ITALY

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.

ITALY

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

Onshore Wind
2 320 - 11 740 MW
4 130 - 20 890 GWh/a

Offshore Wind
20 - 130 MW
80 - 390 GWh/a

Solar Photovoltaic
1 810 - 9 130 MW
2 010 - 10 150 GWh/a

Electrolysers
1 330 - 6 740 MW
3 900 - 19 720 GWh_{H2}/a

POWER
40 - 400 GWh/a

17 - 172 GWh/a
Electricity Produced

TRANSPORT
1 977 - 5 407 GWh/a

1 040 - 2 080
Buses

673 - 1 160
Refuelling Stations

2 - 9
Trains

24 970 - 50 040
Trucks

405 800 - 811 600
Cars

128 - 1 220 GWh/a
into Synthetic Fuels

BUILDINGS
750 - 7 500 GWh/a

34 410 - 149 690
Micro-CHP units
in buildings

20 - 220
Commercial-scale
CHP installations

INDUSTRY
1 130 - 6 412 GWh/a

880 - 1 910 GWh_{H2}/a
in Refineries

0 - 500 kt/a
of Steel

0 - 12.2 kt/a
of Aromatics

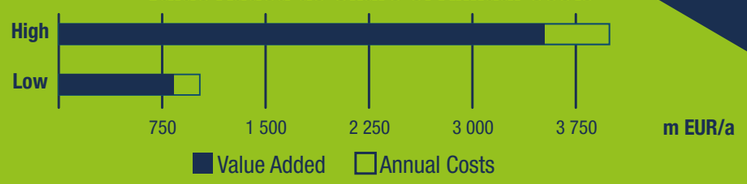
0 - 39.9 kt/a
of Olefins

0 - 29.5 kt_N/a
of Ammonia

780 - 3 510
m EUR/a

Value Added
in the domestic economy

Value Added as Share of Annual Costs



New Jobs
11 510 - 41 760

Emissions avoided
1.6 - 6.3 Mt CO_2/a

EXECUTIVE SUMMARY

Italy's commitment for hydrogen deployment according to its NECP

According to its NECP, Italy wants hydrogen to be part of its energy transition to a low carbon economy. For the Working Group on Hydrogen[1], set up by the Minister of Economic Development, *"hydrogen from renewable energy can play an important role in achieving the objectives of the NECP in the context of the decarbonisation process"*. The Working Group on Hydrogen is gathering more than 70 national stakeholders and analyses demonstration and deployment projects submitted by companies (31 projects mid 2019), *"concerning issues that are closely related to the objectives of the NECP on the decarbonisation of transport, industrial processes and the storage of energy (power to gas)"*[2]. According to its NECP, Italy has the ambition to reach around 1% of its RES target for the transport sector through the direct use of hydrogen in cars, buses, trucks and trains, and possibly sea transport.

Italy is in a favourable starting position given its active national hydrogen association[3] which has contributed to a National Hydrogen Mobility Plan, and its current investments in hydrogen research and demonstration as well as in infrastructure (e.g. refuelling stations) and fleets[4]. Italy is currently involved in the White Dragon[5], Silver Frog[6] and Blue Dolphin[7] IPCEI projects[8], and was also involved in the HyLaw[9] project, that identified and assessed major regulatory barriers, in view of prioritizing measures to address them. The Italian participation in Mission Innovation, especially in Innovation Challenge no 8 on renewable and low-carbon hydrogen[10], will support Italy to accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers. SNAM, Italy's main gas grid Transmission System Operator (TSO), organized a high-level event on hydrogen in October 2019, where Italian and international representatives discussed the role and opportunities of hydrogen in Italy.[11]

Italy's NECP does not include specific objectives or targets for the production or use of hydrogen.

