AUSTRIA

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

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)
fch-ju@fch.europa.eu

Prepared by

Trinomics   ludwig bölkow systemtechnik

Graphic Design:
Ático, estudio gráfico® - aticoestudio.com

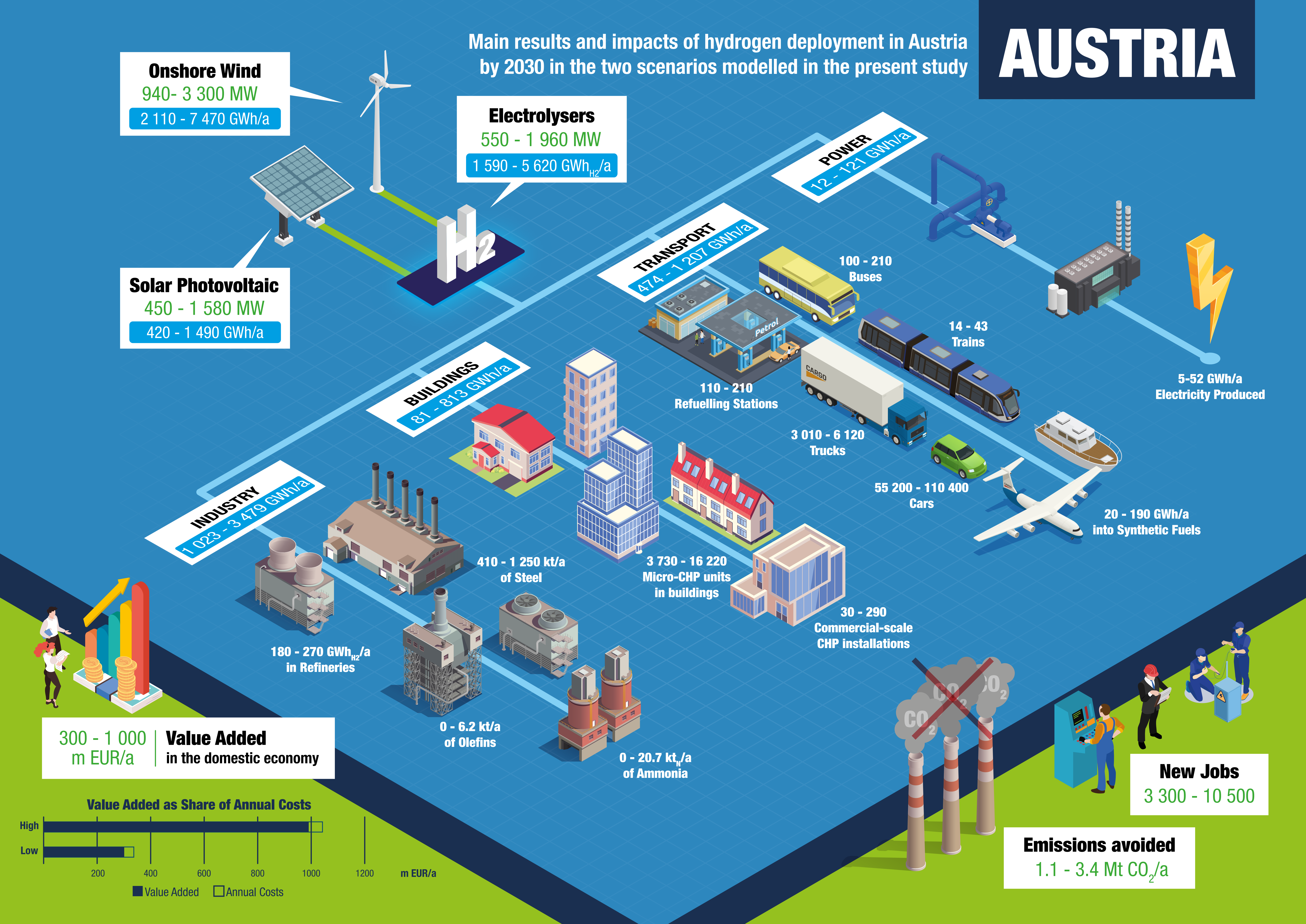
Table of content

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.



Main results and impacts of hydrogen deployment in Austria
by 2030 in the two scenarios modelled in the present study
AUSTRIA
Onshore Wind
940- 3 300 MW
2 110 - 7 470 GWh/a
Electrolysers
550 - 1 960 MW
1 590 - 5 620 GWh$_{H2}$/a
Solar Photovoltaic
450 - 1 580 MW
420 - 1 490 GWh/a
H_2
POWER
12 - 121 GWh/a
TRANSPORT
474 - 1 207 GWh/a
BUILDINGS
81 - 813 GWh/a
INDUSTRY
1 023 - 3 479 GWh/a
100 - 210
Buses
14 - 43
Trains
Petrol
CARGO
110 - 210
Refuelling Stations
3 010 - 6 120
Trucks
55 200 - 110 400
Cars
5-52 GWh/a
Electricity Produced
20 - 190 GWh/a
into Synthetic Fuels
410 - 1 250 kt/a
of Steel
3 730 - 16 220
Micro-CHP units
in buildings
30 - 290
Commercial-scale
CHP installations
180 - 270 GWh$_{H2}$/a
in Refineries
0 - 6.2 kt/a
of Olefins
0 - 20.7 kt$_N$/a
of Ammonia
CO_2
CO_2
CO_2
300 - 1 000
m EUR/a
Value Added
in the domestic economy
Value Added as Share of Annual Costs
High
Low
200
400
600
800
1000
1200
m EUR/a
Value Added
Annual Costs
New Jobs
3 300 - 10 500
Emissions avoided
1.1 - 3.4 Mt CO_2/a

