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Finland as a frontrunner in green hydrogen

Finland is a leader in supporting the energy transition and renewable energy. The national objective is to become carbon neutral by 2035 and to create the first welfare society in the world to entirely renounce fossil fuels. As a central raw material, energy carrier and storage, hydrogen is a key to successfully establishing a renewables-based economy.

To be on the front foot in the hydrogen market and simultaneously achieve the ambitious carbon neutrality and sustainable growth targets, Finnish public and private sector is actively seeking to launch a viable hydrogen-based energy system. The aim is to spearhead sustainable hydrogen development on a European and global level.

With its innovative and dynamic business environment, cutting-edge research and know-how, and a stable political and economic landscape, Finland is well-placed to achieve this goal. The emerging green hydrogen industry is strongly facilitated by active across-the-board collaboration of stakeholders and by opportunities arising from the rapid development of wind power onshore and increasingly also offshore.

The Finnish hydrogen sector

Current status

Finland has a longstanding tradition in the industrial use of hydrogen. The current annual production for industrial purposes is approximately 5 TWh (status 2020), the majority of which is produced through steam methane reforming. Main use-cases are in oil refining and biofuel production, chemical industry, mining and ore refining. Additionally, circa 800 GWh of by-product hydrogen is yearly generated in industrial processes and used in industrial boilers, for district heating, and as process gases. With increased hydrogen demand on the horizon, the available production capacity must be multiplied and existing capacity transformed to rely on electrolysis or carbon-capture technologies.

Transition to green hydrogen

The vastly decarbonised electricity production sector and functioning electricity transmission system provide strong foundations for economically feasible hydrogen production via electrolysis. Although the regulatory environment has so far left some details open, the general atmosphere is favourable towards green hydrogen projects. Energy security and self-sufficiency considerations together with aspirations to build economic growth on carbon neutrality and domestic green industries are central incentives for both private and public sector actors.

The two recent years have witnessed the unveiling of an unprecedented number of green hydrogen projects in Finland, with substantiated investment plans for upcoming years reaching

an aggregate of several billion euros and many more projects being visioned and developed lower down the pipeline. Finland's first industrial-scale green hydrogen and methanation plant entered construction in late 2022. With its ca. 20 MW capacity, the facility upon commissioning more than triples the country's electrolysis capacity. In its wake, the Finnish hydrogen landscape with its planned hydrogen valleys in North, Southwest and Southeast Finland is quickly becoming a home for a variety of green transition projects, many of which are expected to be commissioned already in 2024-2025.

Pioneering business cases

Finland's emergent hydrogen projects are characterised by close cooperation between pioneering hydrogen/P2X-focused developers and traditional local energy companies. Hydrogen demonstrations and full-scale installations alike are being developed in urban industrial areas in connection with existing power generation or chemical plants. This sector-coupled approach enhances competitiveness of the hydrogen value-chain by enabling the harnessing of exhaust gases for on-site CO₂ extraction and the use of waste heat for district heating.

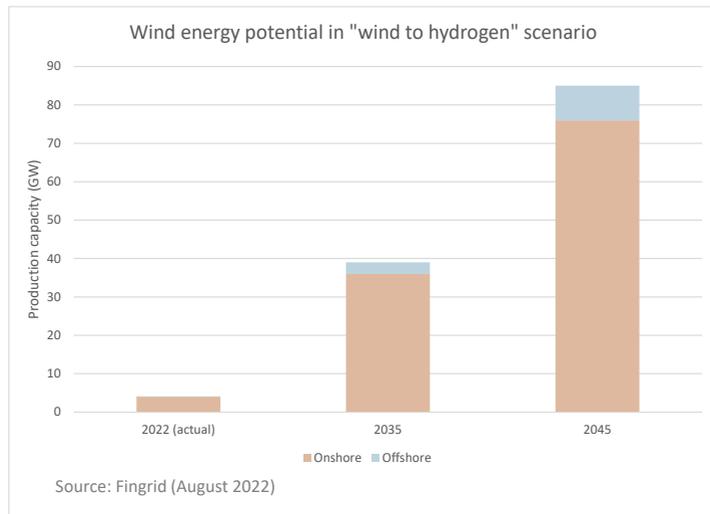
As no dedicated market for hydrogen has yet been created, the vast majority of projects under development rely on green hydrogen as feedstock for integrated e-fuel facilities. Further solutions explore the role of hydrogen in energy storage and system flexibility services, as well as production of downstream chemicals and fertilisers such as ammonia. Future prospects in these fields are estimated to be even brighter: although the market development is subject to significant uncertainty, Nordic hydrogen is considered to be well on the road to being cost-

competitive compared to fossil-based solutions by the end of the decade.

Project development

Project development in Finland calls for working dialogue with local stakeholders, energy companies, grid operators, municipalities and environmental authorities. Key development activities include environmental assessments, securing of land rights and electricity supply, spatial planning and permitting, as well as the conclusion of project agreements.

Finland has no “one-stop-shop” permit for hydrogen electrolyzers, and the permitting practices are just starting to develop. Several individual permits and statements from different state and municipal authorities are required, with limited procedural coordination in place.



Green hydrogen development, however, enjoys some of the procedural privileges and supportive measures for renewable energy. This includes a recently adopted procedural priority to green transition projects between 2023–2028 in administrative courts and the Regional State Administrative Agency.

Future visions

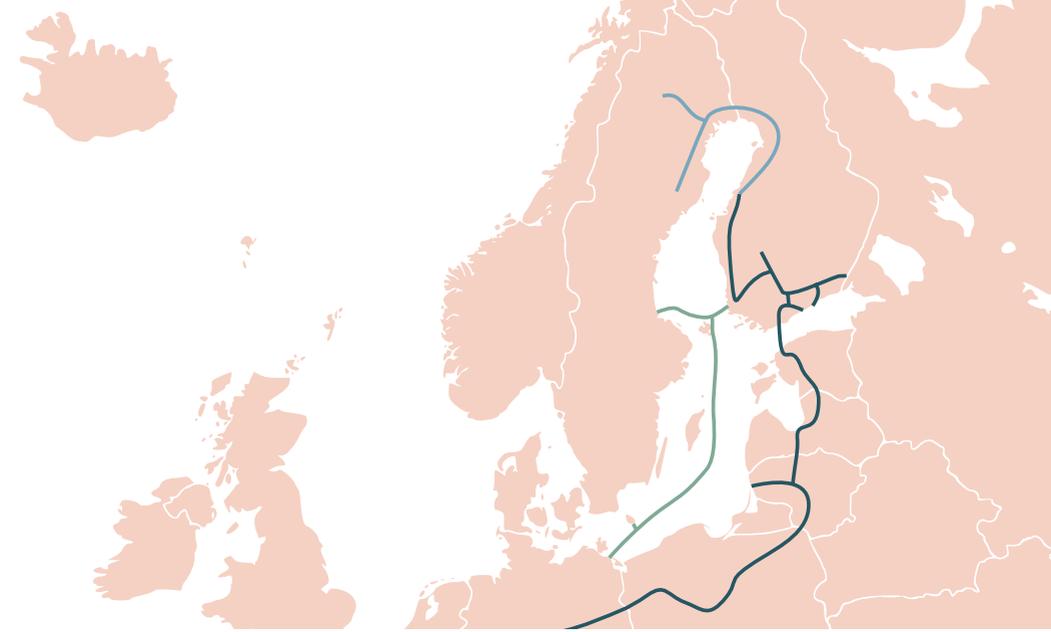
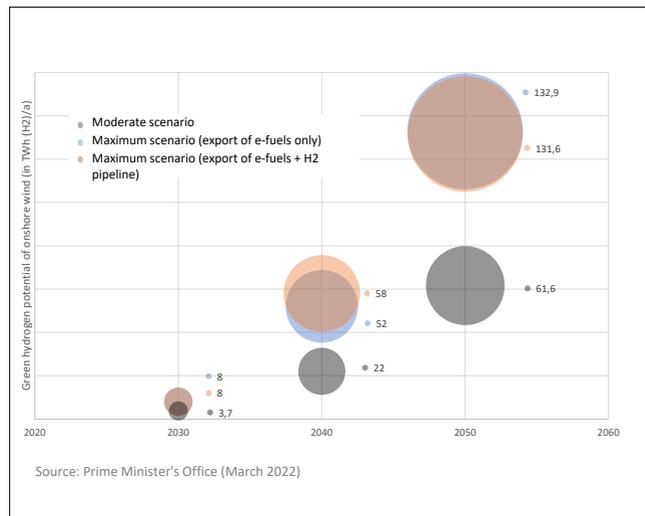
Wind to hydrogen

Thanks to advantageous wind conditions and constantly evolving technology, wind power has become the most cost-competitive form of electricity production in Finland, and the industry is booming. This makes wind a key factor in the country’s significant potential for green hydrogen production and the main enabler of its ambition to become a major hydrogen exporter in Europe. The European Hydrogen Backbone Initiative (EHB) estimates that the supply potential for hydrogen originating in the Nordics and Baltics can reach a total of 185 TWh as early as 2030 and grow to circa 500 TWh by 2040. Most of the supply is expected to be dedicated to green hydrogen, complemented by grid-based hydrogen powered largely by affordable Scandinavian hydropower.

Finland hosts an expanding project pipeline of onshore and offshore wind power, currently reaching over 65 GW in planned capacity. Of this, 13 GW is offshore and the rest onshore. Major projects are concentrated in the geographically favourable coastal and north-western parts of the country. In hydrogen export-oriented scenarios, the annual wind power production is

estimated capable of multiplying to circa 130 TWh per annum by 2035 and reaching nearly 300 TWh by 2045.

At the national level, full utilisation of estimated onshore potential alone is expected to call for up to 27 GW of electrolysis capacity by 2050, equalling over 130 TWh of green hydrogen production annually. Much of this hydrogen is envisaged to be exported or to serve Finland’s transport sector as e-fuel and as direct feedstock for heavy road transport. One Nordic particularity is the vast additional demand potential in decarbonising the countries’ energy intensive steel and chemical industries and oil and biofuel refining sectors. Wind-based hydrogen is visioned as cornerstone for recasting and creating domestic green industries. Businesses have seized the opportunity to jump on the bandwagon and are engaging in ground-breaking industry-led research into i.a. hydrogen engines and hydrogen-reduced iron.



Hydrogen infrastructure

To exploit its hydrogen potential in full, Finland is making significant efforts to create a hydrogen infrastructure. To kickstart pipeline development, the Finnish gas transmission system operator Gasgrid has been given a mandate to establish a national hydrogen network. This includes the construction of a joint pipeline with Sweden (the “Nordic Hydrogen Route”), through which green hydrogen will be transported on a large scale from areas with high wind power production to industrial customers. The pipeline is planned to be operational by 2030.

Further plans to extend the national network with Nordic Hydrogen Routes 2 and 3 to serve two prospective hydrogen valleys in South/Southeast Finland and in Southwest Finland/ Satakunta have been published. All three routes are part of the European Hydrogen Backbone Initiative. Over the longer term, subsea interconnectors to connect Finland all the way to the German and other Central-European demand markets is planned. Significant concrete steps to this end were taken at the end of 2022, with the publication of a Nordic collaboration between

gas TSOs and offshore wind developers to investigate a large-scale, cross-border collection and transportation infrastructure for green hydrogen (the “Baltic Sea Hydrogen Collector”). Additionally, a TSO-led pre-study for a connection from Finland through the Baltic countries all the way to Poland and Germany can be expected in 2023 (the “Nordic-Baltic Hydrogen Corridor”).

The Finnish energy sector in a nutshell

Finland is one of the leading nations in renewable energy. The share of renewables in total energy consumption and electricity supply, in both exceeding 40% and growing, is one of the highest in the EU. While hydro and bioenergy are still quantitatively largest renewable energy sources, the share of wind power is rapidly growing and can in peak hours amount to over a third of domestic electricity generation. Together with the soon phased-out peat, these three major renewables form the country's indigenous energy resources. Characteristic of the national energy portfolio is the strong reliance on nuclear power, solid wood fuels and black liquor.

The Finnish industry sector is the largest individual contributor to total energy consumption. Together, the forest industry, manufacture of basic metals and chemical industry make up as much as 90% of industry sector's energy consumption. While electricity forms a notable share of this and is mostly CO₂-free, due to the processes used approximately one-fourth of energy needed in these industries is still directly derived from fossil fuels – mainly oil, coal and natural gas.

The energy infrastructure is shaped by relatively long transmission distances and dependency on electricity exports

from other Nordic countries. The transmission grid covers nearly 15,000 kilometres of high-voltage lines and is operated nation-wide by the TSO *Fingrid Oyj*. To accommodate increasing electrification and geographically segregated production and consumption hot-spots, significant new investments of around EUR 2,1 billion are planned over the next ten years to expand and upgrade the network. The transmission grid is complemented by regional high-voltage networks and local distribution networks managed by 9 regional and 77 distribution network companies. The national grid is linked with high-voltage connections to Estonia, Sweden and Norway.

In addition to the electricity transmission grid, the dedicated TSO *Gasgrid Finland Oy* operates a geographically more limited gas transmission network in southern Finland. Connected to the European gas markets through the *Balticconnector* pipeline, a LNG terminal in Hamina and a FSRU infrastructure in Inkoo, the national gas network serves the Finnish natural gas market, which is open to competition since 2020 and has a yearly demand volume of circa 25 TWh (status 2021). The grid is also used for smaller quantities of domestically produced biogas. Sales volumes are largely attributable to large industrial end-users and energy companies producing district heating or electricity. Households procure natural gas in small quantities and a vast majority of them only for cooking.