The scenario assessment shows substantial potential benefits of hydrogen deployment in Italy 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 Italy, a significant development of **hydrogen** demand is assumed in transport, especially for passenger cars, buses and trucks, and to a limited extent in aviation (through hydrogen-based liquid fuels or PtL) and navigation[12]. A limited development of hydrogen demand is assumed in the considered scenarios in **industry**, especially in refining, but also the iron and steel sector. Some industries use fossil-based hydrogen as feedstock or reducing agent, which could be replaced by renewable hydrogen. Switching fuels for high temperature heat processes 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 in the Low scenario but would have a stronger demand in the High scenario.

The scenarios assume only a very low share of hydrogen in electricity generation by 2030, mainly by using 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, 4.1 - 21 GW of dedicated renewable electricity sources would have to be installed to produce green hydrogen via electrolysis. "Surplus" electricity from non-dedicated power plants 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, Italy estimates the production of over 114 TWh of variable renewable electricity in 2030. The technical potential for renewable electricity production in Italy seems however significantly higher. Building additional renewable 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 1 000 and 3 900 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[13], the Italian GHG emissions should be reduced by 130 Mt CO_2 in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 1.6 – 6.3 Mt CO_2 to this goal, which is equivalent to 1% - 5% of the required emission reduction.

[1] https://www.mise.gov.it/index.php/it/198-notizie-stampa/2040027-prosegue-il-confronto-al-tavolo-sull-idrogeno
[2] said Undersecretary Crippa
[3] https://www.h2it.it/
[4] https://www.iphe.net/italy
[5] https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5da472e9ff3f1e0b334d5e3b/1571058415654/White+Dragon+poster.pdf
[6] https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9c79b467e52303370991bd/1570535868733/Silver+Frog.pdf
[7] https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9c7b1d9ada8b5691aa0536/1570536236724/Blue+Dolphin+poster.pdf
[8] https://www.hydrogen4climateaction.eu/projects
[9] https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Denmark%20%28EN%29.pdf
[10] http://mission-innovation.net/our-work/innovation-challenges/renewable-and-clean-hydrogen/
[11] https://www.snam.it/en/Media/Press-releases/2019/Snam_hydrogen_challenge_international_conference_Rome.html
[12] 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
[13] 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 ITALY

The energy transition and long-term strategy, referred to in the Italian NECP, entail a gradual electrification of energy consumption and an increased share of electricity from renewable sources. The NECP also mentions that the gas infrastructure will continue to play an important role to ensure the security of energy supply and the flexibility of the electricity system, to facilitate the integration of renewable electricity – for example through power-to-gas – and to enable the development, transport and storage of renewable gases such as biomethane and hydrogen. Italy intends to promote – starting with research, development and demonstration activities – the production and use of hydrogen produced in electrolysers using renewable electricity, in view of reducing emissions and using the potential to store excess renewable electricity when supply exceeds demand. According to Italy's NECP, the expected reduction in the cost of electrolysis technology will make it possible to generate renewable hydrogen at competitive terms for the decarbonisation of energy-intensive industrial sectors and long-haul commercial transport.

The gas infrastructure will be of vital importance for the electricity system, and both are expected to become a 'hybrid' electricity-gas energy system, that can facilitate the development of renewable electricity and gas (biomethane, hydrogen and synthetic methane) and boost the use of alternative fuels in the transport sector. This central role of gas in the energy system will be ensured without developing new major infrastructure. However, coordination of the 10-year development plans of the Italian and neighbouring gas TSOs, as well as further research are needed regarding the possible use of gas infrastructure for hydrogen.

The creation of a vast storage capacity for decarbonised energy vectors (hydrogen/synthetic methane) is considered to make sufficient flexibility available.

The Italian legislation is currently being adapted to transpose RED II. One of the main changes considered to encourage greater use of renewable gas, is the introduction of a mandatory quota for renewable gases (including renewable hydrogen).

Italy has also plans to introduce specific measures to promote the use of biofuels, including hydrogen, in the railway, aviation and maritime sectors.

The NECP also refers to the need to examine with other Member States the possibility of developing joint or synergistic projects. On the basis of initial meetings, Italy has identified the development of hydrogen as an interesting topic (e.g. with Austria).

