



Norwegian
Hydrogen Forum

The Norwegian Hydrogen Guide

2023



Ballard is engaged in several Norwegian hydrogen projects including projects for ferries and coastal cargo carriers, hydrogen trucks and buses as well for stationary backup power solutions.

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Photo: Inne Pedersen

The Secretariat of Norwegian Hydrogen Forum. From left: Jan Carsten Gjerløw, Lin April Løstegård, Tor Kristian Haldorsen and Ingebjørg Telnes Wilhelmsen.



Norwegian Hydrogen Forum (NHF) was founded in 1996 as a non-profit member organization, and promotes the advantages of hydrogen and ammonia as energy carriers. As of 2023, our approximately 90 members span Norwegian producers, distributors, industry, universities, research institutes, companies in the transportation sector, consulting firms and other organizations interested in hydrogen.

NHF works actively to disseminate key information in Norway on hydrogen and ammonia research and technology commercialisation, market trends and international policy making. Moreover, NHF is organizing conferences, seminars, and workshops, some in collaboration with our Nordic sister-organizations, projects, or other national and international stakeholders. Updates are provided by publishing newsletters and posting news on www.hydrogen.no.

NHF is convinced that one of the best ways to serve our members is to contribute to establish a substantial market for hydrogen technologies both in Norway and internationally. To fulfil this ambition NHF is actively promoting our members' interests towards public authorities and decision makers.

Recently, NHF has succeeded in getting substantial political attention and support for introduction of hydrogen technologies at regional as well as national level, ensuring strong financial support schemes in the years to come.

The basis on which NHF is founded concerns the important role hydrogen will have in the transformation to a greener future. Norway has been a frontrunner when it comes to renewable energy such as hydropower. Now, we must show the world that we still are a renewable energy nation to reckon with and take a leading role in the hydrogen and ammonia industry.

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Hydrogen is an energy carrier that can be produced from all energy sources, including natural gas and renewable energy, both of which Norway has in abundance. Due to a rapidly increasing share of intermittent energy sources like solar and wind power in the energy system, there has been a substantial increase in the interest for hydrogen, both to decarbonize and to enhance the flexibility in the energy system. To accommodate and facilitate for the needed growth, the Norwegian government must take an active part. It is NHF's ambition to be a constructive partner for the authorities in this respect.

The first National hydrogen strategy was launched in 2005 by the Ministries of Petroleum & Energy and Transport & Communications. In June 2020, the government presented a new Norwegian Hydrogen Strategy, and in June 2021 they followed up with a roadmap. The roadmap was part of the White Paper "Value creation from Norwegian Energy Recourses". The White Paper states that Norway's position as an energy nation will be further developed through new initiatives such as hydrogen, offshore wind, strengthening of the grid and low emission oil and gas sector.

The current government has stated that it will contribute to developing a coherent value chain for hydrogen produced with low or no emissions, where production, distribution and use are developed in parallel. The government has been asked by the national assembly to present a plan for the introduction of Contracts for Difference in 2023. This is expected to be an important incentive to reduce risk and accelerate investments in hydrogen production and use in Norway.

Norway and the EU have ratified the international Paris Agreement on climate change, and, like the EU, Norway has committed to a target of at least 55 percent reduction of greenhouse gas emissions by 2030 compared to 1990 levels.

The use of hydrogen and ammonia is important to reach the goals. But we must act now, there is no time to lose. That is why NHF is working hard to facilitate the development of the Norwegian hydrogen and ammonia industry, together with our members and international partners. Together we will ensure a sustainable development where hydrogen and ammonia will give a significant contribution to the reduction of CO₂ emissions.

The County Network

The County Network is a cooperation between counties and municipalities in Norway. The main goal is to develop well-functioning value chains for hydrogen throughout the country. NHF is the secretariat for the network.

