HUNGARY

Opportunities for **Hydrogen Energy Technologies** Considering the National Energy & Climate Plans

2

Contract details
Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU)
Study on Opportunities arising from the inclusion of Hydrogen
Energy Technologies in the National Energy & Climate Plans
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Introduction

The **Fuel Cells and Hydrogen Joint Undertaking** (FCH JU), in close cooperation with the **European Commission - DG Energy**, has commissioned a study on the "Role of Hydrogen in the National Energy and Climate Plans". This study is being conducted by the consultancies **Trinomics and LBST**.

This fiche represents one of the outputs of the study; it comprises two major parts:

- Analysis of **national opportunities for hydrogen deployment**, based on the national hydrogen production and demand potential, the gas infrastructure and the enabling environment. In this context, the role of hydrogen in the current National Energy and Climate Plan is in particular analysed.
- Assessment of **national economic, environmental and technical impacts of hydrogen deployment** under a high and a low scenario.

This information is expected to provide useful information to EU Member States that are considering to include renewable or low-carbon hydrogen deployment in their decarbonisation policies or roadmaps.

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Main results and impacts of hydrogen deployment in Hungary by 2030 in the two scenarios modelled in the present study

Onshore Wind
530 - 1 520 MW
1 100 - 3 200 GWh/a

Solar Photovoltaic
180 - 500 MW
170 - 480 GWh/a

Electrolysers
330 - 940 MW
810 - 2 310 GWh_{H2}/a

POWER
2 - 17 GWh/a

TRANSPORT
272 - 654 GWh/a

BUILDINGS
32 - 320 GWh/a

INDUSTRY
504 - 1 316 GWh/a

500 - 1 000
Buses

3 - 11
Trains

80 - 160
Refuelling Stations

3 150 - 6 300
Trucks

41 100 - 82 200
Cars

1 - 7 GWh/a
Electricity Produced

9 - 81 GWh/a
into Synthetic Fuels

1 470 - 6 380
Micro-CHP units
in buildings

0 - 40
Commercial-scale
CHP installations

0 - 21 kt/a
of Steel

0 - 10.5 kt/a
of Aromatics

0 - 17.3 kt/a
of Olefins

0 - 17.6 kt_N/a
of Ammonia

500 - 610 GWh_{H2}/a
in Refineries

130 - 360
m EUR/a

Value Added
in the domestic economy

Value Added as Share of Annual Costs

New Jobs
720 - 1 550

Emissions avoided
0.3 - 0.7 Mt CO_2/a

EXECUTIVE SUMMARY

Hungary's commitment for hydrogen deployment according to its NECP

According to its NECP, Hungary intends to enable the integration of hydrogen in its mobility, industry, building, gas and power systems. The NECP states that *"hydrogen can play a significant role in integrating renewable electricity generation, strengthening domestic security of supply and achieving Hungary's decarbonisation goals"*. New regulatory measures are announced in the gas, storage and transport sectors addressing the entire hydrogen value chain covering generation, storage, transport, distribution and end use. Among the different applications, Hungary considers using hydrogen for decarbonising its gas supply, producing electricity (in the long term), replacing fossil fuels in the transport sector and replacing partially fossil hydrogen by renewable hydrogen. Hydrogen will support the integration of higher volumes of variable renewable electricity in the system, enhance system flexibility, and increase security of supply.

The NECP comprises the 2030 concrete target of a renewable electricity-based hydrogen consumption of 51ktoe in the heating and cooling sector. Hungary also expects using renewable hydrogen as an alternative fuel for transport, even in its Business As Usual scenario (considered as "with existing measures" scenario). With the NECP's additional measures (WAM scenario), renewable hydrogen could cover about 1% of the total transport energy needs by 2030.

Hungary has a positive environment to address the deployment of renewable hydrogen for all its potential applications, given the pilot projects announced and its commitment to address regulatory barriers, its involvement in the Green Hydrogen @ Blue Danube[1], the Black Horse[2], the Silver Frog[3] and the H2Go[4] IPCEI potential projects, the Hungarian oil and gas provider MOL entering the hydrogen business and the Hungarian gas TSO willing to establish a framework to feed in hydrogen in the gas system. Hungary was also involved in the HyLaw[5] project, that identified and assessed major regulatory barriers, in view of prioritizing measures to address them.

