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

H2

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

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
(Ref. FCH / OP / Contract 234)
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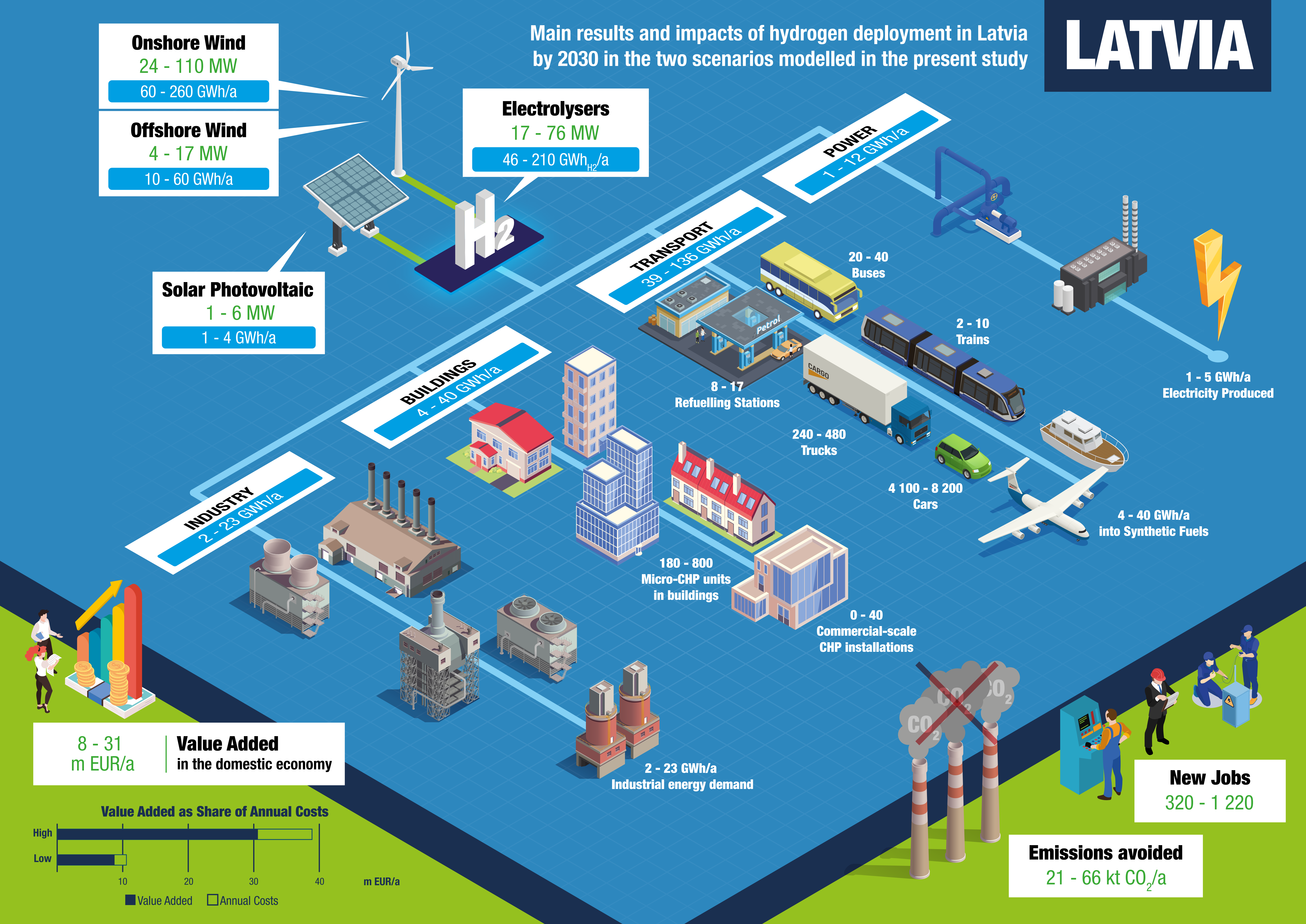
Introduction