The national research network has shown interest in alternative fuels, advanced energy materials, zero emission heating and cooling, and the possible role of hydrogen in this context. Research would focus on the development of power-to-gas storage systems, particularly for the purpose of storage of excess production of variable renewable electricity by means of storage of hydrogen in liquid or gaseous energy carriers. Research will need to focus on improving the performance and costs of electrolysers and on the controlled injection of growing amounts of hydrogen into the gas networks. Italy considers it essential to establish a clear legal and regulatory framework for the injection of hydrogen into the existing natural gas infrastructures, to be used as a mixture with natural gas or separately by applying selective hydrogen separation systems, such as membranes. It is also considered important to assess the feasibility of hydrogen injection into gas storage systems and in end use appliances, and to potentially provide incentives for technological storage options aimed at developing the production of hydrogen from renewable energy sources in synergy with the electricity sector.

Italy considers the systematic and integrated management of research in the energy sector necessary, both for the SET Plan and for Mission Innovation, in order to improve the efficiency and effectiveness of the allocated resources. The participation in Mission Innovation will focus, among others, on Hydrogen (Innovation Challenge, IC8).

Italy has also shown interest in the Important Projects of Common European Interest (IPCEI) facility, to support value chains identified by the European Commission, including those related to hydrogen, for which new proposals for projects in collaboration with other Member States are being prepared.

After 2030, the use of petroleum products in transport is expected to significantly decrease, and mostly replaced by biofuels, hydrogen and electricity, both for passenger and goods transport. Italy has the ambition to reach around 1% of its renewable energy target for transport by using hydrogen fuelled cars, buses, heavy goods vehicles and trains, and eventually sea transport, or by injecting hydrogen into the methane network, including for transport use.

Italy has set up a specific Hydrogen Working Group, where 31 multi-company or transversal project proposals have been presented and discussed. Further steps are planned to prepare a feasibility analysis of the proposed initiatives in view of their industrial development, and to study the various regulatory aspects relating to the hydrogen supply chain.

OPPORTUNITY ASSESSMENT

Hydrogen production potential & its role in energy system flexibility

The indicators suggest that Italy has effectively an important opportunity to produce hydrogen from variable renewable electricity production by using electrolysers, as its technical potential for variable renewable electricity is three times higher than the overall forecasted electricity consumption in 2030. According to the NECP, Italy would only use 11% of its technical potential in variable renewable electricity generation by 2030, so there is also a great margin for building up dedicated renewable electricity capacity for hydrogen production via electrolysis.

There is also an opportunity to specifically utilize power-to-hydrogen conversion and storage as a flexibility provider to the electricity system, since the flexibility needs are predicted to increase along with the growing share of solar PV and wind energy in the electricity mix. This opportunity is however limited by the availability of a significant installed capacity of pumped-storage hydroelectricity, which is an important flexibility provider in Italy.

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
1 066	314%	114.6	11%	based on NECP 180%	Low

Italy has limited readiness for wide-scale deployment of CCS. Even though there are plans in place to use CCUS technologies by 2030, the practical feasibility has not been demonstrated yet.

Energy infrastructure

Italy can effectively consider using its existing methane infrastructure for hydrogen transport and distribution, by blending hydrogen in the public grid in the short (2025-2030) and medium term (2030-2040) and potentially converting (part of) its network to hydrogen in the long term (>2040). As polyethylene pipes are used in only one third of the distribution network, the economic and technical feasibility of such a conversion should be further assessed. Conversion of the network to dedicated hydrogen pipelines would be a long-term consideration, as the hydrogen production volumes are expected to be relatively low until 2030. In the short and medium term, hydrogen could hence be blended with methane in the existing grid, without the need for physical adjustments to the transport, distribution and end-use infrastructure.

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)
28%	1.1	0	YES
MS range 16%-99%			

To date, there are no salt cavern natural gas storage sites in Italy. However, there are few underground tertiary salt deposit layers in the south (including in Sicily), which might be suitable for the construction of hydrogen storage facilities. It could be an opportunity for Italy to explore these possibilities for hydrogen storage.