The scenario assessment shows substantial potential benefits of hydrogen deployment in Hungary by 2030

Hydrogen demand

Two (high and low) scenarios of hydrogen demand in 2020-2030 were developed, based on different levels of ambition linked to the national context. The resulting values are summarised in the scheme in the previous page. For Hungary, a moderate development of hydrogen demand is assumed in the considered scenarios in **transport**, especially for passenger cars and buses, trucks and to a more limited extent in aviation (through hydrogen-based liquid fuels or PtL) and inland navigation[6]. A limited development of hydrogen demand is also assumed in the scenarios in **industry**, especially in the ammonia, refinery, olefin and aromatics industries. These industries use fossil-based hydrogen as feedstock or reducing agent, which could be replaced by renewable hydrogen. Switching high temperature heat processes fuels to renewable hydrogen could represent another important potential use in the considered scenarios.

In the **building** sector, hydrogen can replace part of the current use of natural gas and can be distributed via existing gas grids through admixture to natural gas. The building sector is expected to have in the Low scenario a limited demand of hydrogen by 2030 but would have a stronger demand in the High scenario.

The scenarios assume only a marginal use of hydrogen for electricity generation by 2030, mainly in combined heat and power installations.

Hydrogen production

To cover the estimated hydrogen demand from new uses and from substitution of fossil-based hydrogen, 0.7 to 2 GW of dedicated renewable electricity capacity would have to be installed to produce green hydrogen via electrolysis. While "surplus" electricity might be available in times of high renewable electricity production, the main share will have to be covered by dedicated sources. In the two scenarios, part of the 2030 hydrogen demand would still be covered by fossil-based hydrogen produced via steam-methane reforming of fossil fuels.

In its NECP, Hungary estimates an installed capacity in 2030 of 0.33 GW in wind and 6.45 GW in solar PV, generating over 7.2 TWh of variable renewable electricity in 2030. The technical potential for renewable electricity production in Hungary seems however significantly higher[7]. Building additional renewable electricity capacity dedicated for hydrogen production thus could be a feasible scenario.

Estimated socio-economic and environmental impacts

The annual costs to produce green hydrogen (including the cost of dedicated renewable electricity sources), to develop the transport infrastructure (or adapt the existing one) and end-user applications would in the considered scenarios reach respectively 170 and 430 million EUR. These activities will generate value added in the domestic economy, amongst others by creating jobs in manufacturing, construction and operation of hydrogen technologies and will contribute to greenhouse gas emission reductions. This is in particular important in hard-to-decarbonize industries. According to the European EUCO3232.5 scenario[8], the Hungarian GHG emissions should be reduced by 21 Mt CO_2 in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 0.3 – 0.7 Mt CO_2 to this goal, which is equivalent to 1% - 3% of the required emission reduction.

[1] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9b5e81e73c03421d1dd837/1570463369453/Green+HH2+Blue+Danube+poster_print.pdf*
[2] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9b5b85f5229f74dc24608b/1570462602872/Black+Horse+poster_print.pdf*
[3] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9c79b467e52303370991bd/1570535868733/Silver+Frog.pdf*
[4] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9b82e03ef63205cf33e4a4/1570472681940/H2Go.pdf*
[5] *https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Denmark%20%28EN%29.pdf*
[6] *Detailed assumptions are available in the methodology annex of the report, that can be consulted via the following link : http://trinomics.eu/project/opportunities-for-hydrogen-in-necps.*
[7] *The technical potential for renewable electricity production is based on the study commissioned by DG ENER Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure (Trinomics, LBST, E3M; 2019).*
[8] *EC, 2019. Technical Note on Results of the EUCO3232.5 scenario on Member States. Available at https://ec.europa.eu/energy/sites/ener/files/technical_note_on_the_euco3232_final_14062019.pdf*

HYDROGEN IN THE NECP OF HUNGARY

According to Hungary's NECP, hydrogen can play a major role in integrating the production of renewable electricity, strengthening security of gas supply and contributing to reach the decarbonisation targets. Renewable hydrogen can be used to store, in a cost-effective way and on the long term, large amounts of electricity produced during low demand.

Among the different applications, Hungary considers greening its gas supply by blending renewable hydrogen into its network. Using hydrogen for the production of electricity is not considered as an immediate option, given the higher cost, but it would play a role in the future. Renewable hydrogen is in the NECP considered as an alternative fuel providing an environmental solution for mobility.

Considering the diversity of end-use applications and its potential for long term storage, hydrogen may serve as a link between the electricity and natural gas sectors, supporting the integration of higher volumes of variable renewable electricity in the system, enhancing system flexibility, while greening the gas sector and increasing security of gas supply.

Hydrogen can be blended to natural gas, contributing to satisfy the energy demand of industrial customers and households, improving Hungary's security of supply and storing renewable hydrogen in a cost-effective way. Renewable hydrogen will progressively replace the production and use of biogas, which is still considered the first option to 'greening' fossil gas. To allow the injection of renewable gases (incl. hydrogen) into the existing infrastructure, Hungary has to address several technical and regulatory issues that will be assessed in the frame of pilot projects. The feed-in of hydrogen is considered as an alternative to the phasing out of some distribution pipelines with a low utilisation rate. Hungary plans to establish the appropriate conditions (including safety) and incentives necessary to feed in hydrogen in the gas system.