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 Latvia by 2030 in the two scenarios modelled in the present study
Onshore Wind
24 - 110 MW
60 - 260 GWh/a
Offshore Wind
4 - 17 MW
10 - 60 GWh/a
Electrolysers
17 - 76 MW
46 - 210 GWh_{H2}/a
Solar Photovoltaic
1 - 6 MW
1 - 4 GWh/a
POWER
1 - 12 GWh/a
TRANSPORT
39 - 136 GWh/a
BUILDINGS
4 - 40 GWh/a
INDUSTRY
2 - 23 GWh/a
20 - 40
Buses
2 - 10
Trains
8 - 17
Refuelling Stations
240 - 480
Trucks
4 100 - 8 200
Cars
1 - 5 GWh/a
Electricity Produced
4 - 40 GWh/a
into Synthetic Fuels
180 - 800
Micro-CHP units
in buildings
0 - 40
Commercial-scale
CHP installations
2 - 23 GWh/a
Industrial energy demand
8 - 31
m EUR/a
Value Added
in the domestic economy
New Jobs
320 - 1 220
Emissions avoided
21 - 66 kt CO_2/a
Value Added as Share of Annual Costs
High
Low
10
20
30
40
m EUR/a
Value Added
Annual Costs

EXECUTIVE SUMMARY

Latvia's commitment for hydrogen deployment according to its NECP

In December 2017, Latvia hosted the Baltic Sea Region Hydrogen Network Conference, "providing a forum for national stakeholders to meet and learn from each other how to develop and promote transnational solutions for the development of hydrogen"[1]. According to its NECP, Latvia considers hydrogen as a "future alternative fuel to replace petroleum products". Latvia has an enabling environment to address the deployment of renewable hydrogen mainly in the transport sector, given its research and development activities, the existence of the Latvian Hydrogen Association (gathering scientists, cities, regions and companies since 2005[2]), the first hydrogen refuelling stations in Riga operational since 2016[3], and its strategic vision which considers renewable hydrogen as a long term alternative fuel for transport. Latvia intends to be involved in the extension of the H2GO4 IPCEI project. It was not involved in the HyLaw[4] project, and could possibly carry out a similar assessment to identify and address its national specific barriers to the deployment of hydrogen.

Latvia seems to consider hydrogen applications as a long-term perspective. Its NECP covering 2021-2030 does not include specific objectives or targets for the production or use of hydrogen, nor hydrogen specific policies and measures.

The scenario assessment shows substantial potential benefits of hydrogen deployment in Latvia 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 Latvia, a limited development of hydrogen demand is assumed in the considered scenarios in **transport**, especially for passenger cars, buses, trucks and trains, and to a more limited extent in aviation (through hydrogen-based liquid fuels or PtL) and inland navigation[5]. A very limited development of hydrogen demand is assumed in the scenarios in **industry**, the main application being for generation of process heat.

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 share of electricity generation from hydrogen by 2030, coming from combined heat and power installations.

Hydrogen production

To cover the estimated hydrogen demand, 0.03 to 0.1 GW of dedicated renewable electricity sources 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, Latvia estimates an installed capacity in 2030 of 1.15 GW in wind and 0.02 GW in solar PV, generating over 2.2 TWh of renewable electricity in 2030. The technical potential for renewable electricity production in Latvia seems however significantly higher[6]. Building additional renewable electricity capacity dedicated for hydrogen production thus could be 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 11 and 38 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, such as steel production. According to the European EUCO3232.5 scenario[7], the Latvian GHG emissions should be reduced by 2 Mt CO_2 in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 21 – 66 kt CO_2 to this goal, which is equivalent to 1% - 3% of the required emission reduction.

[1] http://www.scandinavianhydrogen.org/bsr-hydrogen-network-%20conference/
[2] http://www.h2lv.eu/sample-page/
[3] https://www.gasworld.com/nel-advances-latvian-h2-infrastructure/2011468.article
[4] https://www.hylaw.eu/
[5] 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.
[6] 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).
[7] 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 LATVIA

Latvia considers hydrogen as a long-term alternative fuel to replace petroleum products for transport (while the shift to electrical vehicles, biofuels and CNG/LNG is expected to happen in the medium term). In order to prepare such transition, while facing the complexity of transforming its energy system, Latvia recognises the need to start the deployment and adaptation of the infrastructure. In order to enable the use of vehicles powered by alternative fuels (including hydrogen) and to encourage the purchase of these vehicles, Latvia will implement specific measures for individuals, companies and public organisations.

According to its NECP, Latvia plans to retrofit its gas infrastructure to improve its efficiency. In this frame, it will assess the possibility to adapt the natural gas infrastructure enabling it to transport hydrogen. Latvia foresees to develop an action plan for the deployment of hydrogen infrastructure, while also taking actions to set up adequate market conditions, if and where applicable.

