IRELAND

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
(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.

IRELAND

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

Onshore Wind
50 - 480 MW
160 - 1 490 GWh/a

Offshore Wind
0.4 - 3 MW
1 - 13 GWh/a

Solar Photovoltaic
4 - 35 MW
3 - 30 GWh/a

Electrolysers
31 - 290 MW
110 - 960 GWh_{H2}/a

POWER
0 - 326 GWh/a

TRANSPORT
80 - 460 GWh/a

BUILDINGS
10 - 100 GWh/a

INDUSTRY
15 - 82 GWh/a

0 - 60
Buses

2 - 7
Trains

13 - 30
Refuelling Stations

0 - 1 350
Trucks

7 000 - 14 100
Cars

0 - 140 GWh/a
Electricity Produced

23 - 216 GWh/a
into Synthetic Fuels

440 - 1 930
Micro-CHP units
in buildings

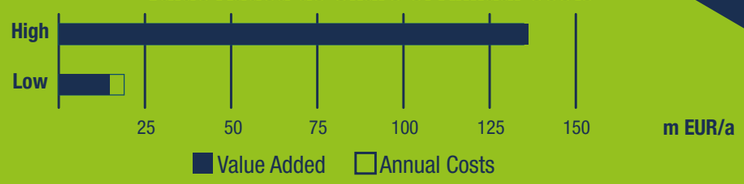
0 - 0
Commercial-scale
CHP installations

8 - 11 GWh_{H2}/a
in Refineries

15 - 130
m EUR/a

Value Added
in the domestic economy

Value Added as Share of Annual Costs



New Jobs
250 - 1 800

Emissions avoided
40 - 240 Kt CO_2/a

EXECUTIVE SUMMARY

Ireland's commitment for hydrogen deployment according to its draft NECP

HydrogenIreland (H2IRL[1]), the new national association that is acting as a forum for the hydrogen community, aims to bring together industry, universities, research institutes and policymakers to exchange information and to initiate and coordinate actions in the domain of hydrogen. A number of leading industrial companies have set up Hydrogen Mobility Ireland (HMI), to plan and deliver a coordinated approach to the deployment of hydrogen in the transport sector. HMI[2] launched in November 2019 its Hydrogen Mobility Ireland Strategy paper that includes a detailed analysis and comparison of hydrogen with other technologies; it also presents different hydrogen production scenarios and proposes the deployment of a refuelling station infrastructure in Ireland.[3]

Ireland is in a favourable starting position for hydrogen deployment given its two national associations (HydrogenIreland and HMI), its industrial companies active in the field of hydrogen, its flagship projects such as GENerating energy secure COMMunities through Smart Renewable Hydrogen[4] or Seafuel[5], its recent plans for the introduction of a hydrogen fuelling infrastructure[6] and its current investments in hydrogen research and demonstration activities. Ireland was involved in the Hylantic[7] project but is not involved in IPCEI projects. It was also not involved in the HyLaw[8] project, and could possibly carry out a similar assessment to identify and address its national specific barriers to the deployment of hydrogen.

The Irish draft NECP 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 Ireland 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 Ireland, a limited development of hydrogen demand is assumed in the considered scenarios in **transport**, especially for passenger cars and trains, and also in aviation (through hydrogen-based liquid fuels or PtL) and navigation[9]. A limited development of hydrogen demand is also assumed in the scenarios in **industry**, in particular for refining. This industry uses fossil-based hydrogen for several processes including desulphurisation, 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 that Ireland will be one of the early adopters of using hydrogen for power generation (back-up), although the produced electricity volumes will be still low in the time period up to 2030.

Hydrogen production

To cover the estimated hydrogen demand from new uses and from substitution of fossil-based hydrogen, 0.1 to 1.5 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 draft NECP, Ireland estimates an installed capacity in 2030 of 8.5 GW in wind energy and 1.5 GW in solar PV, generating almost 22 TWh of renewable electricity in 2030[10]. The technical potential for renewable electricity production in Ireland seems however significantly higher[11]. Building additional renewable electricity capacity dedicated for hydrogen production thus could be a feasible scenario.