Hungary's gas storage strategy should be aligned to the regional context. Hungarian storage capacity could become an important pillar of Croatian-Hungarian market coupling, while considering the conversion of some natural gas storage sites to hydrogen storage.

In the power sector, beyond the use of fuel cells, hydrogen can also be used in conventional gas engines or turbines. Hungary considers converting the operation of its existing gas-fired power plants to purely hydrogen operation.

Renewable hydrogen can partially replace non-energy hydrogen demand in the industry, mainly in the oil refining, fertilisers and pharmaceutical sectors, where natural gas is currently used as feedstock.

According to its NECP, Hungary considers that hydrogen fuel cell cars would be available and deployed from 2025, while fuel cell buses and heavy-duty vehicles could be used already now. Even in its business as usual scenario, Hungary expects renewable hydrogen to play a role in the renewable energy target for transport. With the NECP's additional measures, Hungary could cover about 1% of its transport needs with hydrogen by 2030, and around 5% in 2040 (for a total of around 30% of renewable energy for transport).

Power-to-gas pilot projects enhancing the flexibility of the distribution network and integration of renewable production can be implemented with carbon credit funds.

Hungary is also planning various pilot projects to support innovative solutions of seasonal energy storage, to support the decarbonisation of industrial production by encouraging the use of low carbon hydrogen, to test the option of blending hydrogen to natural gas in the existing infrastructure.

Research projects related to nuclear energy, fossil energy and hydrogen and fuel cells received¬ around 1 % of the total R & D expenditure (~29.9 million EUR) between 2015 and 2018.

Hungary has fixed a specific target regarding the use of renewable energy sources in the cooling and heating sector by 2030: 51 ktoe hydrogen originating from renewable energy.

OPPORTUNITY ASSESSMENT

Hydrogen production potential & its role in energy system flexibility

Since the technical potential of renewable electricity generation in Hungary is three times higher than the expected electricity demand in 2030, there is an opportunity to use the potential surplus capacities for renewable electricity generation to produce hydrogen via electrolysis. According to the NECP, Hungary would by 2030 only use 4% of its technical potential in renewable electricity generation, so there is a great margin for building up these dedicated renewable electricity sources. However, the NECP also forecasts a significant need for electricity imports, so a more feasible scenario is that the newly built renewable electricity sources will be used to cover the domestic electricity demand.

The existence of nuclear power generation capacity in Hungary may represent a specific opportunity for deploying hydrogen; as the variable cost of nuclear power plants is very low, they could be used at full load while converting 'excessive' output into hydrogen. This approach would also enhance the load factor of power-to-hydrogen installations, and improve their economic feasibility.

The increasing share of variable renewable electricity generation also means that the system flexibility needs are forecasted to rise, with the ratio of system flexibility needs compared to forecasted electricity consumption in 2030 being well above the European Union average. This indicator thus shows a significant opportunity to use hydrogen production and storage as a system flexibility provider.

Technical variable renewable electricity potential (TWh/yr)	Technical renewable electricity generation potential compared to forecasted gross electricity consumption in 2030 (NECP)	NECP estimate of variable renewable electricity production in 2030 (TWh/yr)	NECP estimate of variable renewable electricity production in 2030 compared to its technical potential	Ratio between variable power generation capacity in 2030 and average load	Readiness for CO_2 storage
170	328%	7.27	4%	based on NECP 149%	Low

Hungary has limited readiness for wide-scale deployment of CCS. Even though there are plans in place to use CCS technologies by 2030, there is only limited indication of progress towards using captured CO_2 in industrial processes and/or utilizing the potential storage capacities.

Energy infrastructure

Hungary has an extensive natural gas network, which could cost-effectively and resource-efficiently support the feed in of hydrogen into the energy system if the necessary preconditions are met. The first step would be to carry out an assessment of the entire natural gas infrastructure (starting by the share polyethylene in the distribution network) to estimate the risks and costs arising from the transport and distribution of hydrogen across all elements of the value chain (including the end-users' appliances sensitivity to blended gases and potentially variable calorific values).

Hungarian Gas TSO already began the review of its infrastructure, with the aim to extend its use for hydrogen injection. In addition to blending hydrogen to natural gas, Hungary could consider the conversion of part of its network to dedicated hydrogen pipelines.