According to its NECP, Latvia will implement its RD&I Smart Specialisation Strategy (RIS3) planned for the period 2021-2027. The strategy includes, among the potential priority areas, innovative solutions for renewable technologies like the production and use of hydrogen. R&D will be further focused on materials and applications for the production and storage of energy, including the storage of variable electricity coupled with hydrogen production.

According to its NECP, Latvia will propose to include the use and deployment of emerging technologies like hydrogen in the list of topics to be addressed in the frame of the Nordic-Baltic cooperation. Latvia participates in the Baltic Sea Hydrogen Network project[8] (financed by the Swedish Institute[9]), with as aim to "build an extensive, multinational, multilevel and cross sectoral network/partnership regarding Hydrogen around the Baltic Sea, which subsequently will mobilize early users and increase awareness of Hydrogen as an energy carrier in the Baltic Sea Region".

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OPPORTUNITY ASSESSMENT

Hydrogen production potential & its role in energy system flexibility

The estimated technical variable renewable electricity production potential in Latvia is significantly higher than the expected Latvian overall electricity demand in 2030, which, according to the assessment, creates a significant opportunity to use this renewable electricity potential to produce hydrogen via electrolysis. According to the NECP, Latvia would by 2030 use only 1% of its technical potential in variable renewable electricity generation, so there is a great margin for building up dedicated renewable electricity plants for hydrogen production via electrolysis.

There is also an opportunity to utilize hydrogen production as a flexibility provider to the electricity system, since the forecasted variable renewable generation capacity is higher than the average forecasted Latvian load in 2030. This opportunity is however affected by the potential to use the interconnection capacity with neighbouring countries as a flexibility provider to the Latvian electricity system.

	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 (based on NECP)	Readiness for CO_2 storage
Latvia	371	5 162%	2.25	1%	126%	Low

Latvia has limited readiness for wide-scale deployment of CCS. Although it has potentially suitable sites for CO_2 storage and the possibility of using CCS technologies is being explored, there are no concrete indications that this potential will effectively be used.

Energy infrastructure

Latvia could assess the feasibility of using its existing methane infrastructure to transport and distribute hydrogen, either by blending it with natural gas or by converting (part of) its network to hydrogen. As there is no publicly available information regarding the share of polyethylene in the distribution network, there is no indication regarding the technical and economic feasibility of such a conversion; this aspect should hence be further assessed.

	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)
Latvia	N.A.	0.5	0	NO
EU	MS range 16%-99%			

To date, there are no salt cavern natural gas storage sites in Latvia that could be used for hydrogen, nor underground salt layers that could provide suitable storage opportunities for hydrogen.

Current and potential gas & hydrogen demand

In Latvia, the most significant opportunities for the deployment of hydrogen are identified in the transport sector, where hydrogen can play a role in the decarbonisation of road and rail transport and on the medium to long term also domestic and international shipping as well as aviation. In industry, the role for hydrogen deployment is limited on the short term, due to the low share of natural gas in the industrial energy mix and the absence of major industries that already use (fossil based) hydrogen. However, there are opportunities for the deployment of renewable or low-carbon hydrogen for the generation of high-temperature process heat. In the built environment, the role for hydrogen deployment seems limited, although it could play a role in decarbonising the small share of natural gas in energy mix and the remaining fossil fuel use in district heating plants.

Opportunities for hydrogen demand in industry

In Latvia, there are no major industries that already use hydrogen in their production processes. Next to that, natural gas accounts for only 14% of the industrial energy demand. Hydrogen is one of the energy carriers that can be deployed to decarbonise the natural gas supply, but the overall impact of this shift on the energy use in Latvian industry as a whole will remain limited. However, there is another application in Latvia's industry where there is a significant potential for the use of hydrogen, namely the provision of high-temperature process heat. This end-use represents almost two fifths of Latvia's industrial energy demand and hydrogen is one of the solutions that can be deployed to decarbonise this challenging part of industrial energy demand.

	Presence of ammonia industry / share of ammonia production capacity in EU28 total	Presence of refineries / Share of Latvian refineries in total captive hydrogen production by refineries in the EU28	Share of Latvia 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)
Latvia	0%	0%	0%	14%	39%
EU	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

The opportunity for using hydrogen for heating in the residential and services sectors in Latvia is limited, as natural gas has a very low share in the energy mix of these sectors. In Latvia, over 80% of the final energy use in the built environment is used for heating and the direct use of fossil fuels only accounts for a very limited part of the heat demand, as most heat is supplied through district heating or generated through the combustion of biomass. Apart from the direct fossil fuel use for heat generation, fossil fuels account for around 37% of the energy inputs in dedicated (non-CHP) heat plants. Hydrogen is one of the low-carbon energy carriers that can replace this fossil fuel use in CHP plants on the medium to long term.

