

Hydrogen on-site installed and mobile refuelling solutions

EXPERIENCE FROM HUNGARY

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Content of the presentation

- 1) Hydrogen related legislation in Hungary
- 2) Some questions of HRS installation – advantages and disadvantages
- 3) Experiences of Hungarian FCEB demo project in terms of refuelling solutions

There has been legislation on the technical design and official approval of so-called 'autogas' filling stations for many years in Hungary

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Legislation has slightly been amended to include hydrogen (as a fuel) and hydrogen refuelling stations

non-public and
public HRS

Ministerial Decree NGM No.2/2016 on the technical-safety regulatory supervision of pressure equipment, filling equipment, low-capacity compressed gas filling equipment and periodic inspection of 'autogas' vessels

Government Decree No. 213/2019 on the technical safety oversight of pressure equipment, systems and installations.

+ H₂

Public HRS

Ministerial Decree No. 31/2014 on the rules for the building authority procedures for certain specific industrial sites

„**automotive gas**: liquefied petroleum gas (propane, propylene, butane, isobutane, isobutylene, butylene and mixtures thereof), compressed natural gas and other gaseous fuels used for the operation of gas-powered vehicles, and **hydrogen fuel for hydrogen-powered vehicles**”

Though Hungary still does not have many hydrogen-specific regulations HRS deployment can find its official way

Equipment for hydrogen refuelling stations can be classified as "**pressure equipment**" or "**filling equipment**" (Decree NGM 2/2016 NGM; Gov. Decree 213/2019), and in almost all cases, they are classified as a "**specific building**" (Min. Decree 31/2014 (II. 12.)

Gov. Dec. No.213/2019. prescribes the **required content of each type of HRS permit application** (how to build, operate or modify).

Public and non-public access types of the HRS can cause some **difference** in the applicable legislation regarding **permitting process, procedural questions**.

The main technical requirements are also derived from NGM 2/2016.

Beside the prescriptions for **planning, authorization, execution and operation of alternative fuel stations including HRS, several other special** regulations must be taken into consideration e.g. in the field of **fire protection**.

Some NON-OFFICIAL examples of safety distances

<https://standards.iso.org/iso/19880/-1/ed-1/en>

RESTRICTION DISTANCES - flammable / explosive atmosphere around e.g. storage unit or compression unit – 15 m

INSTALLATION LAYOUT DISTANCES – between sub-system – 5 m

PROTECTION DISTANCES - minimum distance of the possible source of an external hazard (e.g. a fire) to prevent damage (gasoline, CNG tank, public road, supermarket, etc.) – 5 – 30 m

CLEARANCE DISTANCES –min. distance between units of a multi-fuel station – Personnel/Users of HRS - 5m; Other fuelling facilities and storage – 10 m

The national legislation currently in force regulates the requirements for the installation of HRS in a way that is **difficult to interpret**. Further changes are necessary to fully regulate the design of both versions:

1. HRS using **H2 produced locally, „on site”**
2. HRS using **H2 delivered to site**

Installation HRS – Location

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Location of HRS installation	Advantages	Disadvantages
On the site of an existing petrol-station, with a „semi-integrated” installation	<ul style="list-style-type: none"> - The supply infrastructure is usually already in place at existing service stations. It only needs to be extended or slightly upgraded. - Hydrogen refuelling is not hindered by other vehicles refuelling on conventional fuels, as it takes place at a separate refuelling station, separated from other conventional refuelling. - During installation, there is no need to rebuild the existing underground tanks or feed pipes to pump as the HRS is built separately. - ATEX zone of HRS does not affect ATEX certification of existing equipment 	<ul style="list-style-type: none"> - Due to separate installation, additional space must be provided for refuelling stations, taking vehicle turning radius into consideration. - Requires a separate canopy, lighting and utility infrastructure.
On the site of an existing petrol-station, with an „integrated” installation	<ul style="list-style-type: none"> - The solution with the least possible extra space requirements, as the refuelling station does not need extra space. - There is no need for a new roof or new utility infrastructure. 	<ul style="list-style-type: none"> - Hydrogen refuelling can be hindered by other vehicles refuelling with conventional fuels, as refuelling takes place at a common filling station. - Existing refuelling environment must be demolished during installation. - Existing equipment in the hydrogen dispenser ATEX zone should be replaced with stricter ATEX certified equipment.
As a separate refuelling station (as greenfield investment)	<ul style="list-style-type: none"> - The solution with the fewest constraints to develop the most ideal hydrogen refuelling station installation concept. 	<ul style="list-style-type: none"> - High investment costs compared to others, as the entire infrastructure (utilities, roads, electricity, etc.) needs to be built.
On the site of a company	<ul style="list-style-type: none"> - This is an ideal installation concept for a HRS if sufficient free space is available. - Size and capacity to suit the needs of the company. 	<ul style="list-style-type: none"> - Adapt existing infrastructure (roads, utilities, electricity) to the needs of the HRS. - Attention must be paid to maintaining safety distances from existing structures on site.