EXECUTIVE SUMMARY

Austria's commitment for hydrogen deployment according to its NECP

Austria has the ambition to become a European leader in the deployment of hydrogen. The government is preparing a national **Hydrogen Strategy**[1], currently subject to public consultation. Its NECP considers renewable hydrogen *"as a key technology for sector integration and coupling"* and comprises the concrete target of a **renewable electricity based hydrogen consumption of 1.1 TWh (4 PJ) in 2030**. New regulatory and financial measures are announced to pave the way for renewable hydrogen in the industrial, building and transport sectors addressing the entire value chain from generation, over storage, transport and distribution to end use.

Austria is in a favourable position given its current **investments in hydrogen research and in pilot and demonstration projects** as well as in infrastructure, e.g. hydrogen refuelling stations, transport and delivery infrastructure with the potential IPCEI Green Hydrogen @ Blue Danube project, decarbonizing the steel industry, producing hydrogen from renewable sources, etc. Austria was also involved in the HyLaw project, that identified and assessed major regulatory barriers, in view of prioritizing measures to address them.

The NECP does not provide hydrogen targets per sector, but more detailed sub-targets and policies and measures may be elaborated in the upcoming Hydrogen Strategy document.

The scenario assessment shows substantial potential benefits of hydrogen deployment in Austria 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 Austria, a significant development of hydrogen demand is assumed in **transport**, especially for passenger cars, buses, trucks and trains, and to a limited extent in aviation (through hydrogen-based liquid fuels or Power to Liquid) and inland navigation[2]. A significant development of hydrogen demand is also assumed in the considered scenarios in industry, especially in the iron and steel sector. Some 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 share of electricity generation from hydrogen by 2030, coming from combined heat and power installations.

Hydrogen production

It is assumed that, to cover the estimated hydrogen demand from new uses and from substitution of fossil based hydrogen, 1.5 - 5 GW of dedicated renewable electricity sources would have to be installed to produce green hydrogen via electrolysis (depending on scenarios). "Surplus" electricity from the markets in times of high renewable electricity production can be used for this purpose as well. However, the main share will have to be covered by dedicated renewable electricity sources. In the two scenarios, part of the total hydrogen demand in 2030 would still be covered by fossil-based hydrogen produced via steam-methane reforming of fossil fuels.

In its NECP, Austria estimates an installed capacity in 2030 of 6.87 GW in onshore wind and 11.53 GW in solar PV, generating over 28 TWh of renewable electricity in 2030. The technical potential for renewable electricity production in Austria seems however significantly higher[3]. Building up additional capacities of renewable electricity sources for dedicated hydrogen generation 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 350 and 1100 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[4], the Austrian GHG emissions should be reduced by 24 Mt CO_2 in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 1.1 – 3.4 Mt CO_2 to this goal, which is equivalent to 5% - 14% of the required emission reduction.

[1] *Hydrogen Strategy kick-off meeting. https://www.bmnt.gv.at/energie-bergbau/energie/Oesterreichische-Wasserstoffstrategie.html*

[2] *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.*

[3] *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).*

[4] *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 AUSTRIAN NECP

Austria's NECP emphasizes the contribution of hydrogen to increase the share of renewable energy in final energy consumption to 45-50% by 2030, and to source 100% of its electricity consumption from renewable energy sources, by **developing a hydrogen strategy** and putting the basic conditions in place for feeding biogas and renewable **hydrogen into existing natural gas infrastructure**.

*In its 7th flagship project on "Renewable hydrogen and biomethane", Austria foresees to act on **promoting investments, exempting taxation and addressing the legal framework for these renewable gases.***

Austria considers that **greening the gas supply**, (i.e. using biomethane, hydrogen and synthetic methane from renewable power sources), is a key component in the development of a sustainable energy system and that a significant share of natural gas should be replaced by renewable gases. Under the Renewable Development Act, the integration of renewable gas into the natural gas distribution system is to be encouraged, for example, by means of a quota system, which may be phased in gradually.

The long-term storage of electricity by hydrogen is to be made possible and encouraged. To this end, it will be examined whether future investment by the hydrocarbon industry close to the industry (e.g. power-to-gas) can be taken into account in calculating the subsidy rates (Mineral Raw Materials Act).

Currently, hydrogen (as a fuel) is subject to taxation under the Mineral Oil Tax Act. Under the 2020 Tax Reform Act, hydrogen will be taxed more favourably by applying the (compared to the mineral oil tax) lower rate of the natural gas tax. In addition, a tax exemption will be applied to renewable hydrogen.

