Distributed Production of Hydrogen and Power for Sustainable Mobility
The project team is developing an innovative technology for Cogenerating Hydrogen, Heat and Power (CH2P) using a high-temperature fuel cell that works with a solid oxide material fed by methane rich gases.
Building the new generation of refueling stations to empower Europe’s transition to hydrogen-based mobility

#hydrogeneconomy #hydrogen #energytransition #greenmobility #EU2050 climate strategy #FCHJU
CH2P for the Hydrogen R-Evolution

Today hydrogen is the best and only choice for large-scale decarbonization of key segments in the transport, industrial and residential sectors. To achieve the EU ambition of reducing global greenhouse gases by 80% before 2050, emissions need to decrease drastically. This requires hydrogen.

In the transport sector, Fuel cell electric vehicles (FCEVs) are zero tailpipe emission vehicles that are ready for market deployment. Yet, FCEVs lack a capillary infrastructure of refueling stations. CH2P aims at overcoming this barrier by building a transition technology for early infrastructure deployment of HRS.

About CH2P

The CH2P project will demonstrate an innovative technology for hydrogen refueling stations (HRS) and charging of electric vehicles. The CH2P system is a technology that provides a novel solution for alternative fuels infrastructure operating with higher efficiency, lower costs and reduced environmental footprint.

Objectives

CH2P’s primary objective is the multiple generation of hydrogen, power and heat using novel Fuel Cells operating with solid-oxide technology (SOFC) fueled by methane-rich gases (natural gas or bio-methane). An SOFC is an electrochemical conversion device that produces electricity directly from oxidizing a fuel. Advantages of SOFC include:

- high combined heat and power efficiency
- long-term stability
- fuel flexibility
- low emissions
- relatively low cost

These advantages result in lower costs for the end users and other benefits such as lower maintenance and lower environmental impact.
Hydrogen Refuelling Stations

The next generation of HRS will be integrated in existing fuel retail stations. This means that CH2P systems will be installed at sites that have a convenience shop, a car wash and sell conventional fuels and potentially electricity for battery electric vehicles as well as hydrogen.

Concept

The CH2P system is designed considering the existing energy infrastructure, the current energy-conversion technologies and the economic conditions for operating an HRS. Starting from the needs of an HRS, the CH2P system integrates all the sub-processes involved in the production of hydrogen:

- sulphur removal
- fuel conditioning
- conversion into power and syngas
- hydrogen purification and compression
- hydrogen dispensing

Concept Diagram:

- Solid Oxid Fuel Cell Stack
- Pressure Swing Absorber (PSA)
- Hot BoP
- Syngas Compressor
- Water Make-Up
- Recycled Water
Technology

The CH2P technology is characterized by the optimal thermal integration of a SOFC system with a hydrogen generation unit. The CH2P technology is placed in a container that is divided into three compartments.

- **COMPARTMENT 1**: SOFC Stack
- **COMPARTMENT 2**: Cold Section
- **COMPARTMENT 3**: Hot Section

### Components

- **Compressor**: Syngas compressor to compress syngas for supplying the PSA.
- **Feedstock supply**: Hot Balance of Plant
- **Buffers**
- **H2 Purification**: Pressure Swing Adsorber (PSA) to clean hydrogen from impurities.
- **Solid Oxide Fuel Cell Stack**: operating at high temperature and high efficiency, where hydrogen is converted into power.
- **Hot BoP**: an assembly of hot components working between 300° and 800° that enables steam methane reforming reactions, heat recovery and steam generation.
- **H2 Storage Vessels**: to store hydrogen.
CH2P aims at advancing the available technologies for producing hydrogen into an innovative prototype for cogenerating hydrogen and electricity. At a first stage, the alpha-prototype (the first version of the CH2P system) will be tested at HyGear. At a second stage, the improved beta-prototype assembled together with the alpha-prototype (the second version of the CH2P system) will be tested in the operational environment at Shell Technology Centre in Amsterdam. Depending on the final testing results, CH2P is targeting higher maturity of the technology reaching a pre-commercial phase for the beta prototype of the system.
Cogeneration of H2 and power through CH2P is economic and efficient (>66% efficiency). Gas stations spend a lot for electric bills. A gas station can have a cost model with savings on energy bills and value on reduced cost for H2. CH2P has the plan to realize a high temperature co-generative system producing hydrogen and power in a flexible way. The value of the CH2P technology:

**Value Proposition**

CH2P has the plan to realize a high temperature co-generative system producing hydrogen and power in a flexible way. The value of the CH2P technology:

1. **Higher efficiency**
   - System efficiency is higher than 66%, the initial project target.

2. **Reliability**
   - Production of hydrogen and power to always match demand side management.

3. **Cost competitiveness**
   - Hydrogen price below 4.5 €/kg versus the actual 9.5 €/kg average price in the EU.

4. **Modularity**
   - 40 kg/day technology integrating 2 modules of 20 kg/day.

5. **Lifetime**
   - Lifetime of 40,000 hours and around 10 years (with module changeouts).

6. **High performance**
   - Hydrogen purity level 99.999% with H2O content <2 ppm and CO content <200 ppb to be compliant with the use in hydrogen cars.

7. **In field testing**
   - At Shell Technology Centre Amsterdam.

8. **Sustainability**
   - Life Cycle Analysis on environmental impacts and costs.

**CH2P and the “inverse” model of hydrogen cost**

When an electrolyser is producing hydrogen, the cost of hydrogen is depending on the cost of electricity. CH2P has an inverse cost model: the higher the cost of electricity from the grid, the lower the cost of hydrogen produced at the station. 

- CH2P generates hydrogen and power from methane.
- The electric power can be used by the refueling station, for self consumption and for charging electric vehicles.
- Cost of electric power from the grid is saved, with lower cost of electricity at the station.
- The higher the cost of electricity from the grid, and higher the savings.
- The projected cost of hydrogen is then reduced proportionally.

Gas stations can have a cost model with savings on energy bills and value on reduced cost for H2.
Four different use cases have been defined for the CH2P-system, ranging from minimum production of hydrogen and power to full power and hydrogen production. The use cases that the CH2P-system addresses are:

Users
The main users of CH2P are drivers of fuel cell electric vehicles and battery electric vehicles. These can be:

- Ships
- Taxi fleets
- Shipment fleets
- Individual car drivers electric and hydrogen
- Bus fleets

Customers
The targeted customers are oil and gas companies that are currently looking for innovative technologies to address the nascent market of hydrogen and electric mobility. Other potential customers include:

- Electricity providers
- Building/Feedstock industry
- Chemistry industry
- Glass industry
- Logistic industry
- Microelectronics industry
- Steel industry
- Chemistry industry
- Glass industry

Usage Scenarios
Four different use cases have been defined for the CH2P-system, ranging from minimum production of hydrogen and power to full power and hydrogen production. The use cases that the CH2P-system addresses are:

1. H2 production for the station
2. Power production for the station
3. H2 production for export to the grid
4. Power production for charging electric vehicles
The CH2P consortium is composed by seven European partners from five different partners in Europe. The consortium is highly interdisciplinary: it consists of three SMEs, a large enterprise and three research institutes that combine their complementary skills and infrastructures to develop and test the CH2P system.

Fondazione Bruno Kessler (Italy)
SOLIDpower S.p.a. (Italy)
HyGear Technology and Services B.V. (The Netherlands)
Deutsches Zentrum für Luft- und Raumfahrt (Germany)
Vertech Group (France)
Shell Global Solutions International B.V. (The Netherlands)
École Polytechnique Fédérale de Lausanne (Switzerland)

www.ch2p.eu
made by Minimolla Design
eco-compatible inks on Fsc paper