Estimated socio-economic and environmental impacts

The annual costs to produce green hydrogen (including the cost of dedicated renewable electricity sources), to develop the transport infrastructure (or adapt the existing one) and end-user applications would in the considered scenarios reach respectively 19 and 129 million EUR. These activities will generate value added in the domestic economy, amongst others by creating jobs in manufacturing, construction and operation of hydrogen technologies and will contribute to greenhouse gas emission reductions. This is in particular important in hard-to-decarbonize industries. According to the European EUCO3232.5 scenario[12], the Irish GHG emissions should be reduced by 13 Mt CO_2 in 2030, compared to 2015. In the scenarios considered, the deployment of hydrogen could contribute 0.04 – 0.2 Mt CO_2 to this goal, which is equivalent to 0.3% - 1.9% of the required emission reduction.

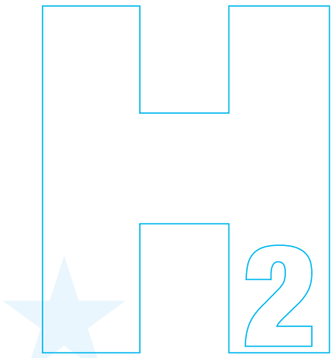
1 *http://hydrogenireland.org/hydrogen-in-ireland/*
2 *https://fleet.ie/hydrogen-mobility-ireland-established/*
3 *http://hydrogenireland.org/2019/11/25/hydrogen-mobility-ireland-strategy-paper-launched/*
4 *https://www.nweurope.eu/projects/project-search/gencomm-generating-energy-secure-communities/*
5 *http://www.seafuel.eu/*
6 *https://www.irishtimes.com/business/innovation/plan-for-80-hydrogen-fuel-stations-for-ireland-by-2030-1.4026492*
7 *https://www.hylantic.com/description/#*
8 *https://www.hylaw.eu/*
9 *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.*
10 *The draft NECP describes two future scenarios "With Additional Measures", but for this purpose the one with higher value of RES production was chosen.*
11 *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).*
12 *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 IRELAND

According to its draft NECP, Ireland considers hydrogen as "a low carbon technology that could have the potential to fully decarbonise the Irish gas network". Hydrogen can be used in almost the same way as natural gas and can be stored to address seasonal energy flexibility needs. Two hydrogen pathways are being examined in Ireland. The first pathway is currently the most competitive one and consists of reforming natural gas into hydrogen with CCS to enable the production of clean hydrogen[13] while the vast majority of the carbon dioxide would be captured. The second pathway, production of hydrogen using electricity through electrolysis of water is currently a higher cost method but is carbon free, if renewable electricity is available for this process. Hydrogen may be used for methanation (production of methane by combining hydrogen with carbon dioxide) or can as such be injected into the natural gas network. Blending, which is the admixture of up to 20% hydrogen with natural gas or biomethane, would allow to further use the current appliances. Further work on the potential for hydrogen to fully decarbonise the gas supply in Ireland will take place in the coming years.

In 2017, Ireland published its National Policy Framework on Alternative Fuels Infrastructure for Transport which covers the time period up to 2030.[14] The NPF represents a first step in determining a longer-term vision for the Irish transport sector. It includes the ambitious target that by 2030 all new cars and vans sold in Ireland should be zero emissions (or zero emissions capable). The Framework also outlines the main fuel options that could provide alternatives to oil for transport, namely: electricity, hydrogen, biofuels, LPG and natural gas (CNG or LNG). It is likely that electricity will fuel the majority of passenger cars, commuter rail and taxis, while natural gas and biofuels will play an increasingly important role for larger vehicles such as heavy-duty vehicles and buses. Hydrogen use is anticipated to take off and increase across the entire fleet spectrum in the medium to long-term but not in the short-term.

According to the Irish draft NECP, its public consultation led to several comments on hydrogen, which shows the interest of stakeholders in this development. Some suggestions could be used to determine the hydrogen policy: stakeholders suggested for instance that for transport there should be an increase in the use of biomethane and renewable hydrogen; the RES-E system should be diversified with support to all technology types including hydrogen generation; electrification is suggested for a large share of heating and transport along with the development of electro-fuels (particularly hydrogen) for large scale energy storage; biomethane and hydrogen can use the existing methane distribution infrastructure and also be used in thermal electricity generating plants; public support is suggested for the expansion of the gas network and for building power-to-gas installations and a dedicated hydrogen transmission network; it is recommended that renewable/ sustainable/indigenous resources such as hydrogen are properly valued; and finally it is acknowledged that hydrogen can offer solutions to the decarbonisation challenges but that this needs adequate policy as well as public and industry support.