At the **regional level**, the Pentalateral Energy Forum, addresses the impact of the implementation of flexibility options, including the role of demand response, PtX and hydrogen as well as the role of storage and electro-mobility, and analyses specific electricity-related barriers to sector coupling. In view of increasing the potential use of hydrogen from renewable sources, the participating countries explore possible common approaches to **guarantees of origin**, cross-border infrastructure, respective **roles of TSOs and DSOs** and hydrogen blending **standards**, and the future role of hydrogen in general.

The 14% **renewable energy target for transport** under the Renewable Energy Directive (RED II), will be implemented by increasing the use of renewable electricity and hydrogen in the transport sector. As 99% of the CO_2 emissions in Austria's transport sector come from road transport, the promotion of the transition to zero- and low-emission vehicles (full electric, plug-in hybrid, hydrogen/fuel cell) and the deployment of charging infrastructure will make a decisive contribution to achieving the climate objectives.

To contribute to the transformation of the energy system, existing capacities need to be used and existing energy infrastructures need to take on additional tasks (e.g. power-to-gas, power-to-heat, wind-to-hydrogen, power-to-liquids, storage). There are flagship projects on which to build, such as the projects on 'component activation' in individual buildings or seasonal storage in connection with district heating networks, as well as the project in the domain of 'hydrogen/ammonia' in industry.

RD&I in renewable hydrogen is key to achieve the energy transition. In parallel to the Austrian hydrogen strategy, IPCEI projects are envisaged, which will showcase Austria's competences in the hydrogen domain globally. Hydrogen needs further funding for research and market uptake.

The 2018 accession to the 'Mission Innovation', a global clean energy initiative, marked a step towards increased **international cooperation and coordinated research** and development efforts. In consultation with Austrian stakeholders, participation in Mission Innovation will focus, for the time being, on Smart Grids (IC1), Heating and Cooling in Buildings (IC7) and Hydrogen (IC8). In its "Energy research initiative 2 – ***'Mission Innovation Austria' programme"***, Austria's Climate and Energy Fund will invest up to 120 million EUR supporting three flagship projects: WIVA P&G[5] (association for the promotion of research and development in the fields of application, network and storage technologies of hydrogen and renewable gases), NEFI (domestic 100% renewable energy supply) and GreenEnergyLab (Smart Grids/Demand Side Management/Demand Response).

Next to the energy efficiency association, which is active in the domain of hydrogen, there is also a dedicated national association for hydrogen (**OÖ Wasserstoff-Forum**[6]).

[5] https://www.wiva.at/v2/wiva-pg/
[6] OÖ Wasserstoff-Forum. https://www.energiesparverband.at/veranstaltungen/details/events/ooe-wasserstoff-forum.html

OPPORTUNITY ASSESSMENT

Hydrogen production potential & its role in energy system flexibility

Austria already has a high share of renewable energy sources in its electricity mix, predominantly thanks to its large hydropower capacity and some wind power and biomass. The technical potential for variable renewable electricity in Austria is more than twice as high (249%) as its estimated final electricity demand in 2030, providing a significant potential for hydrogen production. According to the NECP, Austria would by 2030 use only 16% 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.

Given its high pumped hydro storage capacities, the opportunity to use hydrogen production as a flexibility provider is rather limited. However, it is likely that additional flexibility demand will arise in the future since the pumped storage facilities are located in other geographical areas than the wind and solar PV generation plants.

The potential of low-carbon hydrogen production from fossil fuels combined with CCS is limited, as CO_2 storage is legally banned in the country.

Technical variable renewable electricity potential (TWh/a)	Technical renewable electricity generation potential compared to forecasted gross electricity consumption in 2030 (NECP)	NECP estimate of variable renewable electricity production in 2030 (TWh/a)	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
181	249%	28.34	16%	218%	Low

Austria has limited readiness for wide-scale deployment of CCS. Although it has potentially suitable sites for CO_2 storage, the practical feasibility of such activities has not been extensively studied yet. This is also due to the legal ban on CO_2 storage, which is in force since 2011, and represents a further barrier for low-carbon hydrogen deployment (although the relevant law is re-evaluated every 5 years).

Energy infrastructure

Austria could consider using its existing natural gas infrastructure for hydrogen transport and distribution. The share of polyethylene in its distribution network is relatively high, and it could hence be converted to hydrogen at relatively low cost. In the short term, conversion of the distribution networks to dedicated hydrogen pipelines would not be needed, as the production volumes of hydrogen would be relatively low in the first development stage and it could hence be blended with methane in the existing grid. The threshold for hydrogen content in the gas grid is currently limited to 4%vol or 2%vol if a CNG-storage facility (refuelling station) is linked to the grid. In order to facilitate the injection of hydrogen, the threshold is expected to be increased to at least 10% by 2030, with the possibility for local higher allowances. Depending on this threshold, the public gas infrastructure might require physical adjustments. In the medium term, (partial) refurbishment of natural gas infrastructure for dedicated hydrogen use can be considered. Next to this, Austria could explore whether the salt formations in the Salzburg region might be suitable for the construction of caverns for hydrogen storage.

	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)
Austria	61%	0.5	0	YES
EU	MS range 16%-99%			

There are no salt cavern natural gas storage sites in Austria. However, there are underground salt layers in the Salzburg region, which might be suitable for the construction of hydrogen storage facilities. Gas storage operator RAG Austria AG (supported by the Austrian Climate and Energy Fund) is, among others, exploring their potential through two projects: UndergroundSunStorage[7] and UndergroundSunConversion.