Technical and economic feasibility of converting gas distribution networks to hydrogen (share of polyethylene pipelines in distribution grid)	Natural gas demand in residential and services sectors / length of gas distribution network (GWh/km)	Existing salt cavern natural gas storage sites (TWh)	Suitable geological formations (potential for future hydrogen storage)
Not Available MS range 16%-99%	0.6	0	Under research

The available types of stratigraphical formations are strongly dependent on the geographical features. Due to this, salt caverns (used for underground gas storage) are not largely available in the CEE region. There are also no underground salt layers that could provide suitable storage opportunities for hydrogen.

However, further research is currently carried out to explore other storage possibilities, for instance to use depleted natural gas fields for potential hydrogen storage.

Current and potential gas & hydrogen demand

There are significant opportunities for the deployment of hydrogen in Hungary across sectors. In industry and the built environment, the potential is strongly related to the important role that natural gas currently has in the energy mix of these sectors. Switching from fossil fuels to hydrogen can make a significant contribution to GHG emission reductions in these demand sectors. Hungary also has ammonia industry and refineries that already consume fossil-based hydrogen, which can be replaced by renewable or low-carbon hydrogen. Lastly, there is significant potential for the deployment of hydrogen in the transport sector, especially in road and rail transport.

Opportunities for hydrogen demand in industry

The assessed indicators show that Hungary has a significant potential for hydrogen use in industry. First of all, the country has ammonia industry and refineries, both of which currently use fossil-derived hydrogen. Although the production capacities of these facilities are relatively low compared to the EU total, these industries represent an opportunity for the deployment of renewable or low carbon hydrogen to replace fossil-derived hydrogen. Next to this, natural gas, which accounts for over 30% of the industrial energy demand in Hungary, can be replaced relatively easily with renewable hydrogen. Furthermore, 26% of the energy demand in industry is used to generate heat for high-temperature processes. Hydrogen is one of the low-emission energy carriers that is well-suited for these processes.

Presence of ammonia industry / share of ammonia production capacity in EU28 total	Presence of refineries / Share of Hungarian refineries in total captive hydrogen production by refineries in the EU28	Share of Hungary in total primary steel production in the EU28	Share of natural gas in industrial energy demand (2017)	Share of high-temperature (>200°C) process heat in industrial energy demand (2015)
3%	2%	2%	31%	26%
MS range 0%-16%	MS range 0%-26%	MS range 0%-30%	Average 32% MS range 0%-43%	Average 38% MS range 9%-60%

Opportunities for hydrogen demand for heating and cooling in the built environment

In Hungary's built environment, natural gas accounts for almost half of the final energy demand and over 60% of the heating demand. Therefore, hydrogen could play a substantial role in the decarbonisation of heating in Hungary's built environment.

Share of natural gas in the household and service sector energy demand (2017)	Share of heating in the household and service sector energy demand (2015)	Share of cooling in the household and service sector energy demand (2015)
49%	76%	1%
Average 34% MS range: 0% - 60%	Average 74% MS range: 41% - 82%	Average 3% MS range: 0% - 46%

Opportunities for hydrogen demand in transport

Like most EU countries, Hungary has a large potential for hydrogen use in road transport. 44% of the energy use in this sector is consumed by trucks, buses and light commercial vehicles (e.g. vans). Since electrification of this segment of the road transport sector remains challenging, there is a significant opportunity for hydrogen to decarbonise this part of Hungary's road transport. Further, 30% of the Hungarian rail sector is still dependent on fossil fuels. Together with further electrification, deployment of decarbonised hydrogen can be a suitable solution to reduce GHG emissions from Hungary's rail sector. On the medium to long term, hydrogen and derived fuels can also play a role in the decarbonisation of the aviation sector in Hungary, which up to now still represents a relatively minor share of the energy demand in transport.

Share of heavy transport (trucks, buses & vans) in total energy demand in road transport in 2020	Share of fossil fuels in energy use of rail transport (and absolute consumption) in 2017	Share of inland shipping in overall energy demand for transport in 2017	Energy use by international shipping relative to total (domestic) final energy use in transport in 2017	Share of domestic and international aviation in overall energy demand for transport (incl. energy use int. aviation) in 2017	Share of fossil fuels in energy use of road transport in 2017
44% (18 934 GWh)	30% (500 GWh)	0.1% (48 GWh)	0.0% (0 GWh)	5% (2 659 GWh)	97% (48 473 GWh)
Average 32% MS range 18%-48%	Average 30% MS range 0%-95%	Average 2% MS range 0%-9.8%	Average 14% MS range 0%-1011%	Average 14% MS range 1%-25%	Average 95% MS range 79%-100%

Enabling environment: national hydrogen policies and plans, projects and industry

Hungary shows an increasing interest for hydrogen produced from renewable electricity, to be blended with natural gas for use in different sectors.