	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)
Latvia	12%	82%	0%
EU	Average: 34% MS range: 0% - 60%	Average: 74% MS range: 41% - 82%	Average: 3% MS range: 0% - 46%

Opportunities for hydrogen demand in transport

In the transport sector in Latvia, the potential for the deployment of hydrogen lies primarily in the rail sector and in road transport. The rail sector in Latvia is one of the most fossil dependent rail sectors in Europe, with fossil fuels accounting for 93% of the sector's energy use. Hydrogen trains are one of the low-emission alternatives for the current diesel trains. Next to this, the Latvian road transport sector is still heavily dependent on fossil fuels as is the case in all EU countries. Hydrogen can play a role in the decarbonisation of this sector, especially in segments like heavy-duty transport where electrification is challenging. In Latvia, heavy-duty vehicles and vans represent 38% of the energy demand in road transport, which means that there is significant potential for hydrogen deployment. Furthermore, the energy use for bunkering activities related to international shipping is significant. Although international shipping is not yet covered by European or international climate legislation, EU countries with large shipping activities need to make a collective effort to support the decarbonisation of this sector. Hydrogen and derived fuels are amongst the few solutions for (near) full decarbonisation of energy use in shipping on the long term and the same holds for the aviation sector.

	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
Latvia	38% (4 164 GWh)	93% (609 GWh)	0.4% (54 GWh)	24.1% (3 026 GWh)	10% (1 681 GWh)	99% (11 678 GWh)
EU	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

The NECP's assessment shows that Latvia considers renewable hydrogen as a long-term alternative fuel for transport, and intends to take further steps to facilitate this development, including the adaptation of its gas network, the deployment of hydrogen infrastructure and measures to incentivize the purchase of hydrogen driven vehicles. However, Latvia has not yet set up a comprehensive framework for the deployment and use of hydrogen in all sectors. Its NECP refers to transport only, without concrete objectives or measures.
Taking into account its very large potential for hydrogen deployment based on renewable electricity, it would be appropriate that Latvia properly considers hydrogen within its energy policy to address the decarbonisation challenges in all energy end-use sectors, taking into account the initiatives and policies at EU level. Latvia is expected to continue its coordination's efforts with the neighbouring countries to properly integrate hydrogen into the electricity and gas systems, and to share experience and practices with the other Baltic countries. In the meantime, it would be appropriate that Latvia takes further steps supporting its research centres and industry to carry out hydrogen related research, and to launch where appropriate pilot and demonstration projects, which can contribute to paving the way for the use of renewable or low-carbon hydrogen as a means to achieve deep decarbonisation.

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

Positive environment: Limited

An overarching hydrogen roadmap has not yet been developed; such a comprehensive roadmap would support the country in mainstreaming hydrogen within the energy system. The Latvian Hydrogen Association could provide support in structuring such roadmap, in close collaboration with the other Baltic countries, possibly in the frame of the Nordic Sea Hydrogen Network project.

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

Positive environment: ✗

According to Latvia's NECP, the final non-ETS targets for the period 2021-2030 will only be set for Latvia in 2020-2021 using the latest available verified GHG inventory data for 2016, 2017 and 2018. Hydrogen could be included as an option if Latvia would need to considers additional efforts to reach its target.

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)

The Latvian National Policy Framework (or NPF set in the context of the alternative fuel infrastructure directive (2014/94/EU)) acknowledges that a lack of national policies and planning has jeopardised the use of natural gas and hydrogen in transport. However, the NPF does not include specific measures to deploy hydrogen infrastructure for transport.

	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
Latvia	NO	1	689 536
EU		Total 156	Average 1 677 543

Existence of (investment on) hydrogen-related projects

There was in 2019 1 refuelling station in Latvia. There is no other industrial project in operation

	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)
Latvia	NO	0.0	NO	0

Existence of national tax incentives (CO_2 pricing mechanisms & car taxation)	Positive environment
Latvia has set up a CO_2 pricing mechanism in 2004, which is key to support the progressive shift to low carbon vehicles (including on hydrogen)	✓

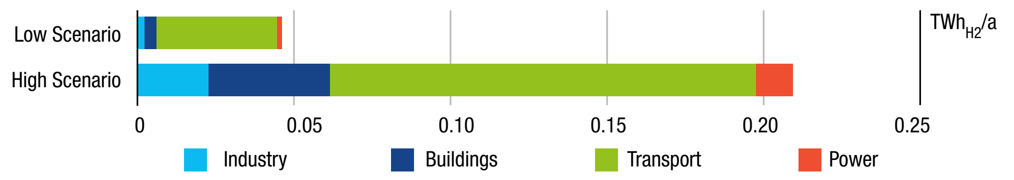
Fossil energy import bill

Like many EU Member States, Latvia 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 will contribute to reducing the energy import dependence and bill.