[7] https://www.underground-sun-storage.at/en.html

Current and potential gas & hydrogen demand

Overall, renewable hydrogen can play a significant role in Austria's future energy mix. The largest demand potentials are identified in the industry, as Austria hosts several industrial companies that currently use fossil energy based hydrogen produced without CCS, or that use fossil fuels for industrial processes, e.g. in steel manufacturing or for the generation of process heat. In the transport sector, the demand potentials are quite similar to other countries, with the short-term potentials residing primarily in the decarbonisation of road freight and fossil-based rail transport. The potential role of hydrogen for heating of buildings in the residential and services sector is relatively limited, although it can be used to substitute existing natural gas use in these sectors.

Opportunities for hydrogen demand in industry

Austria has a substantial potential for the use of renewable or low-carbon hydrogen in its industry. In the short and medium term, this option can be considered to decarbonise existing hydrogen use in ammonia production and refineries. Furthermore, renewable or low-carbon hydrogen can also be deployed to replace natural gas in buildings and industry, e.g. replacing fossil-based supply of process heat. With regard to the latter, the Austrian steel company Voestalpine has set up in 2019 a pilot installation including a 6 MW PEM electrolyser using hydropower and aims to experiment with the use of hydrogen in different stages of the steelmaking process.

There are economic and technical challenges for switching to renewable or low-carbon hydrogen in industry. First of all, prices for fossil fuels and fossil-based hydrogen are still low compared to the expected costs for renewable or low-carbon hydrogen (even when taking into account ETS costs). Furthermore, some industries like steelmaking need to change some of their core processes and equipment in order to enable replacing fossil fuel use with hydrogen on a large scale, which requires significant investments and can cause down time which also represents a cost.

	Presence of ammonia industry / share of ammonia production capacity in EU28 total	Presence of refineries / Share of Austrian refineries in total captive hydrogen production by refineries in the EU28	Share of Austria 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)
Austria	3%	2%	6%	34%	38%
EU	MS range 0%-15%	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 Austria, the energy mix currently used for heating of buildings is quite diverse. As natural gas represents about 20% of the final energy demand in the residential and services sector, hydrogen could make a valuable contribution to the decarbonisation of this part of the energy demand. On the long term, hydrogen could also contribute to the substitution of oil use for heating purposes.

	Share of natural gas in the household and service sector energy demand (2017)	Share of space & water heating in the household and service sector energy demand (2015)	Share of cooling in the household and service sector energy demand (2015)
Austria	20%	77%	2%
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

The potential for the deployment of hydrogen for transport lies primarily in the rail and road freight sectors. In the rail sector (where fossil fuels represent 18% of energy use), the first steps towards hydrogen deployment have been taken. In 2019, the rail operator in the Zillertal (Tirol) ordered five hydrogen-powered trains. Together with electrification, hydrogen is an attractive energy carrier for the decarbonisation of rail transport, especially in mountainous terrain where overhead lines are difficult to build. There is also a substantial potential for the deployment of hydrogen to decarbonise energy use of trucks, buses and vans, which account for almost 40% of the energy use in road transport. Like in all countries, the passenger car sector in Austria is heavily dependent on fossil fuels. Hydrogen can play a complementary role to electrification in the effort to decarbonise this segment of the transport sector. Lastly, there is an opportunity to use hydrogen or hydrogen-derived synthetic fuels to decarbonise energy use in the aviation sector. Passenger air transport in Austria grew by 31% between 2000 and 2015, and globally this trend is expected to continue in the coming decades.

The use of hydrogen in maritime and aviation applications as well as heavy-duty road transport will require further technological innovation to improve hydrogen storage technology in terms of capacity and required space. Application of hydrogen or derived fuels in the navigation and aviation sectors will also require the introduction of (stronger) policy incentives to switch to climate-neutral alternative fuels.

	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
Austria	39% (45 694 GWh)	18% (463 GWh)	<0.1% (45 GWh)	0.2% (245 GWh)	8% (8 621 GWh)	94% (87 978 GWh)
EU		Average 30% MS range 0%-95%	Average 2% MS range 0%-10%	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

Austria has the ambition to become "hydrogen nation number one"[8], and has effectively a positive enabling environment for hydrogen deployment in the coming decade and beyond, despite the existence of some regulatory barriers. The government's commitment is clearly shown in its NECP that announces the elaboration and implementation of a hydrogen strategy and comprises important measures to pave the way for a wide renewable hydrogen deployment in the industrial, building and transport sectors. Austria is investing in the deployment of infrastructure, and is funding fundamental research and demonstration projects. The Tax Reform Act 2020 should incentivize alternative fuels, among which hydrogen. The high energy import dependence of Austria and the existing gap to achieve its GHG target by 2030 could be two additional reasons for Austria to further increase its renewable hydrogen ambition.

Existence of (or concrete plans for) national hydrogen roadmaps or strategies — Positive environment ✓

The government's commitment is clearly shown in its NECP and in the hydrogen strategy currently under development.