Current and potential gas & hydrogen demand

In Italy, there is a considerable potential for the deployment of hydrogen across sectors. In industry, the deployment of renewable or low-carbon hydrogen in ammonia production and refineries can help to reduce the greenhouse gas emissions associated with existing hydrogen use. More generally, hydrogen deployment can contribute to the decarbonisation of the gas supply in industry and act as a low-emission solution for the provision of high-temperature process heat, which is an important energy end-use in Italian industry. In the built environment, hydrogen provides the opportunity to replace the use of natural gas for heating, thereby significantly reducing the greenhouse gas emissions in this sector. Lastly, there are opportunities to deploy hydrogen for a range of applications in the transport sector, but the largest potential lies in road transport. On the medium to long term, hydrogen and derived fuels can also be used to decarbonise shipping and aviation.

Opportunities for hydrogen demand in industry

According to the assessed indicators, Italy has significant potential for hydrogen use in industry, for instance in the fertiliser industry, where methane-derived hydrogen is already used for ammonia production. Furthermore, fossil hydrogen is used in the country's refineries, which together account for 8% of the total captive hydrogen production by refineries in the EU. Natural gas is currently an important fuel in Italy's industry, accounting for 36% of the final energy mix, so hydrogen could play an important role in the decarbonisation of this part of the industrial energy demand. Another striking characteristic of the industrial energy demand in Italy is that 46% of the energy consumption is used for the generation of high-temperature process heat which could be decarbonised via the use of hydrogen. Next to that there are several steel plants in Italy, which are together responsible for 5% of the primary steel that is produced in Europe. Existing steelmaking processes, which are very carbon-intensive could be replaced by steel production using hydrogen-based direct reduction iron.

	Presence of ammonia industry / share of ammonia production capacity in EU28 total	Presence of refineries / Share of Italian refineries in total captive hydrogen production by refineries in the EU28	Share of Italy 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)
Italy	3%	8%	5%	36%	46%
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

In Italy's built environment, natural gas accounts for almost half of the final energy demand and over 70% of the demand for heating. Hydrogen could hence play a substantial role in the decarbonisation of heating in this sector. Italy also has a significant cooling demand, accounting for 5% of the total final energy demand in households and services, and with the increasing summer temperatures the demand for cooling is expected to rise. On the medium to long term hydrogen-based technologies could also be used to satisfy the growing demand for cooling.

	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)
Italy	47%	78%	7%
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 largest opportunities for the deployment of hydrogen in Italy's transport sector reside in road transport, a segment of the transport sector that is virtually completely dependent on fossil fuels. Almost 30% of the energy use in road transport is consumed by trucks, buses and light commercial vehicles (e.g. vans). Since electrification of this segment of the transport sector remains challenging, there is a significant opportunity for hydrogen to decarbonise it. Next to this, hydrogen can complement electric vehicles in the passenger car segment, especially for larger cars and long-distance travel. Italy's rail sector is largely electrified, but for the small share of diesel trains remaining, hydrogen is one of the potential decarbonisation solutions. Although shipping does not have a large share in the total energy use in the Italian transport sector, it is relatively hard to decarbonise and hydrogen and derived fuels can be deployed as a low-carbon solution. On the medium to long run hydrogen and derived fuels can also be deployed to decarbonise 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
Italy	29% (113 206 GWh)	7% (391 GWh)	2.5% (10 104 GWh)	7% (26 779 GWh)	10% (49 869 GWh)	97% (355 705 GWh)
EU	Average 32% MS range 18%-48%	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

Italy has a positive enabling environment for the development of hydrogen. Hydrogen is effectively considered in policy plans, such as the NECP and NPF; there is a significant RD&D expenditure in hydrogen related projects; and there are power to-gas projects and hydrogen refuelling infrastructure showing commitment from various stakeholders including the research community and industry. The assessment shows that Italy has effectively started to set up a comprehensive framework for the deployment and use of hydrogen, mainly in the transport sector. Taking into account its large potential for hydrogen deployment based on renewable electricity using electrolysers, it would be appropriate that Italy comprehensively considers the potential contribution of hydrogen to address the decarbonisation challenges in all energy end-use sectors, preferably in coordination with neighbouring countries and taking into account the initiatives and policies at EU level.