The Hungarian Gas Transmission System Operator has started to review the natural gas transportation rules in order to determine the safe and sustainable level of hydrogen that could be injected in the system.

The Hungarian Oil company MOL Group[9] has signed a Memorandum of Understanding with the Slovakian company InoBat for the development of hydrogen energy projects in Central and Eastern Europe. They plan to invest in projects to produce hydrogen, and to develop hydrogen-rich liquid fuel.

The industry is also considering the production of synthetic methane from hydrogen.

Hungary also considers using its depleted natural gas fields for potential hydrogen storage.

The Ministry for Innovation and Technology intends to launch a pilot project involving the gas TSO and DSOs in order to analyse the technical and regulatory aspects related to the power-to-gas technology and to assess using the Hungarian natural gas network to transport and store renewable hydrogen.

Existence of (or concrete plans for) national hydrogen roadmaps or strategies

Positive environment: Limited

Given the intention of Hungary to deploy hydrogen in its energy system, the plans and measures announced in the NECP could be considered as a good basis to set up a hydrogen roadmap or strategy. The Hungarian Hydrogen and Fuel Cell Association[10] could provide useful input to support this development.

Such a roadmap should be based on a thorough cost and benefit analysis and wide public acceptance assessment and determine the steps to gradually integrate hydrogen in the economy.

[9] https://www.pv-magazine.com/2019/05/23/hungarian-oil-and-gas-provider-mol-enters-the-hydrogen-business/
[10] https://www.fch.europa.eu/event/workshop-hydrogen-fuel-cell-based-mobility-and-fuel-cell-bus-development-central-europe

GHG mitigation gap in non-ETS sectors (need for additional GHG reduction measures)

Positive environment: ✗

According to Hungary's NECP, the annual non-ETS targets for the period 2021-2030 will only be set for 2020-2021 using the latest available verified GHG inventory data for 2005 and 2016, 2017 and 2018. Hydrogen could be considered as an option if Hungary needs additional efforts to reach its target, in order to fill the potential gap

Existence of (active) hydrogen national association

Positive environment: ✓

Current and planned hydrogen refuelling infrastructure for the transport sector

Alternative fuels infrastructure directive (2014/94/EU)

In its National Policy Framework (or NPF set in the context of the alternative fuel infrastructure directive (2014/94/EU)), Hungary has established targets for the deployment of hydrogen refuelling infrastructure, accessible to the public.

Inclusion of hydrogen in national plans for the deployment of alternative fuels infrastructure (2014/94/EU)	Existence of hydrogen refuelling stations (2019)	which is equivalent to 1 refuelling station per … cars
YES	0	Not applicable
	Total 156	Average 1 677 543

Existence of (investment on) hydrogen-related projects

There are currently no operational hydrogen-related industrial projects in Hungary. However, there are several initiatives and projects that are announced or under development.

Existing R&D and pilot projects directly related to hydrogen	RD&D annual expenditure on hydrogen & fuel cells (m EUR) (average 2013-2017)	Activities and projects in industry to use hydrogen as feedstock	Number of power-to-gas projects (existing and planned)
NO	0.1	NO	0

Existence of national tax incentives (CO_2 pricing mechanisms & car taxation)

There are no specific national carbon taxes or fiscal rules in Hungary that would encourage the use of renewable or low-carbon hydrogen.

Positive environment

✖

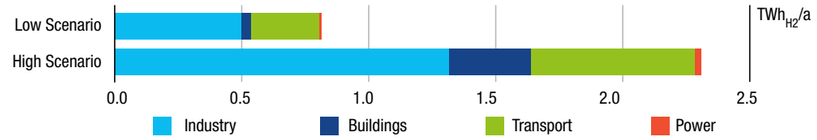
Fossil energy import bill

Like many EU Member States, Hungary is strongly dependent on imports for its natural gas as well as its oil consumption. Switching from fossil fuel to nationally produced hydrogen for industrial processes, heating and transport applications could contribute to reducing the import dependence and bill.

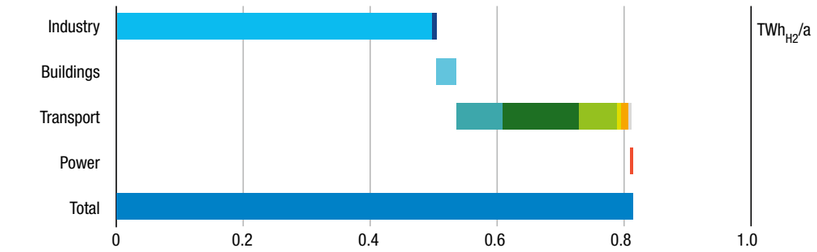
	Import bill for natural gas as share of national Gross Value Added	Import bill for all fossil fuels
	1.4%	**3.7%**
	Average: **0.6%** MS range: 0% - 1.5%	Average: **2%** MS range: 0% - 7%

SCENARIO ASSESSMENT
Estimated renewable/low carbon hydrogen demand for Hungary by 2030

Hydrogen demand in the year 2030 has been estimated in a low and a high scenario covering the range of uncertainty. Today, conventional hydrogen mainly used in industry is produced from fossil fuels (e.g. through steam methane reforming) or is a by-product from other chemical processes. Both scenarios assume that in 2030 renewable hydrogen will be provided to partially substitute current conventional production and to cover additional demand (e.g. from transport sector).

