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COSMHYC DEMO
INNOVATIVE H2 COMPRESSION

Deliverable 2.4

Public report on end users specifications on hydrogen compression and HRS

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1 INTRODUCTION

Hydrogen mobility is of major importance on the way toward a climate neutral EU. In the scope of EU's Green Deal, which objective is to reduce greenhouse gases emission by 55% compared to 1990 level by 2030, hydrogen can play a major role in various sectors, incl. mobility, power-to-gas and industry. The ramp-up of alternative fuels such as hydrogen is needed for achieving 90% reduction of greenhouse gases in the transport sector by 2050. Hydrogen has also the potential to accelerate the deployment of renewable energies for clean, safe and secure energy supply and for sustainable and efficient solutions across sectors. Hydrogen is particularly interesting for large-scale mobility applications, where electric batteries have a limited potential, such as Heavy-Duty Vehicles (HDV) or large-scale fleets of Light Duty Vehicles (LDV) with a high utilization rate, such as fleets of taxis. Over the last few years, a growing interest for hydrogen mobility has been observed, and large-scale deployments of projects all along the hydrogen value chain are expected in the coming decade as can be seen on the figure below[1].

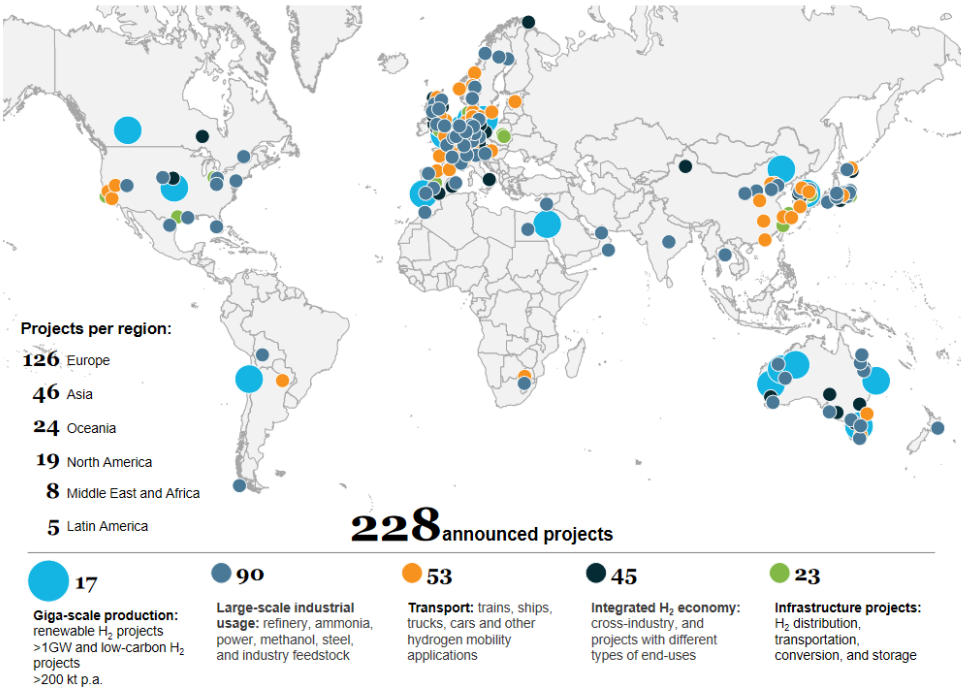

Figure 1 : Global hydrogen projects across the value chain[1]

This report focuses on the hydrogen mobility by summarizing the actual status of the market, describing the subsystems composing a Hydrogen Refueling Station (HRS) and finally presenting the market introduction of H_2 technologies and their deployment.

[1] Source: Hydrogen Insights, *McKinsey & Company, 2021*

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2 H_2 MOBILITY: STATE-OF-ART

A wide range of industrial stakeholders along the value chain have already demonstrated their interest in hydrogen-based technologies. The large number of projects shown in Figure 1 emphasize the importance of hydrogen in the future of mobility.