The Ministry of Economic Development has set up a specific National Hydrogen Working Group which gathers over 70 national stakeholders interested in the development and applications of hydrogen, covering production via power-to-gas, storage as well as end uses in industry and transport.

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

There is no specific comprehensive hydrogen strategy or roadmap, but hydrogen is addressed in several energy policy documents and in the Italian NECP.

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

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)

Italy's National Policy Framework (or NPF, set in the context of the alternative fuel infrastructure directive (2014/94/ EU)), comprises a plan for the deployment of hydrogen technologies, which includes ambitious targets for deployment of hydrogen refuelling stations.

The Italian NECP recalls that the national strategic framework for the deployment of alternative fuels for the transport sector and the creation of associated infrastructure (Legislative Decree No 257 of 16 December 2016, transposing the 2014/94 directive) already promotes the use of alternative fuels, in particular electricity, natural gas and hydrogen. This Decree stipulates that public organisations must ensure that at least 30% (by 2022), 50% (by 2025) and 85% (by 2030) of their fleet's vehicles purchased are electric, hybrid, powered by methane or hydrogen (electric or powered by methane in the case of buses). A budget of 3 million EUR is approved for 2020 to support the replacement of the vehicle fleet of companies operating in Italy.

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	3	12 625 379

Existence of (investment on) hydrogen-related projects

Multiple projects have been announced and are being discussed, e.g. in the Hydrogen Working Group. Italy is currently involved in the White Dragon[14],Silver Frog[15] and Blue Dolphin[16] potential IPCEI projects[17].

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	12.3	NO	3

[14] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5da472e9ff3f1e0b334d5e3b/1571058415654/White+Dragon+poster.pdf*
[15] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9c79b467e52303370991bd/1570535868733/Silver+Frog.pdf*
[16] *https://static1.squarespace.com/static/5d3f0387728026000121b2a2/t/5d9c7b1d9ada8b5691aa0536/1570536236724/Blue+Dolphin+poster.pdf*
[17] *https://www.hydrogen4climateaction.eu/projects*

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

Positive environment

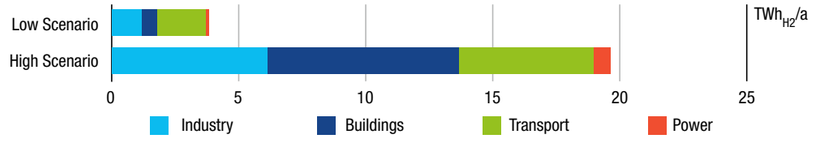
Fossil energy import bill

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

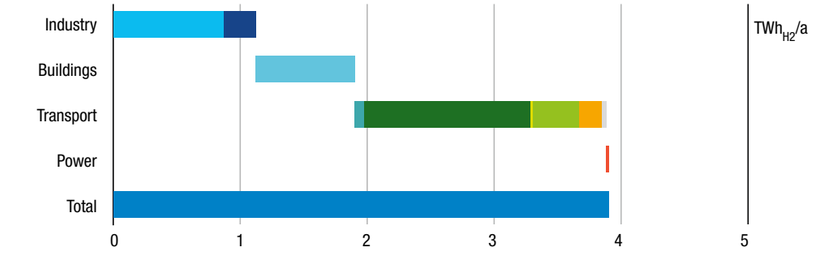
Import bill for natural gas as share of national Gross Value Added	Import bill for all fossil fuels
0.8%	**1.9%**
Average: **0.6%** MS range: 0% - 1.5%	Average: **2%** MS range: 0% - 7%