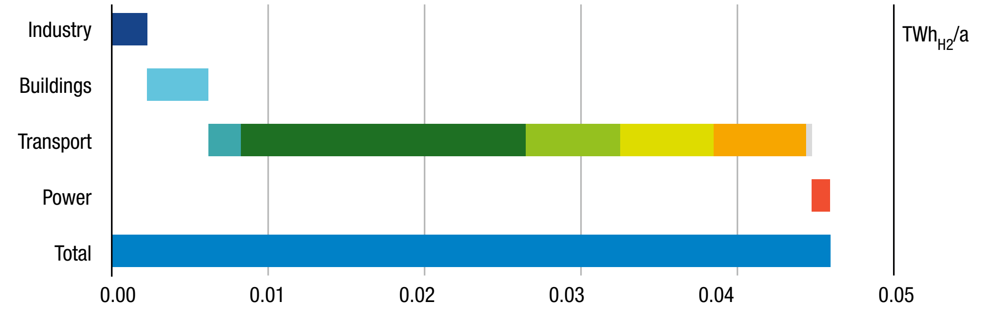
	Import bill for natural gas as share of national Gross Value Added	Import bill for all fossil fuels
Latvia	1.4%	3.2%
EU	Average: 0.6% MS range: 0% - 1.5%	Average: 2% MS range: 0% - 7%

SCENARIO ASSESSMENT
Estimated renewable/low carbon hydrogen demand for Latvia 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).

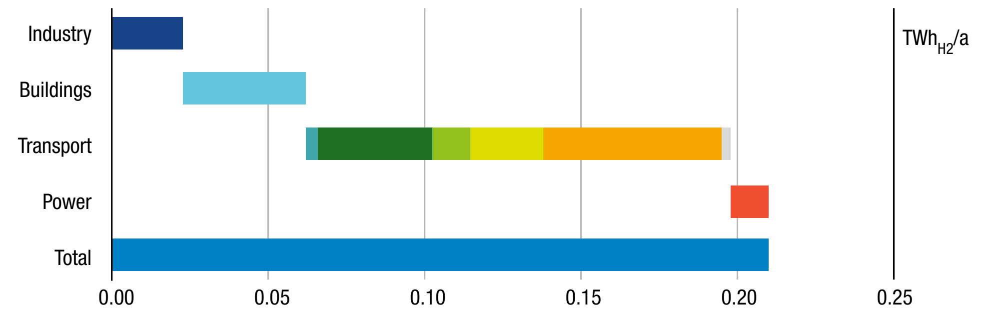


Low scenario



In the low scenario, renewable hydrogen accounts for 0.1% of final total energy demand (i.e. 0.05 out of 44 TWh/a) or 1.1% of final gas demand (4 TWh/a) according to EUCO3232.5.