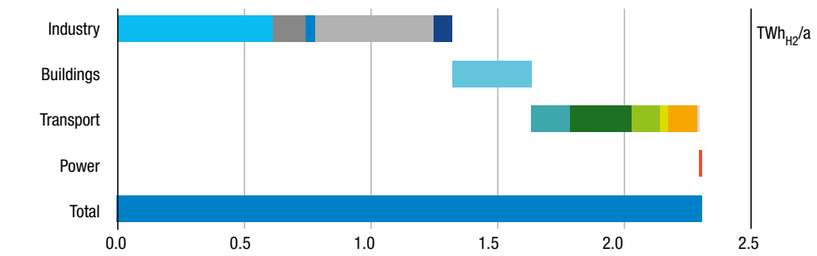


Low scenario

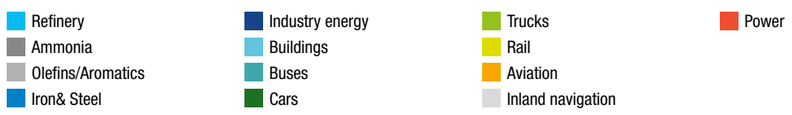


In the low scenario, renewable hydrogen accounts for 0.5% of final total energy demand (i.e. 0.8 out of 160 TWh/a) or 1.7% of final gas demand (47 TWh/a) according to EUCO3232.5.

High scenario



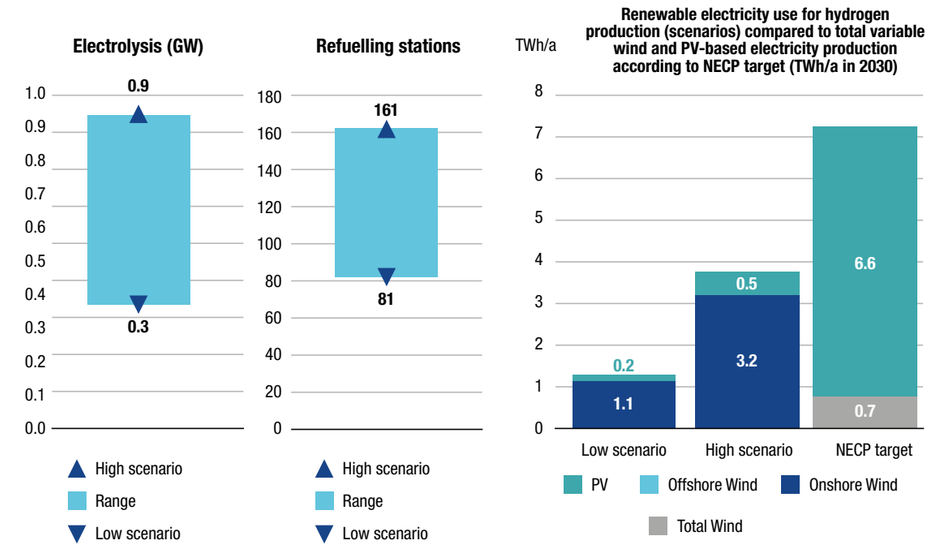
In the high scenario, renewable hydrogen accounts for 1.4% of final total energy demand (i.e. 2.3 out of 160 TWh/a) or 4.9% of final gas demand (47 TWh/a) according to EUCO3232.5.



Hydrogen generation, infrastructure and end users in Hungary by 2030

The analysis of renewable hydrogen generation, infrastructure and end use is based on the demand estimates presented above. Renewable hydrogen is generated from variable renewable power using electrolysis. The analysis covers only national hydrogen production to satisfy domestic demand and does not take into account any cross-border trade of hydrogen (i.e. hydrogen imports and exports are not included in this analysis).

Renewable hydrogen generation and infrastructure



The required renewable power production accounts for 0.8% of the overall technical renewable power potential in the low scenario and for 2.2% in the high scenario.