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

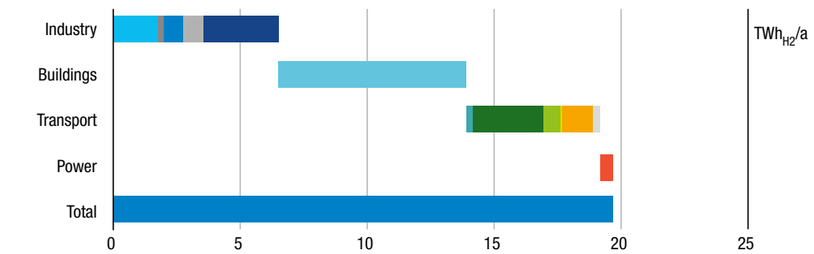


Low scenario

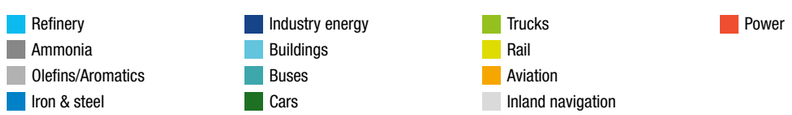


In the low scenario, renewable hydrogen accounts for 0.3% of final total energy demand (i.e. 3.9 out of 1204 TWh/a) or 1.1% of final gas demand (369 TWh/a) according to EUCO3232.5.

High scenario



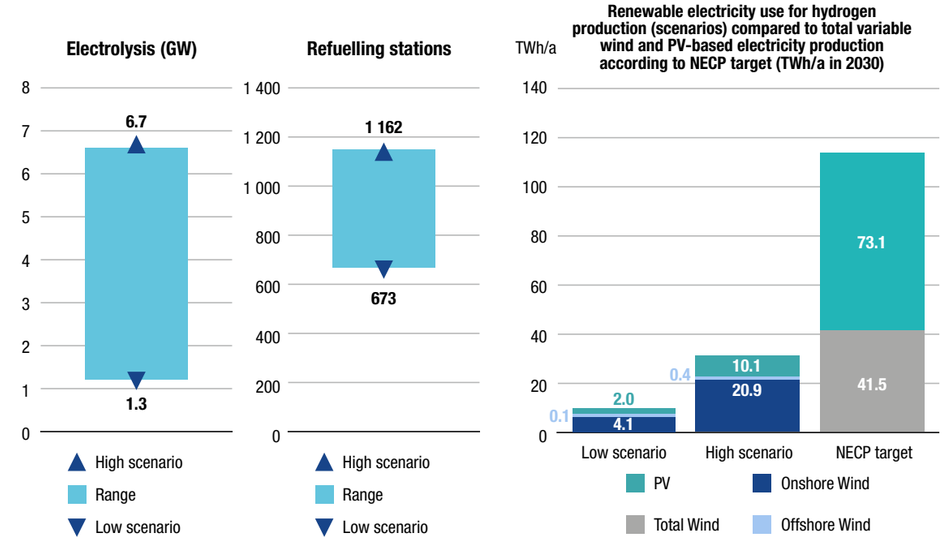
In the high scenario, renewable hydrogen accounts for 1.6% of final total energy demand (i.e. 19.7 out of 1204 TWh/a) or 5.3% of final gas demand (369 TWh/a) according to EUCO3232.5.



Hydrogen generation, infrastructure and end users in Italy 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 1.1% of the overall technical renewable power potential in the low scenario and for 5.4% in the high scenario.

End users

End user	Unit	Low scenario	High scenario
Passenger cars	Nº	405 800	811 600
Buses	Nº	1 040	2 080
Lorries	Nº	24 000	48 100
Heavy duty vehicles	Nº	970	1 940
Trains	Nº	2	9
Substituted fuel in aviation	GWh/a	101	956
Substituted fuel in navigation	GWh/a	27.8	264.3
Micro CHP	Nº	34 410	149 690
Large CHP	Nº	20	220
Iron&Steel	% of prod.	0%	2%
Methanol	% of prod.	0%	0%
Ammonia	% of prod.	0%	5%

According to the estimations, the hydrogen refuelling station network will by 2030 encompass between 670-1160 stations for 432 000-864 000 fuel cell vehicles on the road. In addition, the analysis estimates substitution of up to 2% of the conventional steel production by renewable hydrogen-based steelmaking.