[8] https://www.h2-international.com/2019/10/13/austria-as-hydrogen-nation-no-1/

GHG mitigation gap in non-ETS sectors (need for additional GHG reduction measures) — Positive environment ✓

In the EC's recommendations on the draft Austrian NECP, Austria was called to implement complementary measures for the transport sector and built environment to reduce its GHG emissions in these sectors. Hydrogen could play a role in such measures (see demand potential). According to the final NECP version, the 'with additional measures' (WAM) scenario would allow to reduce the emissions from non-ETS sources in 2030 by 27% compared to 2005, which shows that the implementation of new instruments (e.g. phasing out counterproductive incentives and subsidies for fossil fuels by 2030) will be necessary to fill in the remaining gap to achieve the GHG reduction target of 36% by 2030 (Effort Sharing Regulation) through domestic measures. These measures will later be defined and will mainly address energy efficiency and the deployment of renewable energy sources. As "the transport sector remains the largest emitter in the non-ETS sectors", a higher use of hydrogen in this sector could become an attractive option.

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 Austrian National Policy Framework submitted in November 2016 was already considering hydrogen for transport and targeted a slight increase of hydrogen refuelling points.

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	7	700 000

Existence of (investment on) hydrogen-related projects

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)
YES	7.4	YES	7

Austria is currently building up nationwide filling station infrastructure for hydrogen[9]; its research program Future Mobility[10] focuses on integrated solutions designed to help build the mobility system of the future. Further, according to its NECP, in 2017, Austria allocated 3.3% of its total energy research expenditure to hydrogen.

The Hydrogen Center Austria[11] is actively engaged in research projects. There are currently 6 projects for advancement of hydrogen technology in the industry with a funding volume of 11.4 million EUR and overall investments of 21.6 million EUR.

H2Future is a European flagship project for the generation of renewable hydrogen, which aims to install and operate at the Voestalpne Limz steel plant a large-scale 6MW PEM electrolysis system.

Austria is also involved in 2 potential IPCEI projects[12]: Green Hydrogen @ Blue Danube (Produce green hydrogen on a large scale in South-East Europe & transport via the River Danube to the Interreg Danube Transnational region) and H2GO (hydrogen powered road transport from Northwest to Southeast).

[9] http://www.hydrogen-emobility.com/
[10] https://mobilitaetderzukunft.at/en/about/
[11] http://www.hycenta.at/en/projects/
[12] IPCEI projects: https://www.hydrogen4climateaction.eu/projects

Positive environment

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

The adopted Tax Reform Act 2020 implements specific tax measures that will stimulate the deployment of hydrogen. Among other things, the new tax scheme will influence purchase decisions of vehicles by means of a price- and emissions-related registration tax. In addition, a CO_2 component will be introduced in the motor-related insurance tax. The tax reform also creates tax allowances for biogas, sustainable hydrogen and liquefied natural gas.
Since 1 January 2020, a low tax tariff is applicable for vehicles with an authorised weight of more than 3.5 tonnes, powered by batteries or hydrogen fuel cells.

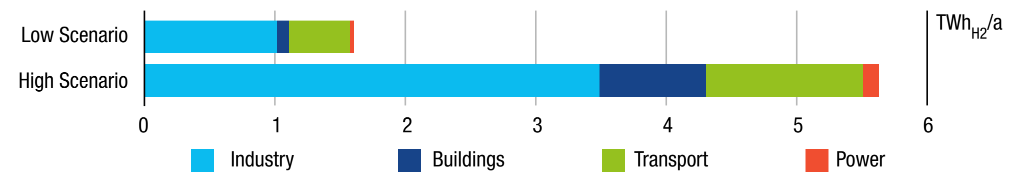
Fossil energy import bill

Like many EU Member States, Austria 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 and heating applications and promoting the use of hydrogen in the transport sector will contribute to reducing the import dependence.

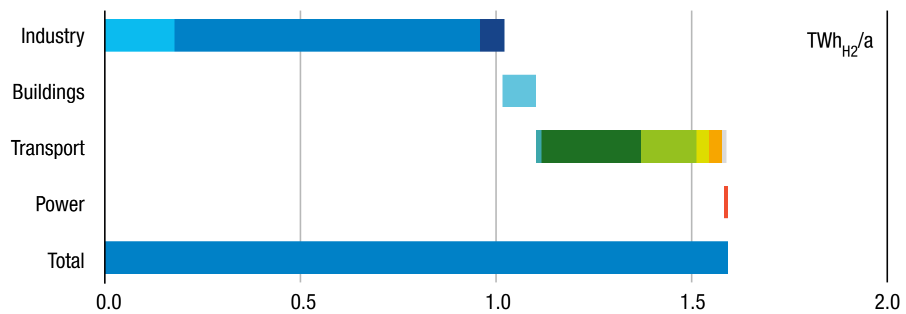
	Import bill for natural gas as share of national Gross Value Added	Import bill for all fossil fuels
Austria	0.7%	2.4%
EU	Average: 0.6% MS range: 0% - 1%	Average: 2% MS range: 0% - 7%

