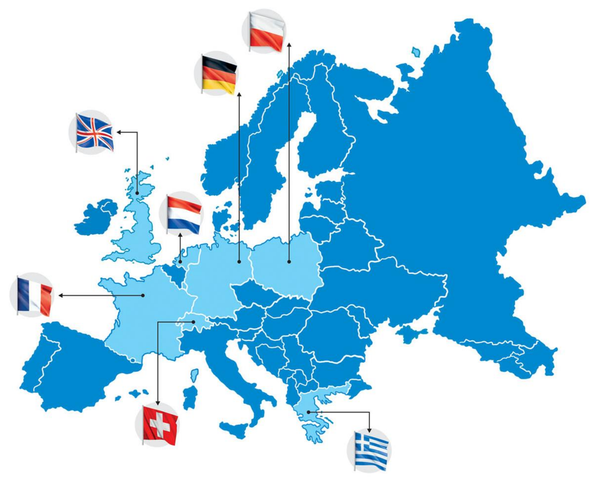
HERMES objectives

The key objective of HERMES is to develop and assess the performance of a closed-loop renewable energy system based on a directly fired supercritical gas turbine engine (s-GT) operating on a variety of liquid/gaseous renewable fuels to provide electricity (and heat) with an efficiency above 65%, with net-zero greenhouse gas emissions and no emission of other pollutants. The HERMES zero-emission GT running on chemically stored renewable energy combines three unique features:

1) interchangeability of renewable fuels;
2) operation of Gas Turbine on high pressure conditions and supercritical fluids as working media, not typically used in the current technology;
3) exploits decentralized CO_2 capture, utilization and storage without additional large-scale storage requirements, resulting in a closed-loop system.



HERMES system

The HERMES project is a European project focused on developing an energy system that can operate on a closed loop using renewable sources. One significant advantage of this system is its independence from peak hours and its utilization of renewable energy sources for power generation.

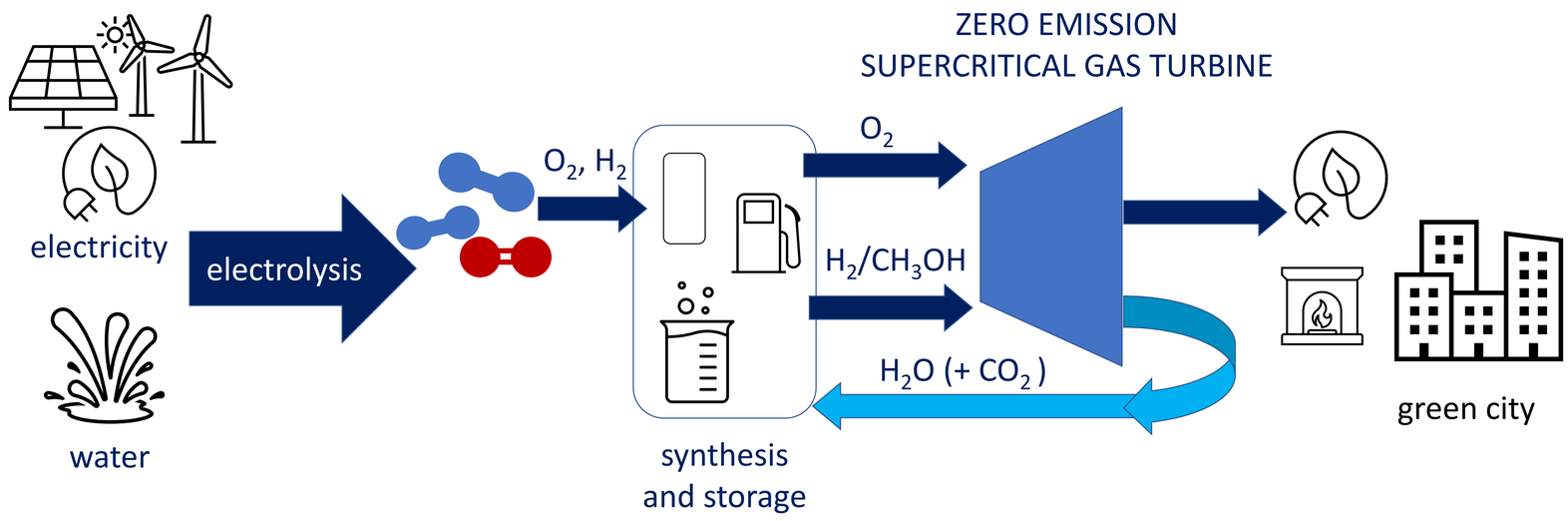


Figure 1. HERMES diagram showing the most critical objectives.