[13] *Ireland defines clean hydrogen as hydrogen produced from SMR/CCS*
[14] *https://assets.gov.ie/26377/3075c29a37b84b10acae95da89d756ea.PDF*

OPPORTUNITY ASSESSMENT

Hydrogen production potential & its role in energy system flexibility

Ireland has one of the highest technical potentials of intermittent renewable electricity production in the European Union, both in absolute values and also as a ratio compared to its forecasted electricity demand in 2030. The opportunity to use this renewable electricity potential to produce hydrogen via electrolysis is thus quite significant. According to the draft NECP, Ireland would by 2030 only use 2% of its technical potential in renewable electricity generation, so there is a great margin for building up additional dedicated renewable electricity sources for hydrogen production..

According to the indicators, there is an opportunity to use hydrogen production as a flexibility provider to the electricity system as well, since the expected installed capacity of intermittent renewable sources is in 2030 three times higher than the forecasted average load. This opportunity is further reinforced by the fact that Ireland has a limited interconnection capacity to export potential electricity surpluses in times of high renewable electricity production, so using this 'excessive' output for hydrogen production represents an opportunity.

Technical variable renewable electricity potential (TWh/yr)	Technical renewable electricity generation potential compared to forecasted gross electricity consumption in 2030 (draft NECP)	Draft NECP estimate of variable renewable electricity production in 2030 (TWh/yr)	Draft 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
1 112	2 553%	21.82	2%	based on draft NECP: 322%	Low

Ireland has limited readiness for low-carbon hydrogen production using fossil fuels coupled with wide-scale deployment of CCS. Even though there are plans in place to use CCS technologies, there is only limited indication of progress towards using captured CO_2 in industrial processes and/or utilizing the potential storage capacities.

Energy infrastructure

Ireland can consider using its existing methane infrastructure for hydrogen transport and distribution, by blending hydrogen in the public grid in the short (2020-2030) and medium term (2030-2040) and potentially converting (part of) its network to hydrogen in the long term (>2040). As the distribution network is almost fully made of polyethylene, it could be converted to hydrogen at relatively low cost. However, conversion of the network to dedicated hydrogen pipelines would be a longer-term consideration. In the short and medium term, hydrogen production will still be rather limited and it could hence be blended with methane in the existing grid, without the need for physical adjustments to the transport 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)
99% (MS range 16%-99%)	1.0	0	YES

To date, there are no salt cavern natural gas storage sites in Ireland. However, there are a few underground salt layers in the North, which might be suitable for the construction of hydrogen storage facilities. It could be an opportunity to explore these possibilities for gas storage.

Current and potential gas & hydrogen demand

In Ireland, there seem to be opportunities for the deployment of hydrogen across sectors. In industry and the built environment this is strongly related to the important role that natural gas currently has in the energy mix of the country. Renewable and low-carbon hydrogen can make an important contribution to the decarbonisation of the gas supply for these sectors. Furthermore, hydrogen could play a role in industry in the provision of process heat, which represents a significant share of the energy demand in Irish industry. Lastly, there is significant potential for the deployment of hydrogen in the transport sector, especially in road and rail transport. Furthermore, on the medium and long term hydrogen and derived fuels can also contribute to the decarbonisation of the energy use in international and domestic shipping and aviation.

Opportunities for hydrogen demand in industry

There seem to be some opportunities for the deployment of hydrogen in industry. Natural gas accounts for 30% of the industrial energy use and hydrogen could be deployed to decarbonise this part of the energy use in this sector. Furthermore, one quarter of the country's industrial energy use is used for the generation of high-temperature process heat. Hydrogen is one of the few low-emission energy carriers that is well-suited for the generation of high-temperature heat and can therefore be used to replace existing fossil fuel use for this application. Lastly, there is some refinery activity in Ireland, where fossil-derived hydrogen is already used, which can be replaced relatively easily with renewable or low-carbon hydrogen.