End users

End user	Unit	Low scenario	High scenario
Passenger cars	Nº	41 100	82 200
Buses	Nº	500	1 000
Lorries	Nº	2 700	5 500
Heavy duty vehicles	Nº	410	830
Trains	Nº	3	11
Substituted fuel in aviation	GWh/a	8	80
Substituted fuel in navigation	GWh/a	0.1	1.1
Micro CHP	Nº	1 470	6 380
Large CHP	Nº	0	40
Iron&Steel	% of prod.	0%	1%
Methanol	% of prod.	0%	0%
Ammonia	% of prod.	0%	5%

According to the estimations, the hydrogen refuelling station network will by 2030 encompass between 80-160 stations for 45 000-90 000 fuel cell vehicles on the road.

In addition, the analysis estimates substitution of up to 1% of the conventional steel production by renewable hydrogen-based steelmaking.

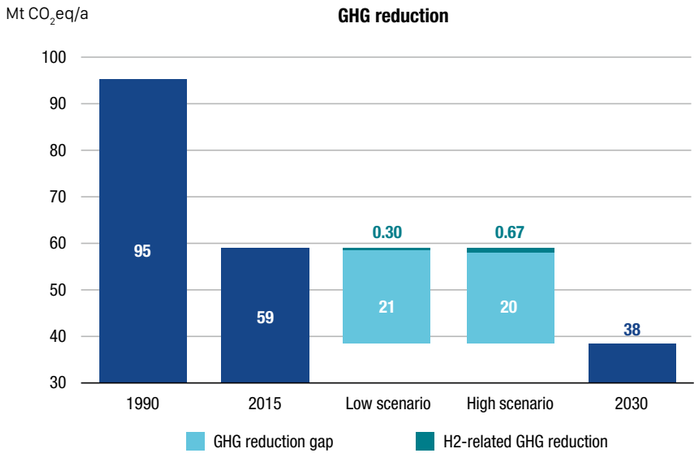
Further use of renewable hydrogen is foreseen in ammonia production (up to 5%).

Finally, the introduction of 1 470-6 420 stationary fuel cells for combined power and heat production is estimated.

Environmental and financial impact in Hungary by 2030

Greenhouse gas (GHG) emission reductions were calculated by estimating the fuels replaced by hydrogen, and their respective greenhouse gas footprint. Comparing these to the 2030 GHG reduction targets results in the contribution of hydrogen to achieving these targets.

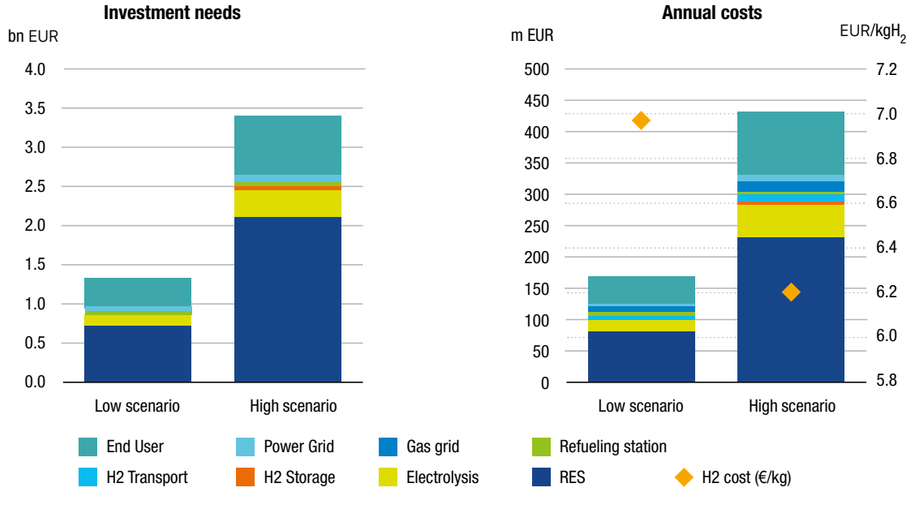
Environmental impact



An additional GHG emission reduction of 0.3-0.7 Mt CO_2 is estimated in 2030 corresponding to 1.4%-3.2% of the overall GHG emission reduction gap towards 2030 target (based on EUCO3232.5).

Financial impact

The financial scenario assessment includes investments (CAPEX) until 2030 and operating expenses (OPEX) per year in 2030. Cumulative investments in hydrogen technologies are estimated at 1.3-3.4 billion EUR until 2030, while annual expenditure would amount to 170-430 million EUR (including end user appliances as well as power and gas grids).