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

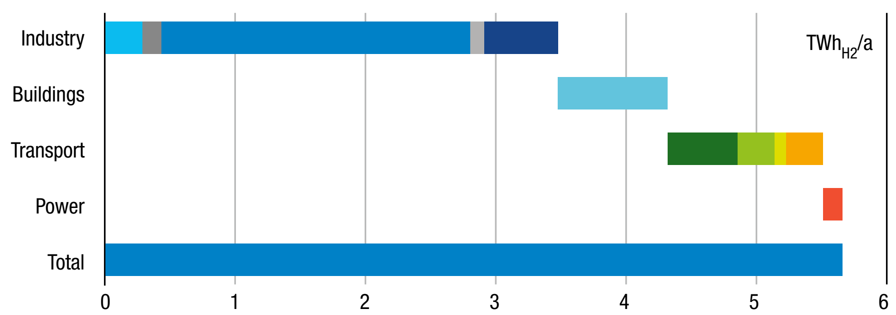


Low scenario

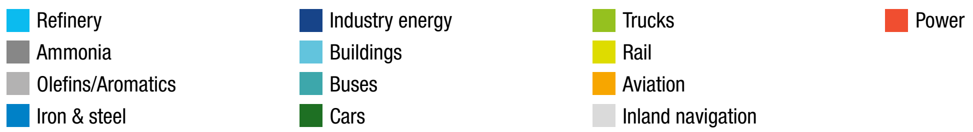


In the low scenario, renewable hydrogen accounts for 0.6% of final total energy demand (i.e. 1.6 out of 281 TWh/a) or 3.2% of final gas demand (49 TWh/a) according to EUCO3232.5.

High scenario



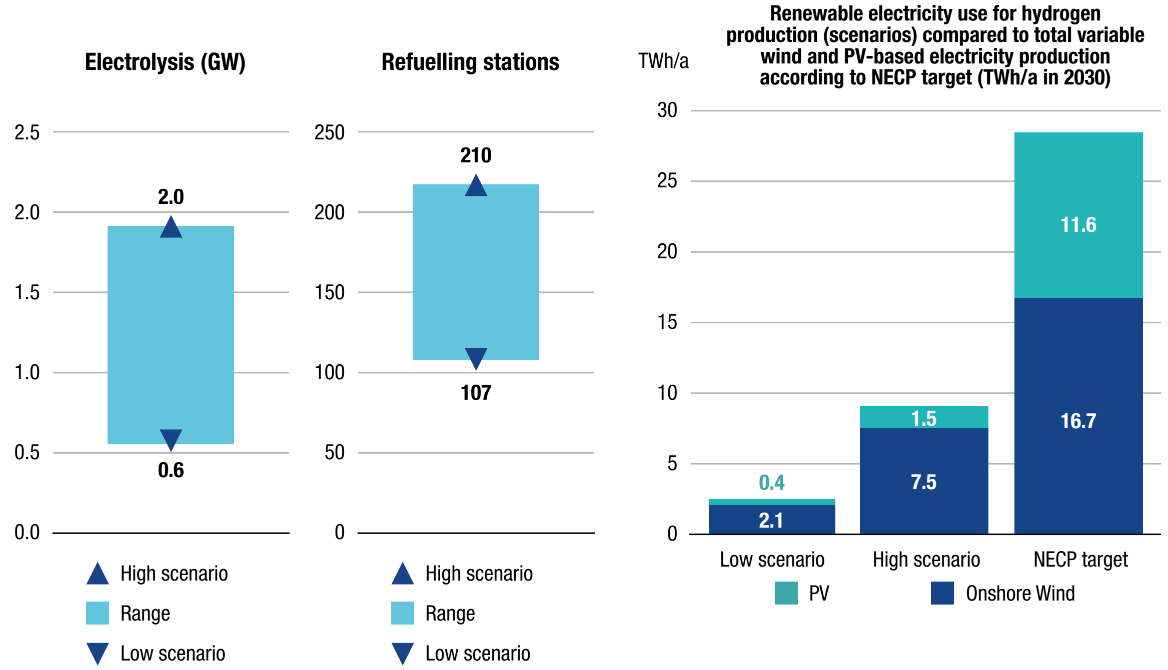
In the high scenario, renewable hydrogen accounts for 2.0% of final total energy demand (i.e. 5.6 out of 281 TWh/a) or 11.4% of final gas demand (49 TWh/a) according to EUCO3232.5.



Hydrogen generation, infrastructure and end users in Austria 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 2.0% of the overall technical renewable power potential in the low scenario and for 7.2% in the high scenario.

End users

End user	Unit	Low scenario	High scenario
Passenger cars	Nº	55 220	110 400
Buses	Nº	100	210
Lorries	Nº	2 900	5 900
Heavy duty vehicles	Nº	110	220
Trains	Nº	14	43
Substituted fuel in aviation	GWh/a	19	184
Substituted fuel in navigation	GWh/a	0.6	6
Micro CHP	Nº	3 730	16 220
Large CHP	Nº	30	290
Iron&Steel	% of prod.	6%	18%
Methanol	% of prod.	0%	0%
Ammonia	% of prod.	0%	5%

According to the estimations, the hydrogen refuelling station network will by 2030 encompass between 110-210 stations for 58 000-117 000 fuel cell vehicles on the road.

Further, the analysis estimates substitution of up to 18% of the conventional steel production capacity by renewable hydrogen-based steelmaking.