Hydrogen is mainly used in vehicles at medium or high pressure (350 or 700 bar) and thus needs to be compressed and distributed in HRS. The storage pressure in the vehicles depends on the applications and constraints of the vehicle himself. Currently, two pressure level are used on the market:

- 350 bar: mainly for some HDV (city busses, trucks, trains) and some specific mobility applications (range extender vehicles, forklifts)
- 700 bar: mainly for LDV and personal cars (e.g. Toyota Mirai[2]) and some HDV applications (coaches, long-distance trucks)

Figure 2: Toyota Mirai II available since early 2021

The roll-out of hydrogen mobility has already started for captive fleets (city busses, utility vehicles, taxi fleets in Paris), some HDV fleets (e.g. Hyundai Xcent trucks in Switzerland) and passenger cars in some countries (e.g. the first H2mobility network in Germany). In particular, HDV & captive fleets offer the possibility to increase the refueling station network progressively by selecting strategic implantation sites. In fact, for a main part of HDVs, the hydrogen needs are easier to fulfill because of the repetitive & foreseeable driving profiles of the vehicles. For example, installing a HRS for a bus fleet means that the vehicles needs are well known. Knowing the size of the fleet, the infrastructures needed to support the hydrogen demand is easier to size and the economic risk is lower. Public authorities have already launched important projects and deployments of vehicles as can be seen on Figure 3 with CCTVI[3] (Communauté de Communes Touraine Vallée de l'Indre, french local authority) and the launch of the first H_2 garbage truck in France.

[2] Source of the picture: Toyota's website https://www.toyota.fr/new-cars/mirai/

[3] Source: Hydrogen Today, https://hydrogentoday.info/news/9252

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In order to answer the increasing hydrogen demand of the mobility market foreseen in the future decades, the HRS network is of major importance and needs to increase significantly. This expansion needs to be achieved through technological breakthrough decreasing the cost and increasing the reliability and efficiency of a HRS. The following subchapters emphasize the current deployment foreseen in that field with a focus on the expected achievements on innovative H_2 compression technologies in the frame of COSMHYC DEMO.

Figure 3: First garbage truck in France delivered during summer 2021

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3 HYDROGEN REFUELING STATIONS

The hydrogen mobility market demand requires, in the forefront, an adapted hydrogen refueling infrastructure. European technology manufacturers have made significant progress, thanks to industrial development efforts and demonstration projects. Ambitious deployment plans are laid out by governments worldwide.

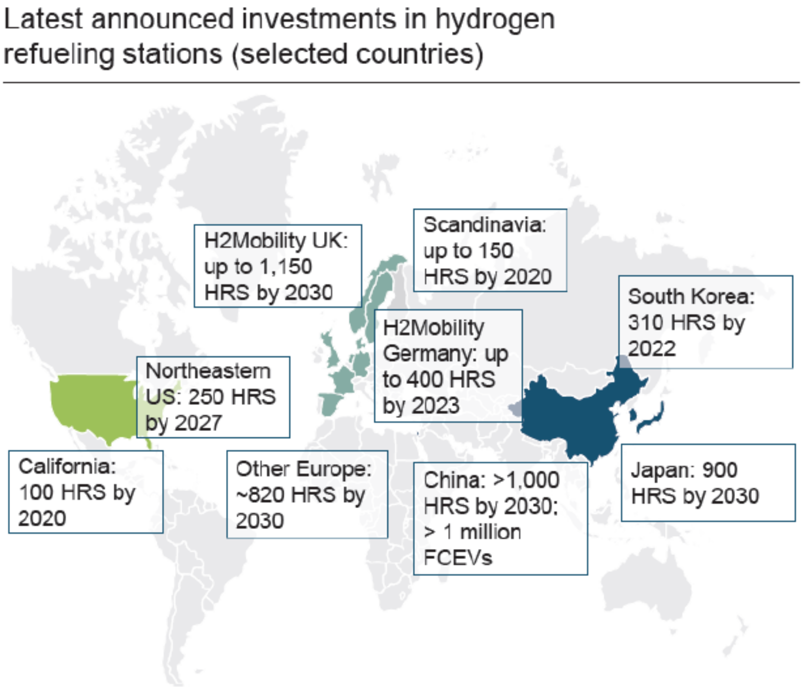

Figure 4: Foreseen HRS deployment

HRS consist of different subsystems, including compression, storage, cooling and dispensers.