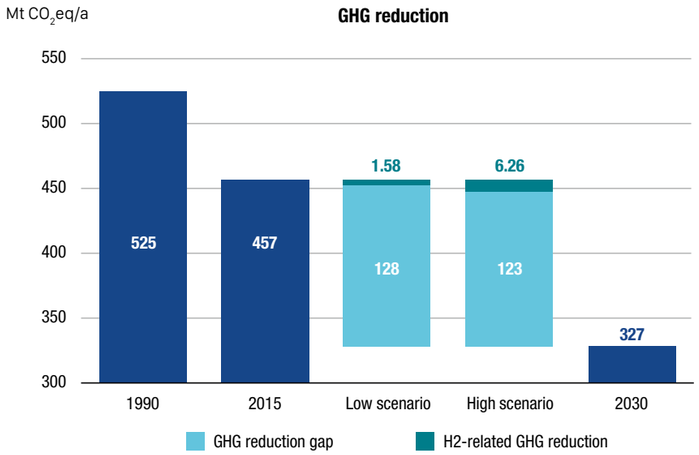
Further use of renewable hydrogen is foreseen in ammonia production (up to 5%)

Finally, the introduction of 34 430-149 910 stationary fuel cells for combined power and heat production is estimated.

Environmental and financial impact in Italy 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.

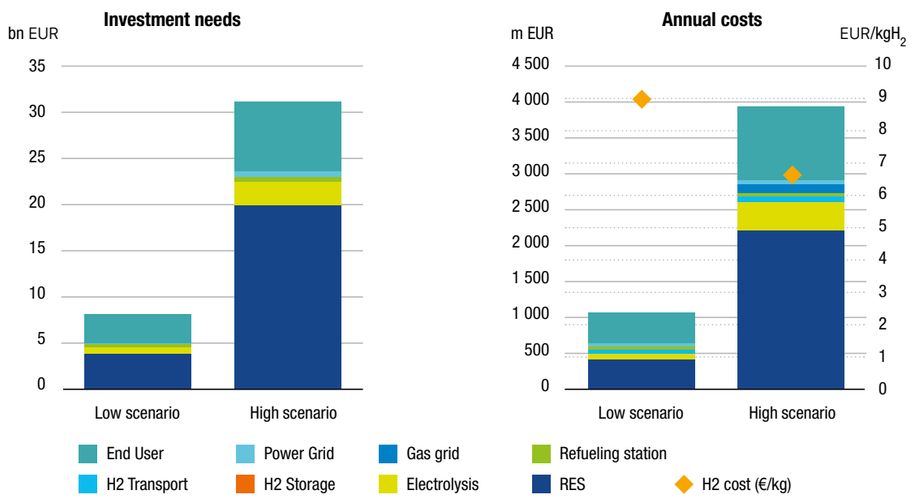
Environmental impact



An additional GHG emission reduction of 1.6-6.3 Mt CO_2 is estimated in 2030 corresponding to 1.2%-4.8% 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 8.2-31.2 billion EUR until 2030, while annual expenditure would amount to 1050-3930 million EUR (including end user appliances as well as power and gas grids).