High scenario



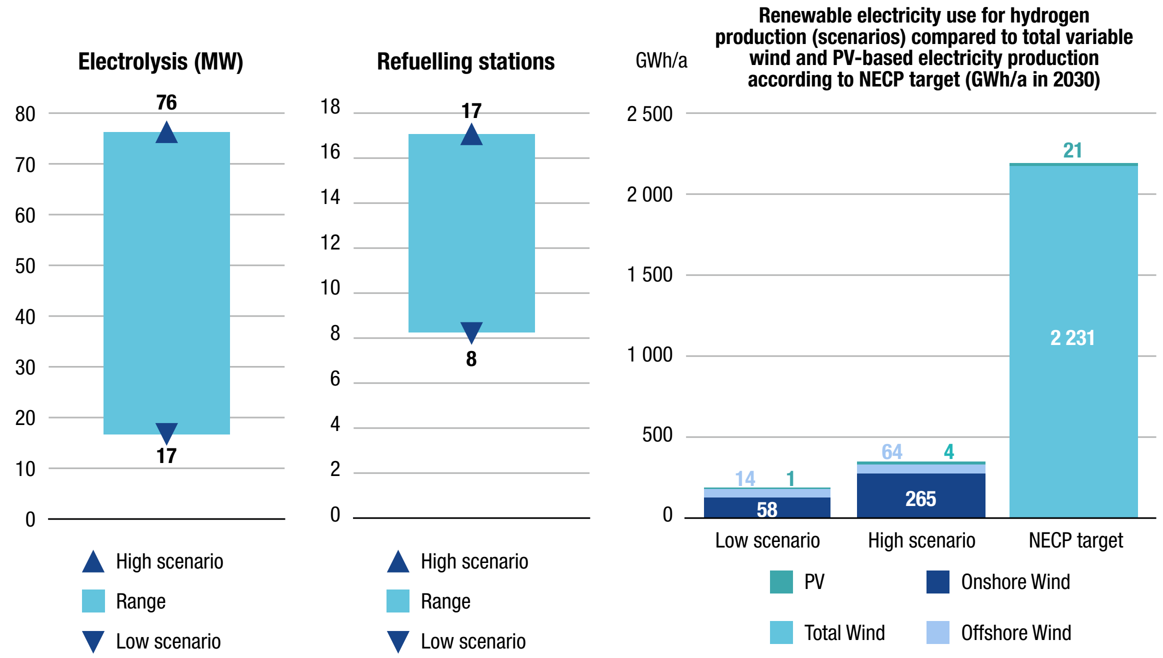
In the high scenario, renewable hydrogen accounts for 0.5% of final total energy demand (i.e. 0.2 out of 44 TWh/a) or 4.9% of final gas demand (4 TWh/a) according to EUCO3232.5.

Refinery
Ammonia
Methanol
Iron & steel
Industry energy
Buildings
Buses
Cars
Trucks
Rail
Aviation
Inland navigation
Power

Hydrogen generation, infrastructure and end users in Latvia 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 0.04% of the overall technical renewable power potential in the low scenario and for 0.2% in the high scenario.

End users

End user	Unit	Low scenario	High scenario
Passenger cars	Nº	4 100	8 200
Buses	Nº	20	40
Lorries	Nº	200	400
Heavy duty vehicles	Nº	40	80
Trains	Nº	2	10
Substituted fuel in aviation	GWh/a	4	38
Substituted fuel in navigation	GWh/a	0.2	1.8
Micro CHP	Nº	180	780
Large CHP	Nº	4	38
Iron&Steel	% of prod.	0%	0%
Methanol	% of prod.	0%	0%
Ammonia	% of prod.	0%	0%

According to the estimations, the hydrogen refuelling station network will by 2030 encompass between 8-20 stations for 4 000-9 000 fuel cell vehicles on the road.[10]

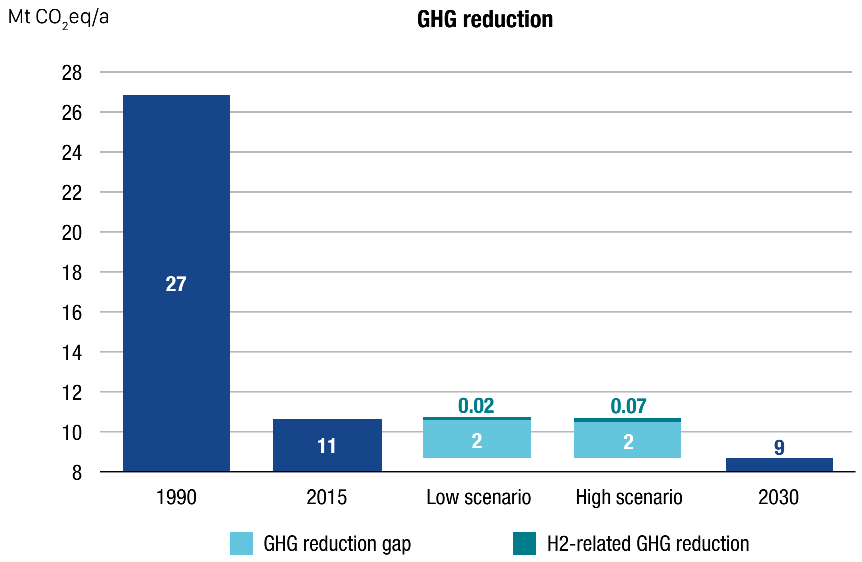
Finally, the introduction of 180-820 stationary fuel cells for combined power and heat production is estimated.

[10] In order to ensure a minimum coverage of the country with hydrogen refuelling stations, more stations may be necessary for supplying hydrogen to the vehicle fleet.

Environmental and financial impact in Latvia 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.