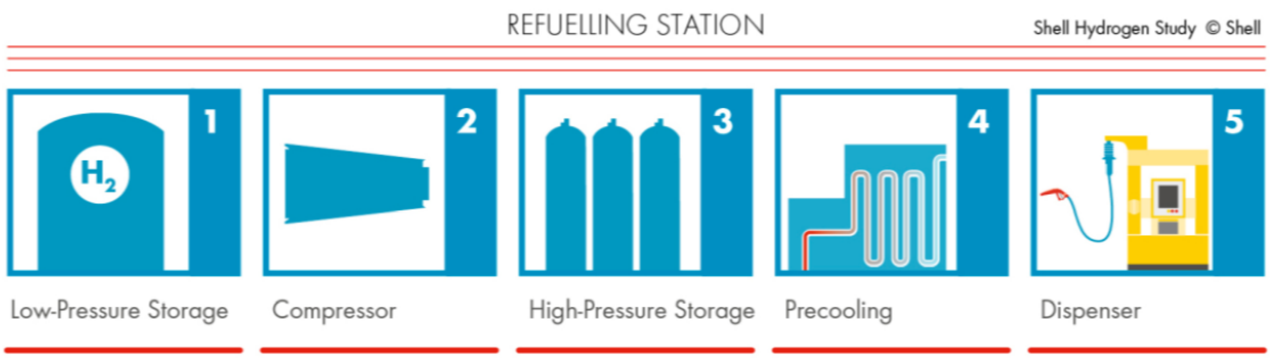

Figure 5: Subsystems composing a HRS

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The compressor plays a central role in the infrastructure and is the main controllable component of the HRS. Therefore, most of the end users requirements on the HRS have an impact on the compressor itself.

4 IDENTIFIED END USER REQUIREMENTS

Based on internal exchanges within the consortium as well as with vehicles manufacturers, the following requirements on the compression to address the various needs of LDVs & HDVs as highlighted above are the following:

- Overall outlet pressure of the compressor of 950 bar, with the possibility of an intermediary pressure of 450 bar
- Typical baseload flow rate of ≈ 8 kg/h
- Peak flow rate of ≈ 35 kg/h
- Flexibility to absorb hydrogen at different various flow rates and inlet pressure to enable direct coupling with intermittent renewable energy sources, e.g. PV of wind power
- Limited footprint to limit the impact of regulatory constraints, e.g. requested distance between equipment and public areas.
- Containerized solution to facilitate installation & commissioning as well as to reduce the operation constraints

5 COSMHYC DEMO PROJECT

Based on the above user requirements, an overall compression concept was developed in COSMHYC DEMO and is explained hereafter.

This hybrid solution enables to optimize the strengths of both technologies and reach a cost and energy efficient solution well adapted to the needs of H2 mobility:

- The metal hydride compressor (MHC) is the supply compressor, it takes hydrogen from the source at low pressure and limited flow rates and compress it to an intermediary level (e.g. 200-450 bar)
- The mechanical compressor is the fueling compressor, it collects hydrogen at the intermediary pressure level, compress it to refueling pressure (e.g. 450-900 bar) at large flow rates and send it to the dispensers

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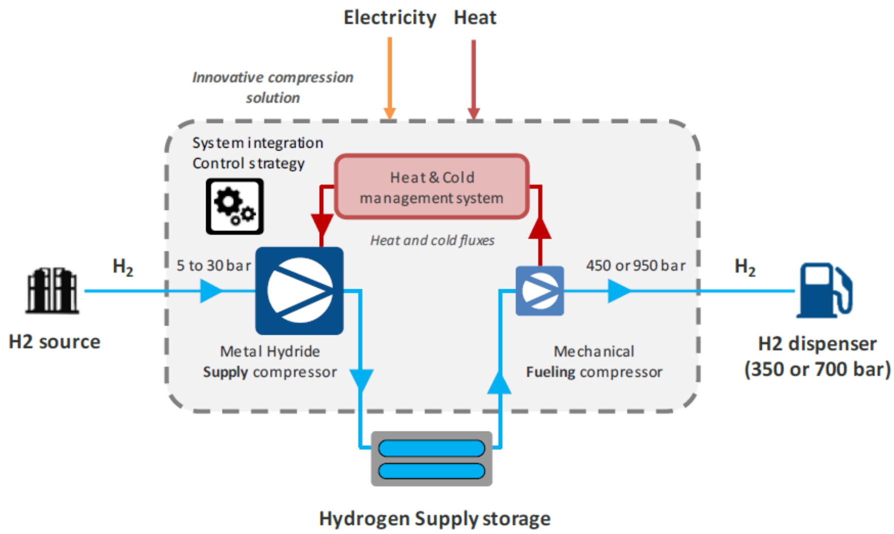

Figure 6: COSMHYC DEMO hybrid compression solution

6 CONCLUSION

Based on the state-of-art of H2 mobility and the identified end users constraints, a flexible, modular compression concept was developed in the frame of COSMHYC DEMO, based on a combination of a metal hydride compressor and a mechanical booster. The solution will be built during the project and a 1-year demonstration will take place in the facility of CCTVI, close to Tours (France).

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