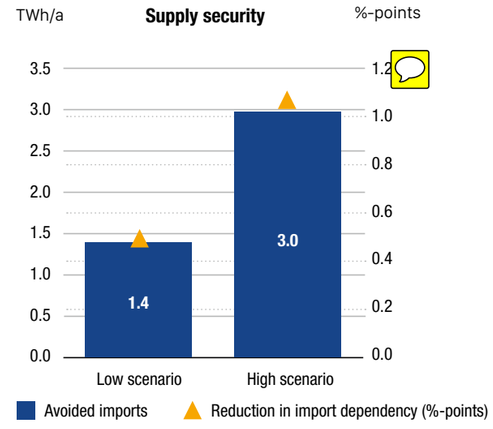


Impact on security of supply, jobs and economy in Hungary by 2030

Hydrogen contributes to the security of energy supply security objective by reducing fossil energy import dependence and enhances energy supply diversification by facilitating deployment of renewable energy sources. This is assessed by estimating imported fossil fuels that will be replaced by hydrogen based on domestic renewable sources.

Security of energy supply

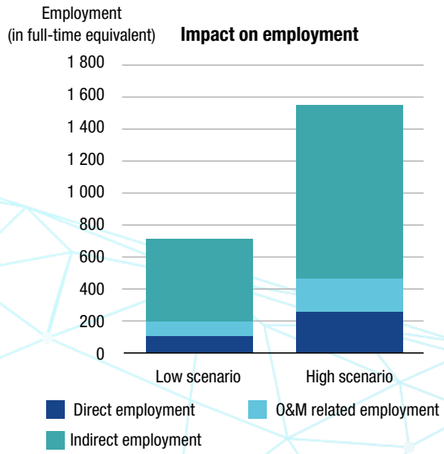
Deployment of renewable hydrogen would lead to 1.4-3.0 TWh/a of avoided imports, and thus reduce import dependency by 0.5-1.1% (in volume terms) in 2030, depending on the scenario.

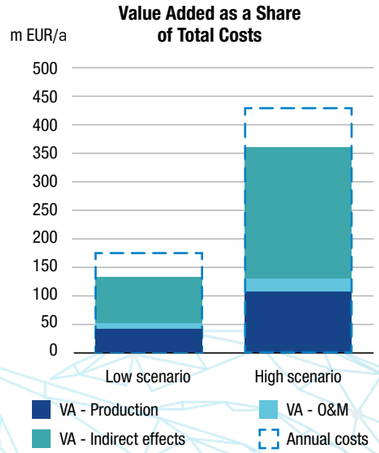


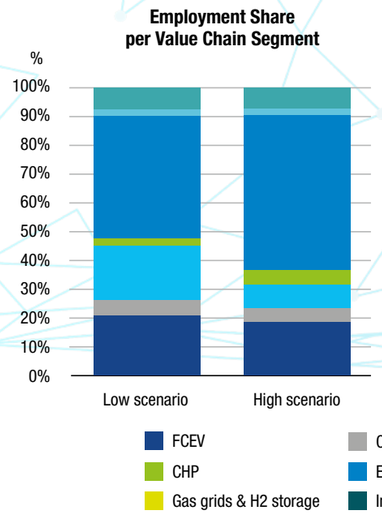
Impact on employment and value added

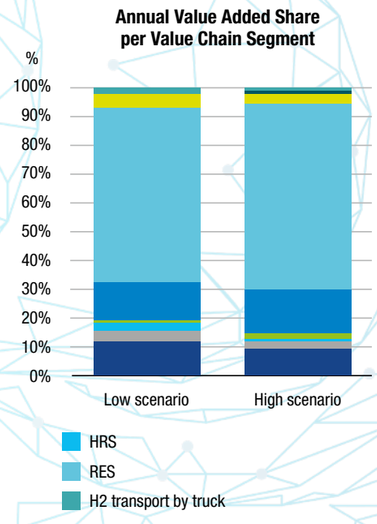
This analysis shows that in the years 2020-2030 around 52 million EUR can be retained annually in the domestic economy as value added in the low scenario, and over 133 million EUR in the high scenario (value added is defined here as sum of wages for employees, margins for companies and taxes). If the indirect effects induced by the investment in and operation of hydrogen technologies are also taken into account, around 134 million EUR (low scenario) and over 360 million EUR (high scenario) of value added can be created in the Hungarian economy annually, which is almost equivalent to the amount of annual investment needed. Most of this value added is expected to be created by building and operating renewable electricity sources and electrolysers for hydrogen production.

The hydrogen-related expenditures in 2020-2030 are estimated to generate employment of 204 - 460 direct jobs (in production and operations & maintenance), and contribute to a further 520 - 1085 indirectly related jobs, depending on the scenario. Most of these jobs are expected to be created by building and operating electrolysers for hydrogen production, hydrogen refuelling stations and in automotive industry.









HUNGARY

Opportunities arising from the inclusion of **Hydrogen Energy Technologies** in the National Energy & Climate Plans

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

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