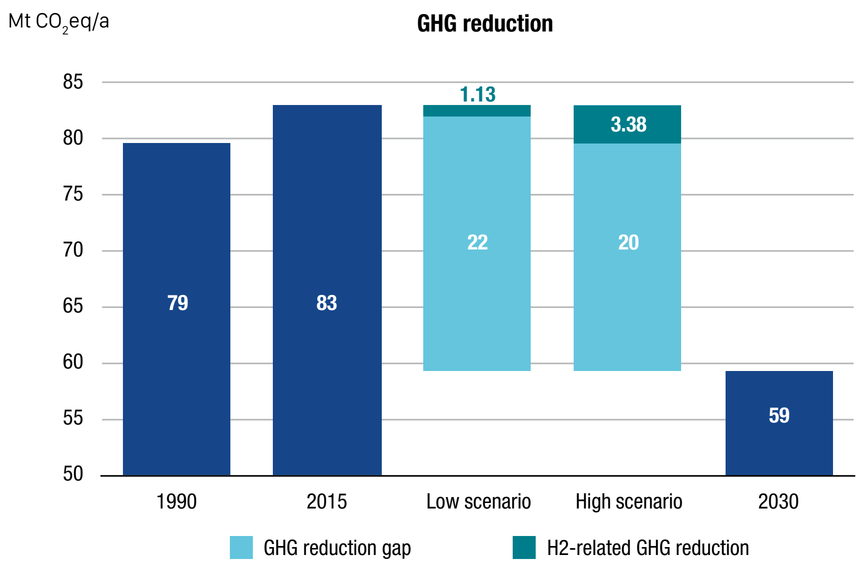
Additional use of renewable hydrogen is foreseen in ammonia industry (up to 5%).

Finally, the introduction of 3 760-16 510 stationary fuel cells for combined power and heat production is estimated.

Environmental and financial impact in Austria 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.

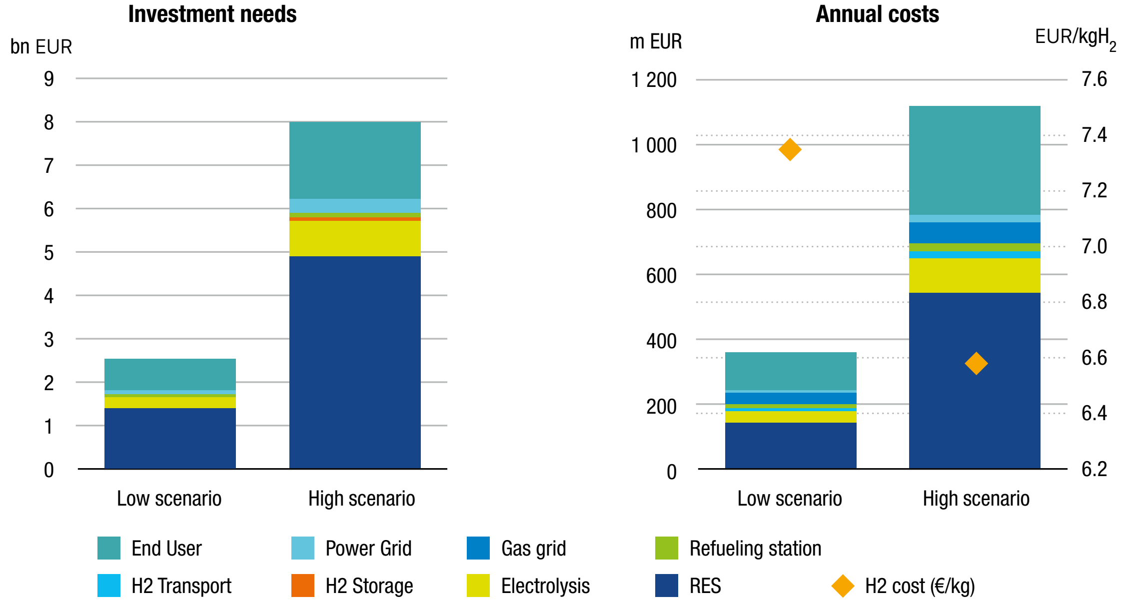
Environmental impact



An additional GHG emission reduction of 1.1-3.4 Mt CO_2 is estimated in 2030 corresponding to 4.8%-14.4% of the remaining 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 2.5-8.0 billion EUR until 2030, while annual expenditure would amount to 350-1110 million EUR (including end user appliances as well as power and gas grids).