Installation HRS – Hydrogen supply

Method of hydrogen supply	Advantages	Disadvantages
Hydrogen arrives at the refuelling station by road in so-called " trailer swaps ". The trailer swap remains on site and serves as a storage tank	<ul style="list-style-type: none"> - The trailer does not need to stay at the HRS for refuelling. - Trailer swap tanks can be pressurised up to 350 bar, allowing more to be stored on site than in fixed tanks at 200- 500 bar 	<ul style="list-style-type: none"> - Trailer swaps must be positioned to provide adequate turning radius for their removal, so they require more space than fixed storage tanks. - Not a widespread solution yet, so it is difficult to reach among hydrogen suppliers.
Hydrogen arrives at the filling station by road, in a tube trailer . On site, it is transferred into storage tank(s)	<ul style="list-style-type: none"> - It is currently the most widely used solution in Hungary, so it is easily available. - Hydrogen storage tanks are fixed, and do not need to be surrounded by the appropriate turning radius for transport, as is the case with transportable storage tanks. - A protective wall can be built around fixed storage tanks in a small space. 	<ul style="list-style-type: none"> - The maximum storage pressure currently available is 200 – 350- 500 bar. This should be taken into consideration when calculating the storage capacity. - The most common transport vehicles currently in use also have a pressure of 200 bar, so either a compressor or a cascade system is needed for transfer.
Hydrogen produced by on-site electrolysis	<ul style="list-style-type: none"> - Hydrogen is always available, so you don't have to worry about the time needed for delivery and transfer. - The potential disruption of hydrogen supply is not an issue, unlike road transport. 	<ul style="list-style-type: none"> - Relatively high installation costs. - The necessary infrastructure for supplying hydrogen also needs to be built, as hydrogen must be supplied even when the electrolyser is not operating.

Installation HRS – Refuelling method and methods of service

Hydrogen filling method	Advantages	Disadvantages
Refuelling system capable of filling at 350 bar	- 500 bar medium pressure buffer tank is sufficient after the compressor.	- For truck and bus refuelling only.
Refuelling system capable of filling at 700 bar	- Applicable to passenger car refuelling. -(new generation high pressure trucks)	- 1000 bar high pressure buffer tank required downstream of the compressor
Refuelling system capable of filling at 350 and 700 bar	- Can be used for refuelling HDVs and cars.	- Requires two dispensers, high pressure buffer making it a more expensive solution.
Methods of service	Advantages	Disadvantages
HRS without self-service mode	- Refuelling is carried out by service staff. - Greater operational safety thanks to trained staff.	- Staff and infrastructure required.
HRS with self-service	- No need to maintain staff or build the necessary infrastructure	- Refuelling is done by the customer without staff assistance. – technical supervision is needed as of now

Hydrogen fuel cell bus pilot project

ÉZFF/208/2022-TIM-SZERZ - „BIG HYDROGEN PROJECT”



DEMONSTRATION

- With two buses
- During one year (2024)
- In six county towns & in the surrounding suburbs of Budapest
- **Installed and mobile (light) fuelling**



OBJECTIVES

- Systematic data collection and analyses
- Operational experiences (vehicles, drivers, refuelling, PTO-s)
- Running a passenger survey for a year
- Flagship awareness raising campaign
- Promotion of hydrogen technology
- Preparing decisions for decisionmakers, input for future subsidy programmes



Fuel Cell Electric Buses

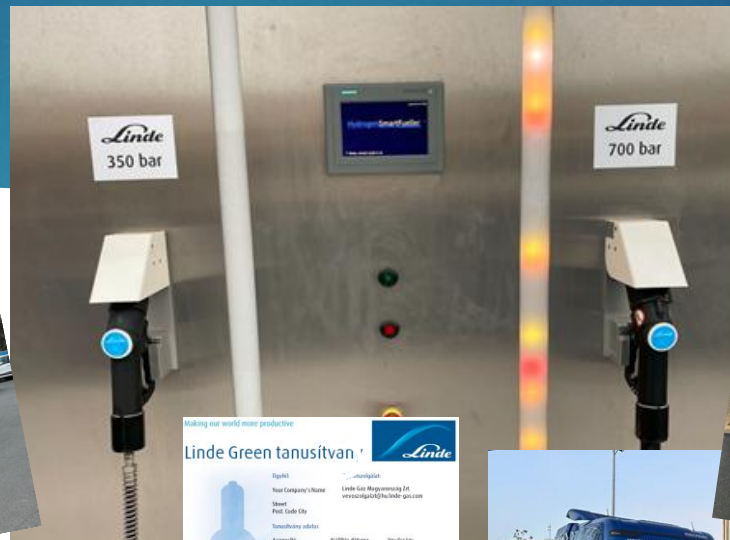
Solaris Urbino 12 electric H2
Prim-Vol Trade Ltd.



Toyota Caetano H2.City
Truck-Trailer and Parts Ltd.