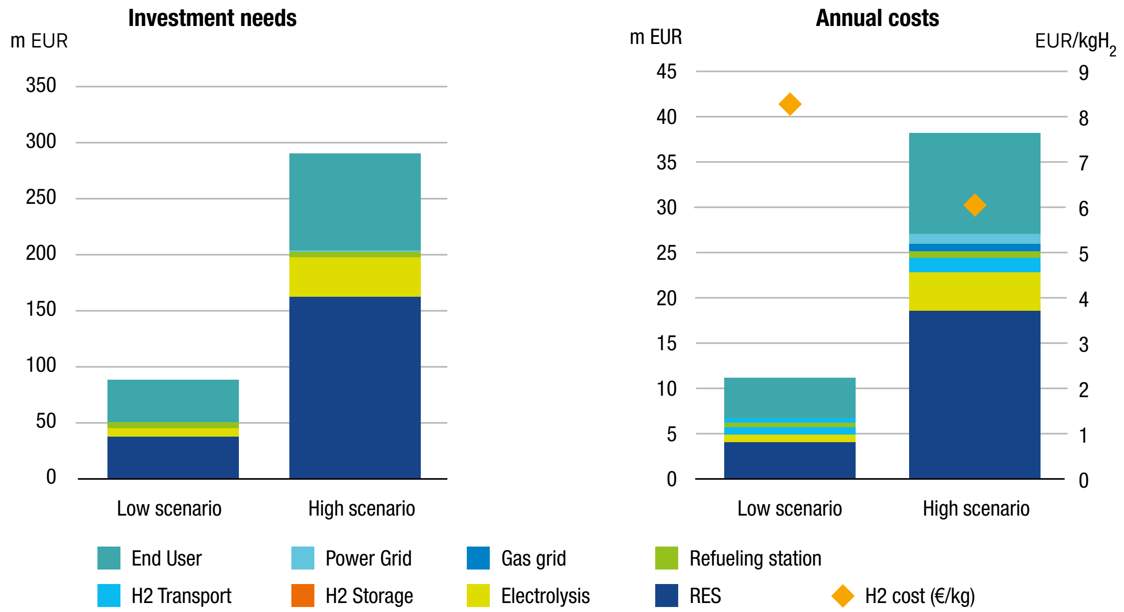
Environmental impact



An additional GHG emission reduction of 0.02-0.07 Mt CO_2 is estimated in 2030 corresponding to 1.1%-3.5% 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 0.1-0.3 billion EUR until 2030, while annual expenditure would amount to 10-40 million EUR (including end user appliances as well as power and gas grids).

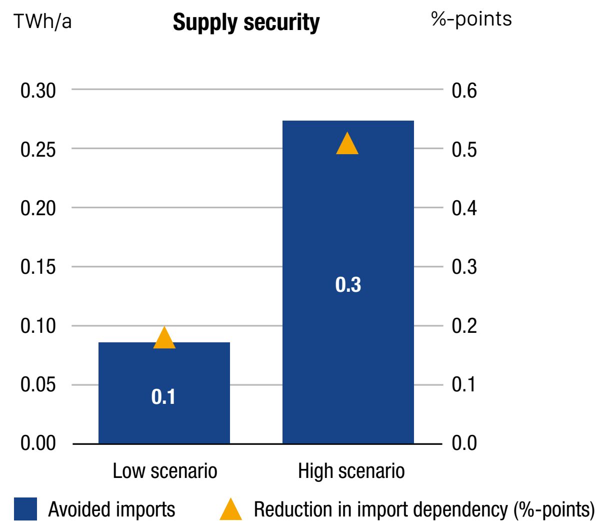


Impact on security of supply, jobs and economy in Latvia by 2030

Hydrogen contributes to the 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

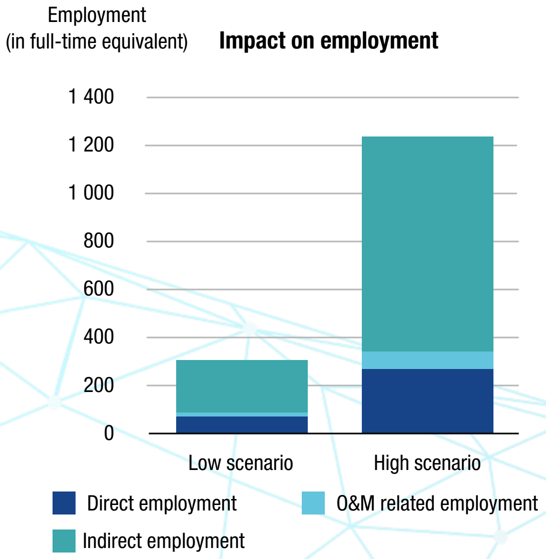
Deployment of renewable hydrogen would lead to 0.1-0.3 TWh/a of avoided imports, and thus reduce import dependency by 0.2-0.5% (in volume terms) in 2030, depending on the scenario.