Presence of ammonia industry / share of ammonia production capacity in EU28 total	Presence of refineries / Share of Irish refineries in total captive hydrogen production by refineries in the EU28	Share of Ireland 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)
0%	0.3%	0%	30%	26%
MS range 0%-16%	MS range 0%-26%	MS range 0%-30%	Average 32% MS range 0%-43%	Average 38% MS range 9%-60%

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

In Ireland, natural gas currently accounts for about a quarter of the final energy demand in the built environment. The demand for heating represents 80% of the country's energy demand and over 80% of this demand is fulfilled with fossil fuels, where oil is the dominant fuel, followed by natural gas and coal. This means that there is an opportunity for the deployment of hydrogen to decarbonise the heat demand in the Irish built environment. Natural gas use can be replaced with hydrogen relatively easily as the required infrastructure is already in place, although admixture of high hydrogen concentrations does require adaptations to the gas network and end-use appliances. On the medium and long term hydrogen could also be one of the decarbonisation strategies for the replacement of oil-fired boilers.

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)
26%	80%	2%
Average: 34% MS range: 0% - 60%	Average: 74% MS range: 41% - 82%	Average: 3% MS range: 0% - 46%

Opportunities for hydrogen demand in transport

Like all EU countries, Ireland has a strong opportunity for the use of hydrogen use in road transport. One third of the energy use in Ireland's road transport is consumed by trucks, buses and vans and hydrogen is one of the energy carriers that can be used to decarbonise these modes of transport. Additionally, the country's rail sector is still almost fully dependent on fossil fuels. Hydrogen could be one of the solutions to decarbonise this sector, by replacing the existing diesel trains. Lastly, a significant amount of energy in Ireland is used to fuel international ships. On the medium to long term the energy use of these ships could also be decarbonised through the deployment of hydrogen and derived fuels, which is also the case for the small part of Ireland's energy use that is used for domestic shipping. The same holds for the aviation sector. Although international aviation and shipping are currently not yet covered by European or international climate legislation, EU countries need to make a collective effort to support the decarbonisation of these sectors.

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 consump-tion) 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
33% (14 491 GWh)	91% (433 GWh)	1.9% (878 GWh)	3.7% (1 749 GWh)	20% (12 712 GWh)	96% (43 575 GWh)
Average 32% MS range 18%-48%	Average 30% MS range 0%-95%	Average 1.5% 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

Ireland's draft NECP acknowledges the potential of hydrogen to play an important role in the energy transition (especially in the transport and heating sectors), but to effectively make use of this potential adequate policies as well as public and industry support are needed. Further policies, including targets and objectives, as well as industry and research activities are required to kick-off the deployment of hydrogen. Taking into account its large potential for hydrogen deployment based on renewable electricity, it would be appropriate that Ireland more comprehensively considers hydrogen within its energy and climate policy to address the decarbonisation challenges in all energy end-use sectors, taking into account the initiatives and policies at EU level.

To facilitate hydrogen development, it is deemed appropriate that Ireland further invests in hydrogen related research and in pilot and demonstration projects (through the Ireland's Climate Action Fund) and launches the deployment of hydrogen refuelling stations, 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 ✓

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 Hydrogen Roadmap for Irish Transport, 2020-2030 could serve as basis in structuring such national hydrogen roadmap.
Ireland could consider collaborating with other countries, in particular the UK (including Northern-Ireland, especially in the maritime and gas sectors.

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

Ireland's 2030 target for greenhouse gas (GHG) emissions not covered by the EU Emissions Trading System (non-ETS), is -30 % compared to 2005, as set in the Effort Sharing Regulation (ESR). With the transport, building and agriculture policies set out in the draft NECP, Ireland projects to miss this target by at least 17.5 percentage points. Therefore, hydrogen deployment could be considered as one of the additional policies to fill in the gap.

Existence of (active) hydrogen national association — Positive environment ✓

Current and planned hydrogen refuelling infrastructure for the transport sector

Alternative fuels infrastructure directive (2014/94/EU)

According to its 2017 National Policy Framework[15] (or NPF, set in the context of the alternative fuel infrastructure directive (2014/94/ EU)), Ireland expects a hydrogen market to emerge in the coming years.
However, the NPF stated that "Ireland has no immediate plans to establish a hydrogen refuelling network, as the cost of the infrastructure is massively disproportionate to current demand. However, Ireland is willing to support trials relating to hydrogen fuelled vehicles, and the feasibility of establishing a hydrogen refuelling network will be regularly assessed to take account of changes in technological development and market uptake".

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	**NO**	**Not applicable**	
	Total **156**	Average **1 677 543**	

Existence of (investment on) hydrogen-related projects

There are currently no hydrogen-related industrial projects in Ireland.