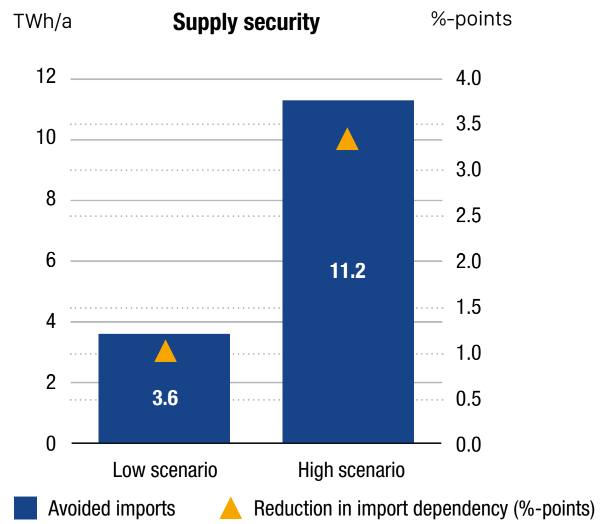


Impact on security of energy supply, employment and value added in Austria by 2030

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

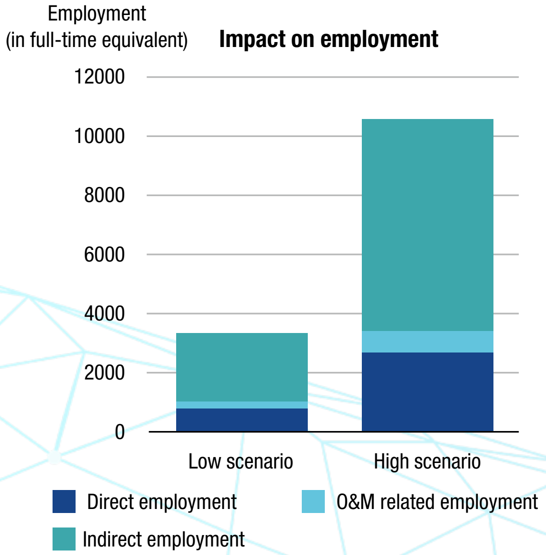
Deployment of renewable hydrogen would lead to 3.6-11.2 TWh/a of avoided imports, and thus reduce import dependency by 1.1-3.4% (in volume terms) in 2030, depending on the scenario.

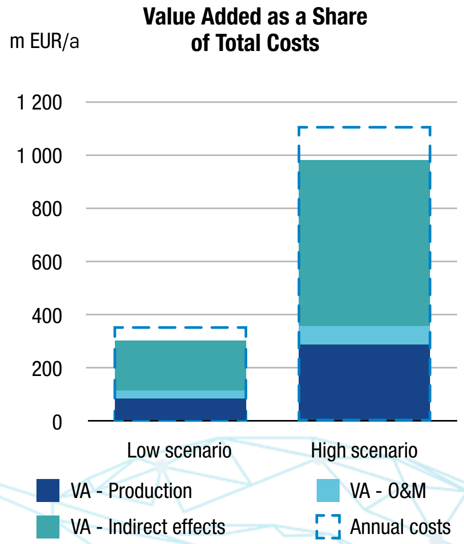


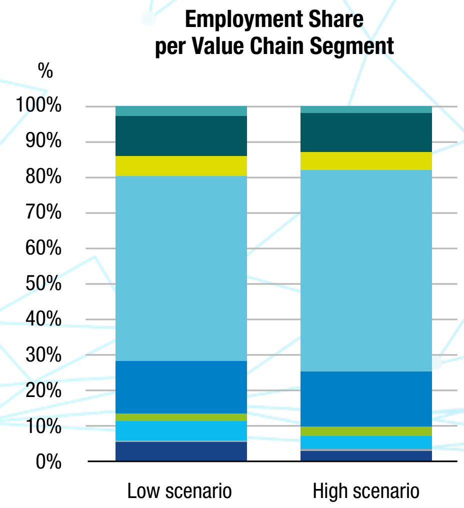
Impact on employment and value added

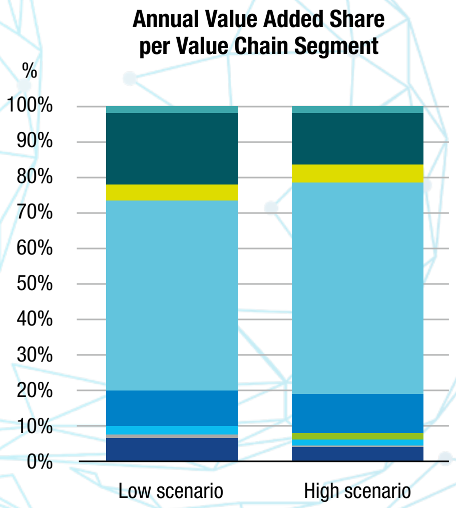
The estimates show that in the years 2020-2030 more than 120 million EUR can be retained annually in the domestic economy as value added in the low scenario, and more than 360 million EUR in the high scenario (value added is defined here as sum of wages for employees, margins for companies and taxes). If we also take into account the indirect effects induced by the investment and operation of hydrogen technologies, around 300 million EUR (low scenario) and almost 1 000 million EUR (high scenario) of value added can be created in the Austrian 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-up electrolysis capacity, by building dedicated renewable electricity sources for hydrogen production and in industry applications, in particular in the steel industry.

The hydrogen-related expenditures in 2020-2030 are estimated to generate 1 000 – 3 400 direct jobs (in production and operations & maintenance), and contribute to a further 2 300 – 7 100 indirectly related jobs, depending on the scenario. Most of these jobs are expected to be created in the production of renewable electricity, by building up and maintaining electrolyser capacity and in industry applications.









FCEV
CHP
Gas grids & H2 storage
Other transport
Electrolysers
Industry
HRS
RES
H2 transport by truck

AUSTRIA

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

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING