Hydrogen Mobility Ireland

The Need for and Vision of Hydrogen Mobility in Ireland

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Introduction

Renewable hydrogen is a necessary energy vector to deliver emissions reductions across the road, rail, aviation, and maritime sectors, whether in its pure form or converted into renewable fuel such as green methanol or sustainable aviation fuel. Ireland must enable the production and use of hydrogen in mobility to achieve its policy targets and capitalise on several opportunities:

- Ireland is required to utilise green hydrogen in mobility by EU directives and regulatory mandates, while Northern Ireland is subject to UK policies requiring the use of hydrogen in mobility.
- Implementing policies which create opportunities for hydrogen in mobility will facilitate inward investment, contribute to creating and sustaining Irish jobs, and enable emissions reductions.
- Hydrogen can support the development and optimisation of the Irish energy system through increased energy security and a reduction in wasted 'dispatched-down' renewable power.

This paper from Hydrogen Mobility Ireland (HMI) demonstrates the need for and vision of renewable hydrogen in decarbonising the Irish mobility sector.

EU directives and regulations require 700MW of electrolysis to be deployed for mobility in Ireland by 2035

EU policies mandate the use of hydrogen to decarbonise mobility – setting specific targets through time until 2050:

1. **Renewable Energy Directive (RED) – Road and Rail**
   In RED, the European Commission introduced a target for renewable energy consumption in transport, including a target for the use of RFNBOs which requires 1% (by energy) of RFNBO fuels in road and rail by 2030. This will create an annual hydrogen demand of 11,000 tonnes in Ireland,[1] corresponding to 100MW of electrolysis capacity.[2]

Renewable Fuels of Non-Biological Origin (RFNBOs)

RFNBOs are fuels produced using non-biological renewable energy sources. Examples of RFNBOs include green hydrogen, e-ammonia, and e-methanol.

To qualify as a RFNBO, hydrogen must be produced using electricity supplied by:

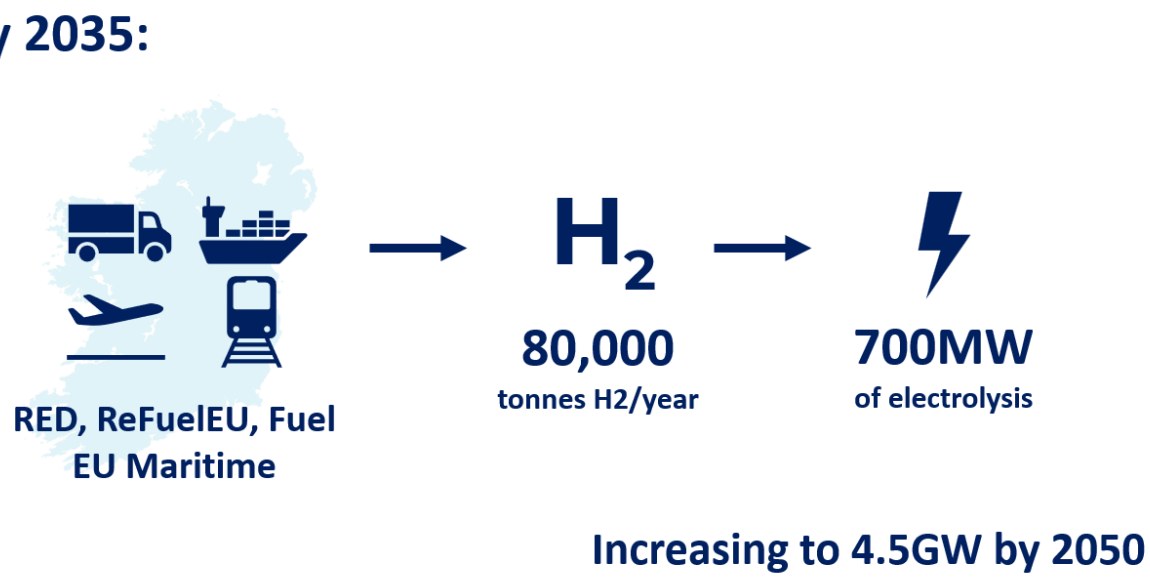
- A direct connection to renewables
- Grid electricity (if the grid is >90% renewable)
- Renewable electricity supplied via the grid with a PPA (subject to additionality and time-matching requirements)

2. **ReFuelEU – Aviation**
   ReFuelEU sets requirements for aviation fuel suppliers to increase the share of Sustainable Aviation Fuel (SAF) blended into conventional aviation fuel supplied at EU airports. A requirement is included for 5% of aviation fuel to be produced using RFNBO hydrogen by 2035. This will create an annual hydrogen demand of 64,000 tonnes in Ireland,[3] corresponding to 570MW of electrolysis capacity.[2]

[1] Road and rail energy consumption in Ireland: 1.37E+11 MJ/year (SEAI 2022); hydrogen energy density: 120 MJ/kg.
[2] Assuming Electrolyser efficiency = 55 kWh/kgH2; Capacity factor = 70%.
[3] Aviation energy consumption in Ireland: 4.22E+10 MJ/year (SEAI 2022); aviation fuel energy density: 44 MJ/kg; Hydrogen to SAF weight ratio: 1.33 (1.33kg hydrogen to produce 1kg SAF – technoeconomic assessment 2023).

3. **Fuel EU Maritime – Maritime**
   Fuel EU Maritime sets limits for the yearly average greenhouse gas (GHG) intensity of the energy used by ships calling at European ports, including a target for RFNBOs which requires 1% (by energy) of RFNBO fuels to be used by vessels in 2031, and 2% by 2034 if the 2031 target is not met. Assuming a 2% requirement by 2034 will create a minimum annual hydrogen demand of 700 tonnes in Ireland,[4] corresponding to 6MW of electrolysis capacity.[2]

According to requirements set by the EU, aviation and maritime sectors will use 83% of the 700MW of electrolysis capacity required by Irish transport in 2035. Both sectors are expected to consume hydrogen in the form of e-fuels: synthetic aviation fuels for the aviation sector, and likely e-ammonia or e-methanol for maritime sector.[5] 83% of hydrogen production will therefore be processed in an e-fuel production facility, with the remainder being dispensed as hydrogen.



Ireland is yet to implement policies mandating the use of hydrogen in mobility – as required by RED, ReFuelEU, and Fuel EU Maritime.

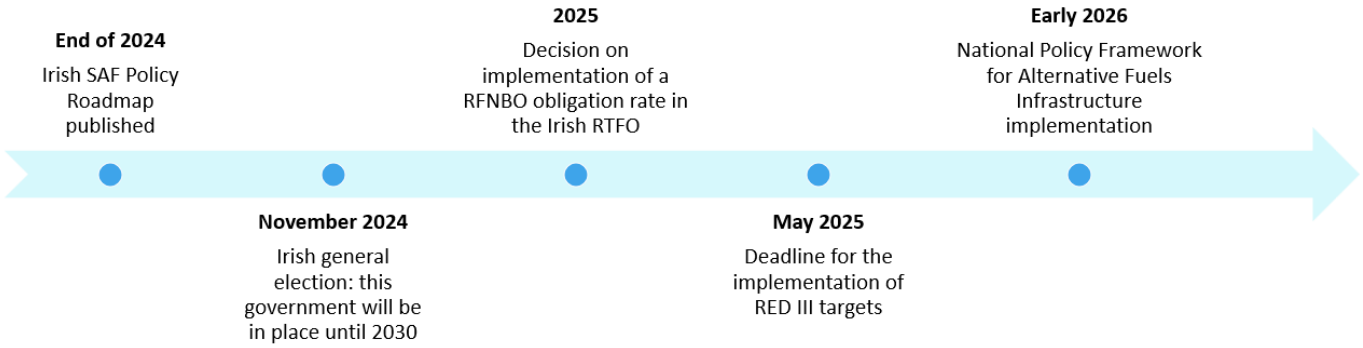
Ireland's Renewable Transport Fuel Obligation (RTFO) sets targets for renewable fuels in road, rail, aviation, and maritime. **An obligation for RFNBO fuels may be introduced into the RTFO in 2025**, dependent on consultations, the establishment of necessary Delegated Acts, and the availability of RFNBO fuels. A recurring theme in the RTFO is that '*there is low or no availability of [developmental fuels] and their feedstocks'* requiring *'support or incentives targeting production of these [developmental fuels]'.* In order to secure production of developmental fuels, Ireland must implement policies which generate demand for them, and provide a sufficiently profitable and risk-mitigated business case for their production.

[4] Ammonia is assumed to be the RFNBO fuel used in the maritime sector. Maritime energy consumption in Ireland: 4.16E+9 MJ/year (SEAI 2022); Required % of RFNBO fuel to meet 2035 emissions target: 2%; Hydrogen LHV: 120 MJ/kg. Hydrogen to ammonia conversion efficiency: 97%.

[5] 'A pathway to decarbonise the shipping sector by 2050', International Renewable Energy Agency, 2021

Ireland's National Sustainable Aviation Fuel Policy Roadmap will be published by the end of 2024 and will set targets for the use of SAF in Ireland and set out the supporting policy/regulatory measures. Clarity on this policy will enable industry to develop plans to meet targets ahead of government deadlines.

Now is the time to implement policies supporting the production of RFNBO fuels - with corresponding targets in the RTFO.



Deployment of hydrogen mobility will enable Ireland to capitalise on economic and environmental opportunities

In addition to achieving EU policy targets, building 700MW of electrolysis capacity for hydrogen mobility in Ireland is expected to bring:

1. **€6bn of investment:** Building 700MW of electrolysis required to fulfil RED, ReFuelEU, and Fuel EU Maritime, along with the 2.0GW[6] of additional renewable assets required to power the electrolysers, and the downstream road, rail, aviation, and maritime infrastructure will create over €6bn of investment.[7]
2. **260,000 tonnes of emissions avoidance per year:** 100,000 tonnes of CO2 equivalent per year in the road and rail sector,[8] 150,000 tonnes in the aviation sector,[9] and 7,500 tonnes in the maritime sector.[10] Total emissions avoidance is expected to increase to 1.2Mt per year by 2050 across road, rail, aviation and maritime.
3. **600 new operational jobs, €128M of additional GVA each year, and contribute to sustaining HMI member jobs -** deploying hydrogen production at industrial scale will benefit the Irish economy:
   a. Due to EU policy driving the demand for decarbonising products, **HMI members rely on the development of the hydrogen industry in Ireland to prevent their business and jobs being offshored.**

[6] Renewables load factor: 25%; Electrolyser load factor: 70%; Electrolyser capacity: 700MW.
[7] See Appendix for detailed calculations.
[8] 1% of road/rail fuel to be replaced with RFNBO hydrogen by 2030:
CO2 savings = 1% Road and rail energy consumption in Ireland (MJ) x CO2 produced by 1MJ of diesel; CO2 produced by 1MJ of diesel = 0.0733 kg/MJ (European Commission).
[9] 5% of Irish aviation fuel replaced with synthetic aviation fuel by 2035 and 35% by 2050:
CO2 savings = 5% Aviation energy consumption in Ireland (MJ) / aviation fuel energy density x CO2 produced by 1kg of aviation fuel; aviation fuel energy density: 44 MJ/kg; CO2 produced by 1kg of aviation fuel= 3.16kg (IATA).
[10] 2% of Irish marine fuel replaced with RFNBO fuel by 2035:
CO2 savings = 2% Maritime energy consumption in Ireland x CO2 emissions by 1MJ of VLSFO; CO2 emissions per MJ VLSFO = 0.0911kg (Fuel EU Maritime)

b. For 700MW of electrolysis capacity: 2.0GW of upstream renewable power capacity, 42 Hydrogen Refuelling Stations (HRS), 70 tube trailers (transportation of hydrogen), and a large-scale e-fuel production facility (580MW capacity) are required[7] – **creating a total of 600 new operational jobs,** [11] **corresponding to €128M of additional GVA output per year**.[12]

Hydrogen can support the development and optimisation of the Irish energy system

In addition to bringing capital investment, emissions avoidance, and new jobs, producing hydrogen and green chemicals can unlock the benefits of abundant wind power to support Irish energy independence:

1. **Energy security: All liquid fuels used in Ireland are currently imported in the form of crude oil.** 40-50% of gas used in Ireland is imported, the remainder being supplied by Ireland's Corrib gas field – which is expected to be depleted by 2025,[13] leaving Ireland dependent on imported fossil fuels. The production of **hydrogen and green chemicals on-island will increase energy security (all island)** by utilising the abundant renewable energy resources present in Ireland to displace imported fossil fuels. Further, Ireland will have the opportunity to export excess hydrogen to neighbouring countries. ESB, in collaboration with the German Government, is currently investigating potential hydrogen and green derivative transportation pathways to Germany.[14]
2. **Dispatch-down reduction: 8% of wind power was dispatched down in 2022 (all island)** due to overloading of local and national networks – a percentage that is expected to increase as further renewable assets are deployed.[15] **Building large-scale electrolysis allows wind assets to be fully utilised by providing long-term energy storage, enabling further investment in the deployment of wind farms**.

To achieve these benefits, Ireland must implement the relevant policies to drive demand: RED, ReFuelEU, and Fuel EU Maritime, into national legislation.

Conclusions

The implementation of EU directives mandating for the use of hydrogen in transport into Irish policy will not only support the development of 700MW of electrolysis capacity by 2035, but a surrounding ecosystem of renewable power and downstream industries. This will:

- Unlock over €6 billion in private investment, stimulating innovation and growth of the Irish economy.
- Reduce emissions by over 260,000 tonnes of CO2 equivalent per year.
- Create 600 permanent new jobs operating renewable power assets and hydrogen production facilities, adding €128M in GVA per year to the Irish economy.
- Contribute to sustaining HMI member companies' existing jobs.

[11] See Appendix for detailed calculations.
[12] Calculated using €257k GVA output per electricity/gas supply job (renewable power, electrolysis, e-fuel production) and €57k per transportation/storage job (tube trailer driving) – Office for National Statistics (UK)
[13] 'Oil and gas', Ireland energy 2050, accessed 09 October 2024
[14] 'ESB to lead on landmark green hydrogen study alongside Irish and German governments', ESB, accessed 06/12/24
[15] 'Annual Renewable Constraint and Curtailment Report 2022', Eirgrid, May 2023

- Increase energy security through on-island fuel production, displacing imported fossil fuels.
- Reduce dispatch-down of renewable assets through long-term energy storage, allowing the full utilisation of Ireland's renewables.

Now is the time to ensure that the correct policies are in place to create demand for hydrogen and derived RFNBO fuels. HMI has developed a further two papers 'Collective Ambitions of HMI Members' and 'Policy Support Required in Ireland', showing the projects that HMI members are willing to deliver with the correct policy support from Government - establishing a clear roadmap to the industrialisation of hydrogen mobility by 2035.

APPENDIX

Capital investment required for 700MW of hydrogen production with upstream and downstream industries

The proposed Irish hydrogen ecosystem fulfilling EU renewable transport directives and regulations by 2035 is made up of 2.0GW of renewable power production 700MW of electrolysis, a large-scale e-fuel production facility (processing 83% of hydrogen production), a Hydrogen Refuelling Station (HRS) network (dispensing the remaining 17% – or 36 tonnes/day), and over 3,500 hydrogen powered buses, trucks, and Non-Road Mobile Machines (NRMM).[16]

The quantity of investment unlocked via the deployment of the hydrogen ecosystem is detailed in Table 1. The capital costs of a hydrogen production facility are assumed to be primarily made up of the cost of electrolysers, compressors, tube trailers, and static storage. Costs of hydrogen production facility components, upstream renewables, and vehicles are obtained from HMI members' experience.

[16] Number of buses/trucks/NRMMs = Percentage of hydrogen used in road transport supplied to (buses/trucks/NRMMs) x Daily quantity of hydrogen used in road transport / (bus/truck/NRMM) daily hydrogen consumption
Percentage of hydrogen used in road transport supplied to buses: 40% (assumed); Percentage of hydrogen used in road transport supplied to trucks: 20% (assumed); Percentage of hydrogen used in road transport supplied to NRMMs: 40% (assumed); Daily quantity of hydrogen used in road transport: 35,700kg/day; Bus daily hydrogen consumption: 25 kg/day; Truck daily hydrogen consumption: 35 kg/day; NRMM daily hydrogen consumption: 5.5 kg/day.

Component	Quantity	Cost per unit	Cost
Electrolyser	700MW	€1.2M/MW	€830M
Compressors	21 units	€900k	€19M
Tube trailers	63 units	€420k	€26M
Static Storage	19,000kgH2	€900k/1000kg	€17M
Vehicles (buses, trucks, NRMM)	610 buses 220 trucks 2,750 NRMMs	€350k €450k €60k	€565M
HRS	42 units (1 tonne/day each)	€3M	€125M
Upstream Renewables	Onshore turbines: 980MW Offshore turbines: 1000MW	€1.0M /MW €3.0M /MW	€3980M
E-fuel facility	580MW facility	€640M /facility	€640M
TOTAL	**700MW ecosystem + e-fuel facility**	**€6.2bn**	

Table 1: Components/infrastructure required for 700MW of electrolysis capacity.

The number of new operational jobs unlocked via the deployment of the hydrogen ecosystem is detailed in Table 2. The number of jobs is calculated based on publicly available data for reference facilities.[17]

Reference facility/vehicle	Reference number of employees	Scaling Factor	Required capacity	Required number of employees
10MW electrolyser	3 employees	80%	700MW	168
3.6GW Dogger Bank Wind Farm (offshore)	200 employees	100%	1000MW	56
520MW Clyde Wind Farm (onshore)	50 employees	100%	980MW	94
1 Hydrogen Refuelling Station	3 employees	100%	42 units	126
1 Tube trailer	1 employee	100%	63 units	63
1GW HØST ammonia production plant	150 employees	100%	580MW	87

Table 2: Number of new operational jobs created by 700MW of electrolysis capacity.

[17] Dogger Bank Wind Farm (offshore), Clyde Wind Farm (onshore), HØST ammonia production plant.