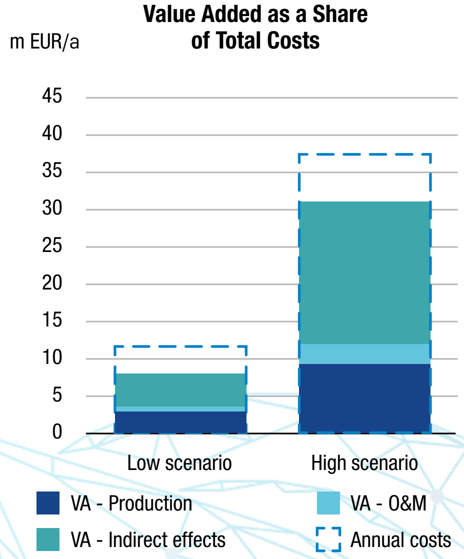


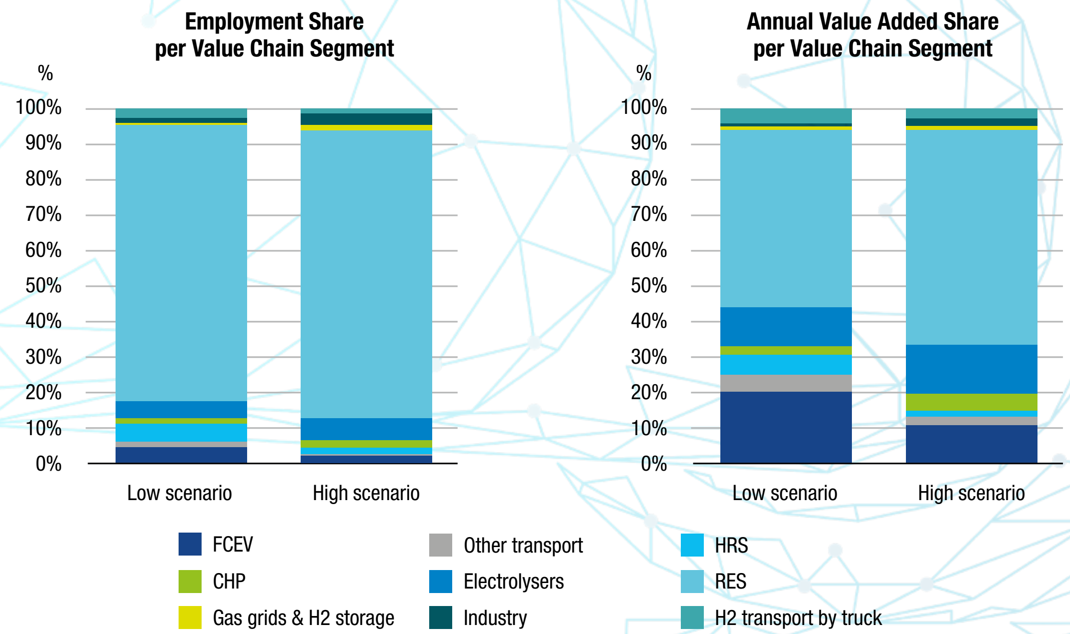
Impact on employment and value added

This analysis shows that in the years 2020-2030 around 3 million EUR can be retained annually in the domestic economy as value added in the low scenario, and almost 12 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 8 million EUR (low scenario) and almost 32 million EUR (high scenario) of value added can be created in the Latvian economy annually, which is equivalent to three quarters of the annual investment needed. Most of this value added is expected to be created by building dedicated renewable electricity sources and electrolysers for hydrogen production, and in automotive industry. In the high scenario, a more significant share of value added is expected to be created by building and operating hydrogen transport networks and storage facilities.

The hydrogen-related expenditures in 2020-2030 are estimated to generate employment of 80 – 340 direct jobs (in production and operations & maintenance), and contribute to a further 230 – 900 indirectly related jobs, depending on the scenario. Most of these jobs are expected to be created by building and operating dedicated renewable electricity sources and electrolysers for hydrogen production and by investing in hydrogen refuelling stations.







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