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350-700bar refill capability



Charger equipped with cooling unit

Free fuelling for incoming vehicles during test period

IN 1 YEAR NO REFUELLING LOST DUE TO REFUELLING STATION FAILURE, DOWNTIME ONLY FOR PLANNED MAINTENANCE



Refuelling service with professional staff, by appointment

Maximum vehicles per day: 4 cars or 2 buses, 2 cars

Refuelled vehicles: buses, 1 truck, cars, taxis, forklifts

Refuelling time

350bar for buses 20-22 minutes

700bar for cars in 5-10min

H2 transport using 200bar trailers (350kg max cap.)

H2 volume used: ~4300kg



Test project 2024 - challenges



- **Installation:** regulatory specifics (e.g.: refuelling station installation, H2 point of use design, National Fire Safety Code (OTSZ), disaster management, EX/ATEX zones (design of explosive zones), lightning protection, skilled personnel), site conditions (safety distances, design feasibility, power supply).
- **Ensuring accountability**
- **Business issues** are tested as well
- **Station sizing** (buffer and compression unit capacity) according to demand (contractually 1 bus + 2 cars)
- The importance of **timing loads** on demo capacity
- **Demo refuelling station**, role of professional staff support
- **Annual maintenance costs, cooling and compression energy requirements** can be significant
- Promotions, organisation of **Original Equipment Manufacturer tests**

Messer mobile H2 refuelling station solution



- Mobile Refuelling Station could be installed in a few hours.
- The training and instruction of the refuelling personnel was particularly easy where CNG buses were also available.
- Messer supplied a complete spark-safe tool kit in addition to installation, commissioning and training.

Refuelling with mobile HRS

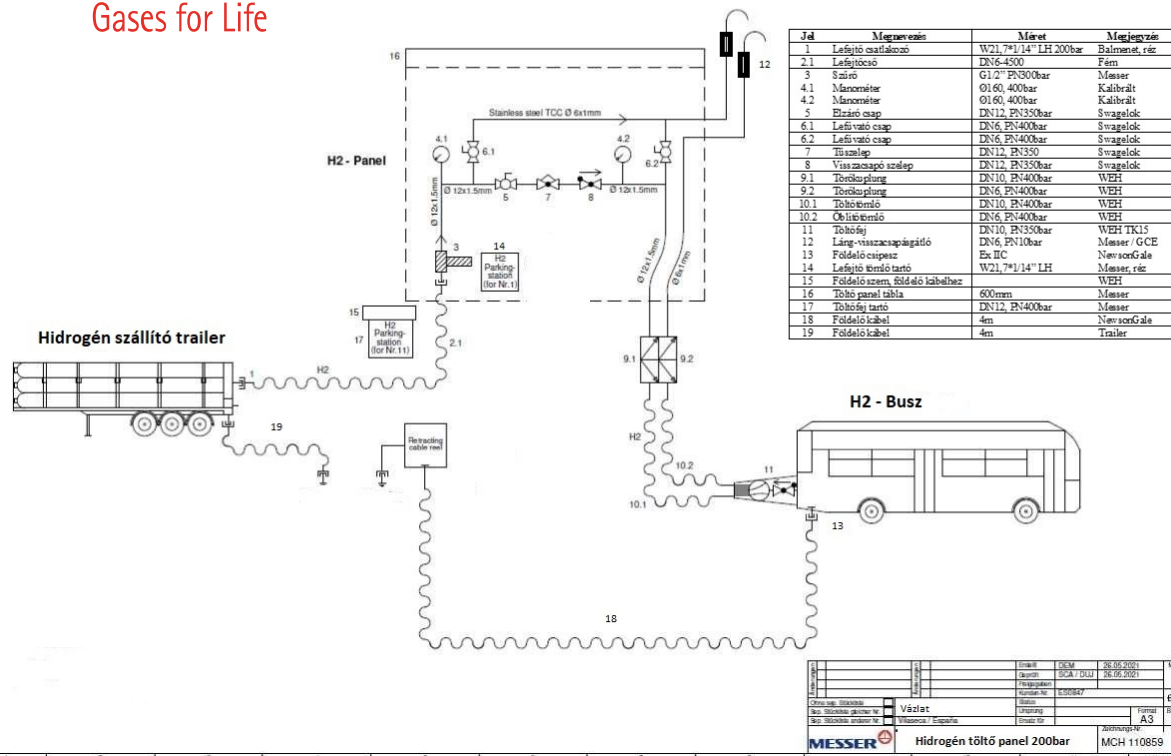
- Hydrogen refuelling for 200 km driving per day (min. 4000 km per month)
- Hydrogen consumption: 14-20 kg / day
- Variables:
 - ▶ Topography
 - ▶ Forda types
 - ▶ Weather, temperature conditions
 - ▶ Driving techniques
- Participating towns: Debrecen, Miskolc, Kecskemét, Kaposvár, Zalaegerszeg, Győr
- Refuelling the bus from 200bar to 198-190 bar in 10 minutes
- Mobile refuelling station relocation every month
- 2 x 1 month per town



Mobile refuelling panel for buses



H2 hidrogén töltő panel - állomás 200bar



Mobile refuelling panel for buses with lightning protection

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MESSER
Gases for Life



OTHER MODULAR SYSTEMS

ARPA



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KIND ATTENTION!**