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

[15] *https://assets.gov.ie/26377/3075c29a37b84b10acae95da89d756ea.PDF*

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

Ireland has set up a CO_2 pricing mechanism in 2010 and has introduced carbon related taxation for vehicles; both measures are key to support the progressive shift to low carbon vehicles (including on hydrogen).

Positive environment

Fossil energy import bill

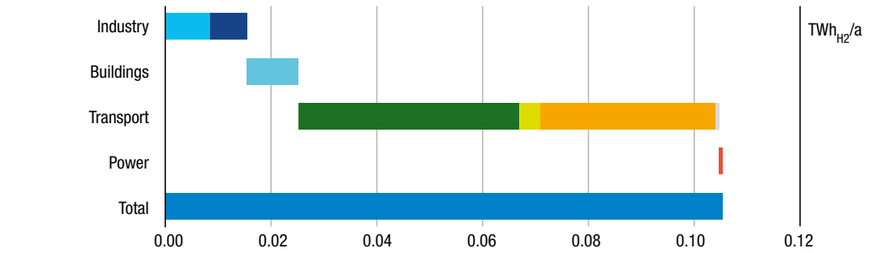
Like many EU Member States, Ireland is strongly dependent on imports for its oil consumption, and to a lesser extent for its natural gas consumption. Switching from fossil fuel to nationally produced hydrogen for industrial processes, heating and transport applications will contribute to reducing the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

	Import bill for natural gas as share of national Gross Value Added	Import bill for all fossil fuels
	0.3%	**1.3%**
	Average: **0.6%** MS range: 0% - 1.5%	Average: **2%** MS range: 0% - 7%

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

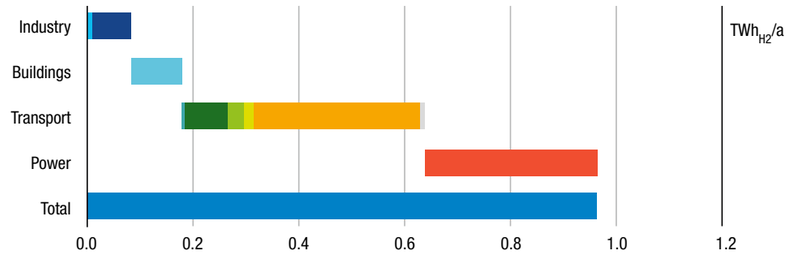
Hydrogen demand in the year 2030 has been estimated in a low and a high scenario covering the range of uncertainty. Today, conventional hydrogen mainly used in industry is produced from fossil fuels (e.g. through steam methane reforming) or is a by-product from other chemical processes. Both scenarios 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

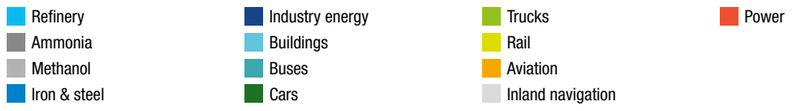


In the low scenario, renewable hydrogen accounts for 0.1% of final total energy demand (i.e. 0.1 out of 121 TWh/a) or 0.6% of final gas demand (18 TWh/a) according to EUCO3232.5.

High scenario



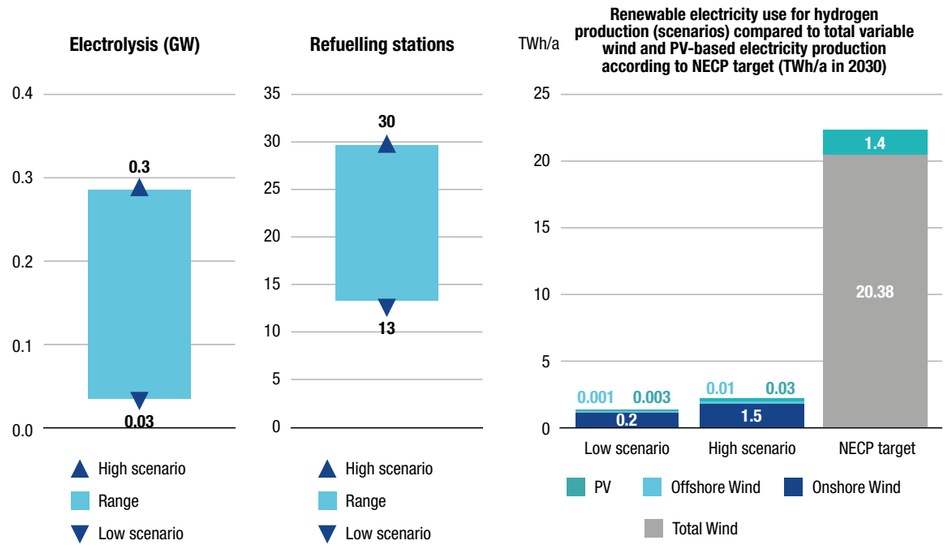
In the high scenario, renewable hydrogen accounts for 0.8% of final total energy demand (i.e. 1.0 out of 121 TWh/a) or 5.5% of final gas demand (18 TWh/a) according to EUCO3232.5.



Hydrogen generation, infrastructure and end users in Ireland 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 intermittent 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 0.3% in the high scenario.

End users

End user	Unit	Low scenario	High scenario
Passenger cars	Nº	7 000	14 100
Buses	Nº	0	60
Lorries	Nº	0	1 300
Heavy duty vehicles	Nº	0	50
Trains	Nº	2	7
Substituted fuel in aviation	GWh/a	22	210
Substituted fuel in navigation	GWh/a	0.6	5.3
Micro CHP	Nº	440	1 930
Large CHP	Nº	0	0
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 10-30 stations for 7 000-16 000 fuel cell vehicles on the road. [16]

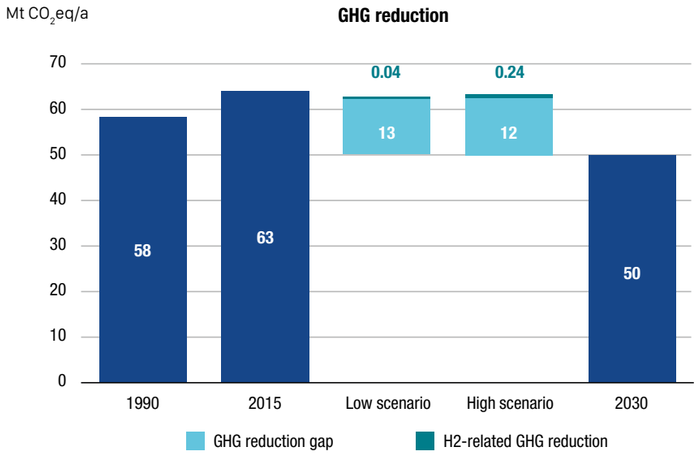
The introduction of 440-1 930 stationary fuel cells for combined power and heat production is estimated.

[16] *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 Ireland 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.

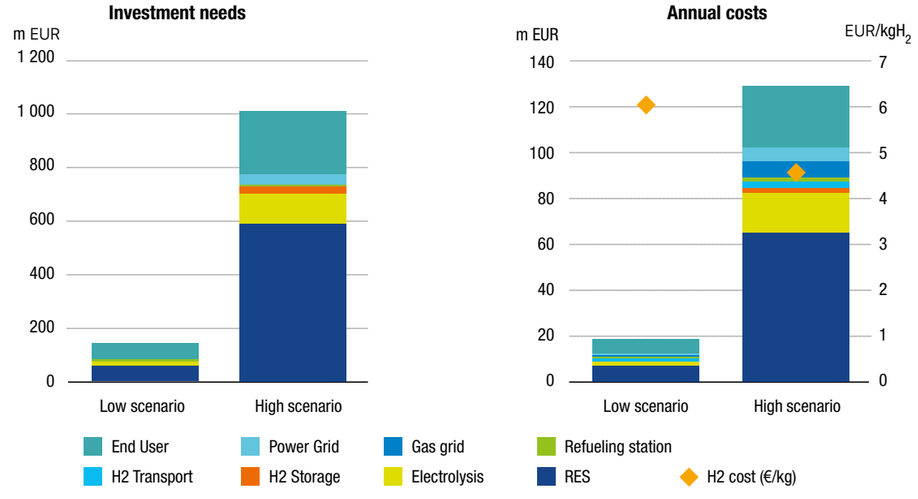
Environmental impact



An additional GHG emission reduction of 0.04-0.2 Mt CO_2 is estimated in 2030 corresponding to 0.3%-1.9% 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 0.1-1.0 billion EUR until 2030, while annual expenditure would amount to 20-130 million EUR (including end user appliances as well as power and gas grids).

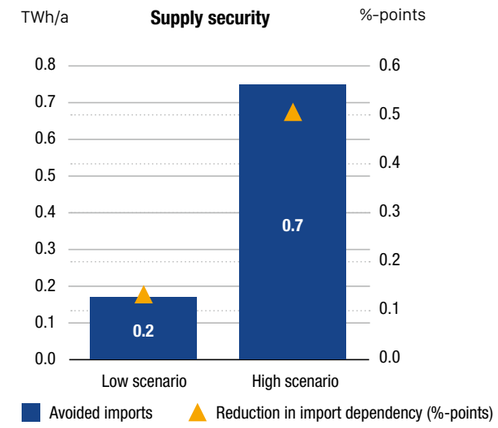


Impact on security of supply, jobs and economy in Ireland by 2030

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

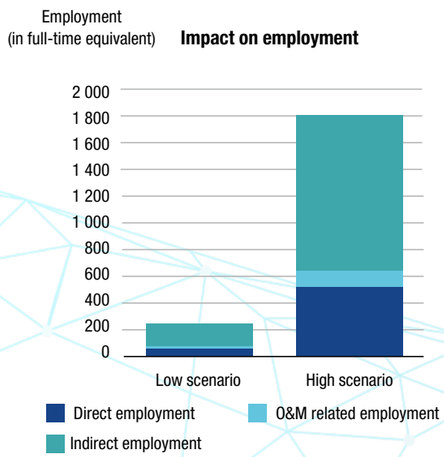
Deployment of renewable hydrogen would lead to 0.2-0.7 TWh/a of avoided imports, and thus reduce import dependency by 0.1-0.5% (in volume terms) in 2030, depending on the scenario.

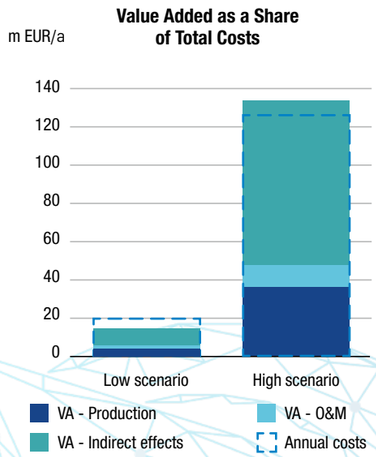


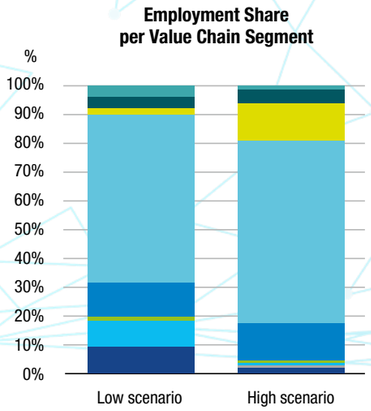
Impact on employment and value added

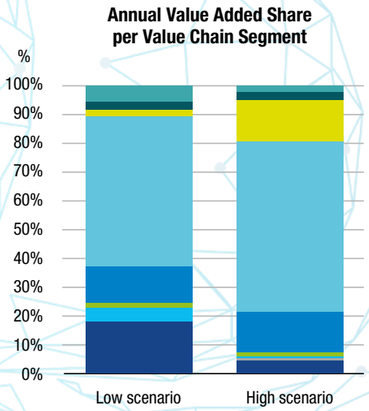
This analysis shows that in the years 2020-2030 around 6 million EUR can be retained annually in the domestic economy as value added in the low scenario, and almost 47 million EUR in the high scenario (value added is defined here as sum of wages for employees, margins for companies and taxes). If the indirect effects induced by the investment in and operation of hydrogen technologies are also taken into account, around 15 million EUR (low scenario) and over 130 million EUR (high scenario) of value added can be created in the Irish economy annually, which is almost equivalent to, or even higher in the high scenario, than the amount of annual investment needed. Most of this value added is expected to be created by building and operating dedicated renewable electricity sources and electrolysers for hydrogen production, and by building and operating hydrogen transport networks and storage facilities.

The hydrogen-related expenditures in 2020-2030 are estimated to generate employment of 80 – 600 direct jobs (in production and operations & maintenance) and contribute to a further 170 – 1 200 indirectly related jobs, depending on the scenario. Most of these jobs are expected to be created by building and operating renewable electricity sources, electrolysers and hydrogen transport infrastructure.









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

IRELAND

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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