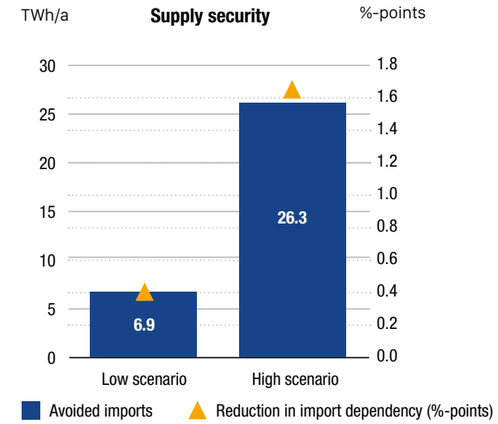


Impact on security of supply, jobs and economy in Italy by 2030

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

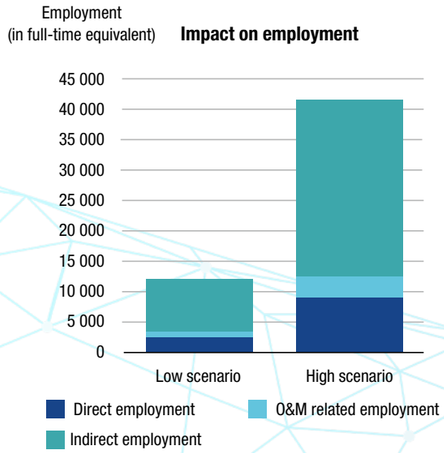
Deployment of renewable hydrogen would lead to 6.9-26.3 TWh/a of avoided imports, and thus reduce import dependency by 0.4-1.7% (in volume terms) in 2030, depending on the scenario.

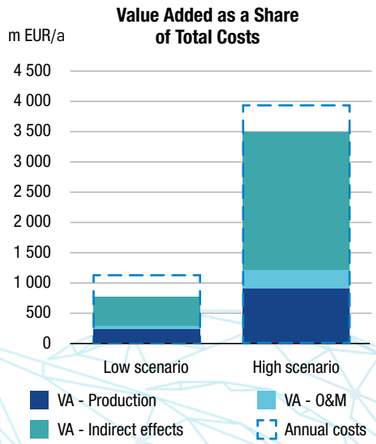


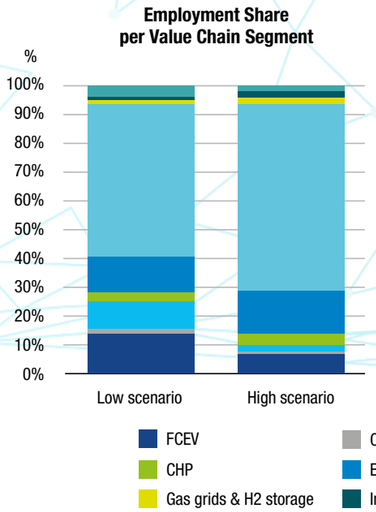
Impact on employment and value added

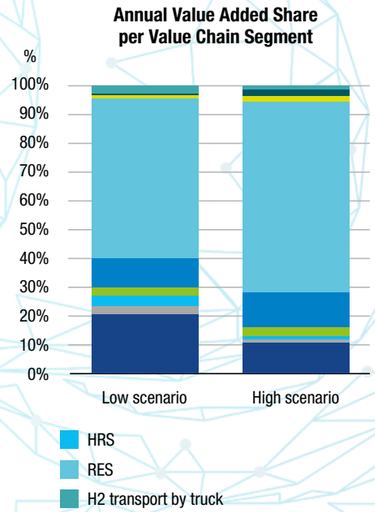
This analysis shows that in the years 2020-2030 around 300 million EUR can be retained annually in the domestic economy as value added in the low scenario, and almost 1 200 million EUR in the high scenario. If the indirect effects induced by the investment in and operation of hydrogen technologies are also taken into account, around 780 million EUR (low scenario) and over 3 500 million EUR (high scenario) of value added can be created in the Italian economy annually, which is very close to the amount of annual investment needed. Most of this value added is expected to be created by building-up renewable electricity generation capacity, followed by the investment in fuel cell electric cars and the investment in and operation of electrolysers.

The hydrogen-related expenditures in 2020-2030 are estimated to generate employment of 2 900 – 12 100 direct jobs (in production and operations & maintenance), and contribute to a further 8 600 – 29 700 indirectly related jobs, depending on the scenario. Most of the jobs created are expected to be related to the production and operation of renewable electricity generation capacity and electrolysers, followed by jobs in the car industry. In the high scenario, employment in these sectors remains important, but a more significant job creation is expected to occur in industry and hydrogen transport (via truck and pipeline) as well.









ITALY

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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