Useful contacts

Networks and advisors

Bergmann Attorneys at Law

Helsinki-based law firm with a strong specialization in industrial projects in construction and engineering, energy, and infrastructure.

Pohjoisesplanadi 35 E
00100 Helsinki
office@bergmann.fi
www.bergmann.fi

Both2nia

Network of collaborators involved in the hydrogen economy with the common goal to establish Europe's largest hydrogen cluster around the Gulf of Bothnia.

www.both2nia.com

Hydrogen Cluster Finland

Network of companies and industrial associations, aiming to facilitate information sharing and collaboration, promote hydrogen economy and create business opportunities.

www.h2cluster.fi

The Finnish Wind Power Association

(Suomen Tuulivoimayhdistys ry)

Association founded in 1988 for promotion of wind energy in Finland with over 160 private individual members and 140 member companies and associations.

Yliopistonkatu 34 B 17
40100 Jyväskylä
tuuli@tuulivoimayhdistys.fi
www.tuulivoimayhdistys.fi

Business Finland

Finnish innovation funding, trade, investment, and travel promotion organization, fully owned by the Finnish Government.

Porkkalankatu 1
00180 Helsinki
<https://www.businessfinland.fi/en/do-business-with-finland/home>

Finnish Energy Industries

(Energiateollisuus ry)

Sector organisation for the industrial and labour market policy of the energy sector, with about 270 member companies.

Eteläranta 10
00130 Helsinki
info@energia.fi
www.energia.fi

State administration and state-owned companies

Finnish Energy Authority

(Energiavirasto)

Licensing and regulatory authority regulating and promoting operation of the electricity and gas markets, emission reductions, energy efficiency and use of renewable energy

Lintulahdenkuja 2 A
00530 Helsinki
Tel: +358 29 5050 000
kirjaamo@energiavirasto.fi
www.energiavirasto.fi

Gasgrid Oy

State-owned enterprise responsible for the Finnish gas transmission network. Currently involved in early-stage development of hydrogen infrastructure in Finland and the Nordics.

Keilaranta 19 D
02150 Espoo
info@gasgrid.fi
www.gasgrid.fi

Fingrid Oyj

Enterprise in majority state ownership responsible for the Finnish electricity transmission grid.

P. O. Box 530 / Läkkipäntie 21
00101 Helsinki
Tel. +358 30 395 5000
kirjaamo@fingrid.fi
www.fingrid.fi

Regional State Administrative Agency (AVI)

(Aluehallintovirasto)

6 regional agencies responsible for carrying out executive, steering and supervisory tasks related to, inter alia, environmental protection, environmental sustainability, and public safety. AVIs are involved in environmental permitting of hydrogen projects.

www.avi.fi

Centres for Economic Development, Transport and the Environment (ELY Centres)

(Elinkeino-, liikenne- ja ympäristökeskus (ELY-keskus))

15 ELY Centres responsible for the regional implementation and development tasks of the central government. ELY Centres are involved in the assessment of environmental impacts of hydrogen projects.

www.ely-keskus.fi
Tel. +358 295 020 900
(service desk for environmental matters)

**South Ostrobothnia Centre
for Economic Development,
Transport and the Environment
(ELY Centre for South
Ostrobothnia)**

(Etelä-Pohjanmaan ELY-keskus)

Dedicated contact point authority for
renewable energy projects, offering
national permit guidance.

P.O. Box 156 / Alvar Aallon katu 8
60101 Seinäjoki
Tel. +358 295 020 920
(renewable energy permit guidance)

**Energy and environment
policies**

**Ministry of Employment and the
Economy**

(Työ- ja elinkeinoministeriö, TEM)

The ministry responsible for, inter
alia, energy policy and integration
of the national preparation and
implementation of climate policy.

P.O. Box 32
00023 Government
Tel. +358 2951 6001
kirjaamo.tem@gov.fi
www.tem.fi

Ministry of the Environment

(Ympäristöministeriö, YM)

The ministry responsible for the built
environment, housing, biodiversity,

sustainable use of natural resources
and environmental protection.

P. O. Box 35 / Aleksanterinkatu 7
00023 Government
Tel. +358 2951 6001
kirjaamo.ym@gov.fi
www.ym.fi

Services for the
renewable energy sector

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- Process and document management

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- Taxation

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