Current progress

❑ Determination of laminar burning velocity (S_L) at elevated pressure

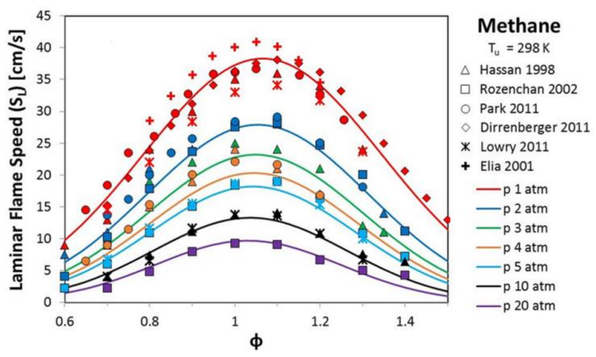


Figure 2. Laminar flame speeds for methene [1].

❑ Investigation of injected fuel (gaseous or spray) behaviour, mixing and auto-ignition characteristics at high pressures in Combustion Research Unit (CRU)

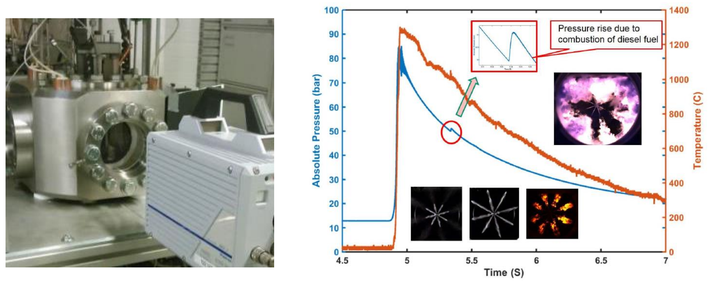


Figure 3. Experimental set-up (CRU) for auto-ignition study with results [2].

Supercritical combustion study

The aim: The research will focus on understanding the complexity of combustion process of two types of fuel with the supercritical working fluid.
We are able to create a more uniform and flexible solution, independent of the type of fluid, by investigating two fuel states, liquid methanol and gaseous hydrogen. Experimental research provides knowledge of supercritical combustion and allows verification of numerical models.

Fuel: H_2 / CH_3OH
Oxidizer: O_2
Working fluid: Xe

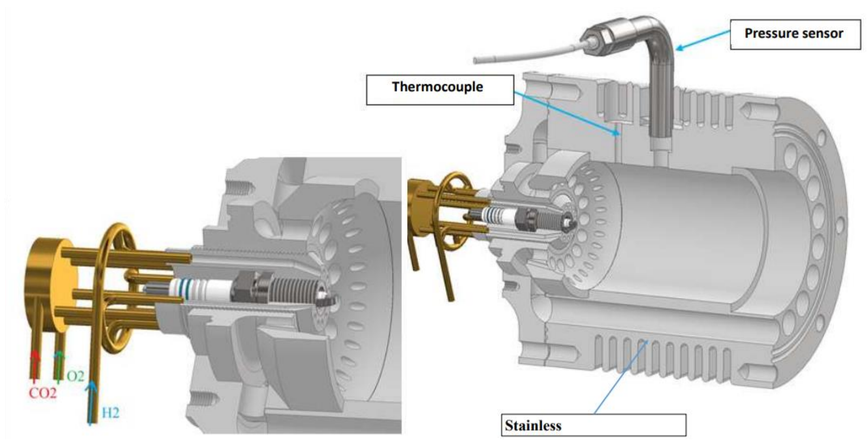


Figure 4. Design example of a combustion chamber for CO_2 working fluid [3].

References:

[1] Amirante, Riccardo & Distaso, Elia & Tamburrano, Paolo & Reitz, Rolf. (2017). Laminar flame speed correlations for methane, ethane, propane and their mixtures, and natural gas and gasoline for spark-ignition engine simulations. International Journal of Engine Research. 18. 146808741772001. 10.1177/1468087417720018.

[2] M6 HERMES progress meeting presentation by Imperial College London

[3] M6 HERMES progress meeting presentation by Wroclaw University of Science and Technology

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