Regional authorities play an important role in the work of phasing out fossil fuels and facilitating deployment of low- and zero-emission solutions. Hydrogen has over the last years received significantly increased focus from the authorities and the industry, and several projects and initiatives have been initiated throughout Norway. This provides both a challenge and opportunities for counties and municipalities, both on political and administrative level. Counties and municipalities are important to facilitate the development in such a way that energy resources are utilized, green jobs are created and greenhouse gas emissions are reduced.

The County Network aims to:

1. Increase the competence about hydrogen in counties and municipalities
2. Provide input to regional and local action plans and strategies
3. Act as a discussion partner for NHF's preparation of input for public consultations
4. Work for improved national framework conditions that are of particular importance to municipalities and counties
5. Increase the cooperation between the participants by sharing experiences and coordinating activities



AGDER
fylkeskommune



Møre og Romsdal
fylkeskommune



Nordland
FYLKESKOMMUNE



Rogaland
fylkeskommune



Troms og Finnmark fylkeskommune
Romssa ja Finnmarkku fylkkagielda
Tromssan ja Finmarkun fylkinkomuuni



Trøndelag
fylkeskommune



Vestfold og Telemark
FYLKESKOMMUNE



Vestland
fylkeskommune



VIKEN
FYLKESKOMMUNE



Berlevåg kommune



bodø
KOMMUNE



Kristiansand
kommune



Kvinesdal
KOMMUNE



Oslo



PORSGRUNN
KOMMUNE



TRONDHEIM
KOMMUNE

Figure: Participants of the County Network



Herøya in Vestfold and Telemark is one of the largest industry areas in Norway, and has established a local hydrogen network.



The city of Trondheim aims to play a vital role in the hydrogen value chain and intends to enhance the establishment of a robust regional infrastructure for renewable and fossil-free fuels including hydrogen. Europe's first hydrogen trucks are operated by ASKO Midt-Norge, located in Trondheim.





Troms og Finnmark County has adopted a hydrogen strategy and intend to utilize the natural advantages for the production of hydrogen, both from natural gas and wind power. The EU-project Haeoulus operates a new-generation electrolyser integrated within a state-of-the-art wind farm in a remote area with access to a weak power grid, located at Raggovidda in Finnmark.



The Vestfjorden Ferries operating the route between Bodø and the Lofoten islands will use hydrogen from 2025. The city of Bodø is the regional capital of Nordland county and a center for logistics and transports. The goal is to realize zero-emission transport systems within the next decades. Hydrogen is expected to play a key role in this ambition.

The Nordic Hydrogen Partnership

Nordic Hydrogen Partnership (NHP) is a collaboration between the Nordic hydrogen associations. The partners are Norsk Hydrogenforum in Norway, Vätgass Sverige in Sweden, Brintbranchen in Denmark, VTT Technical Research Center of Finland and Icelandic New Energy on Iceland. As well as being a platform for communication between the Nordic countries, NHP use their expertise to boost the cross-sector implementation of hydrogen and fuel cell technologies in the Nordics, in close cooperation with several industry representatives.

The Nordic Hydrogen Partnership was established in 2006, when the different Nordic hydrogen organizations joined forces to coordinate the market introduction of hydrogen cars and HRSs to the Nordic market. The Nordic Hydrogen Partnership originally was given the name Scandinavian Hydrogen Highway Partnership (SHHP), but this name was changed by the end of 2020 to accommodate the broadened scope of the organization.

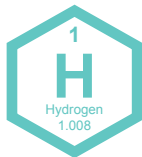
Next Wave (2019 –) is an initiative established through the Nordic Hydrogen Partnership. The goal of the project is to stimulate the globally leading hydrogen technology companies in the Nordic region to establish the world's first expansion of hydrogen infrastructure for large vehicles, and to accelerate a greater roll-out of hydrogen trucks and buses. The other partners in the project, together with NHP, are Kunnskapsbyen Center of Innovation and Everfuel. The project receives funds from Nordic Innovation.

nordichydrogenpartnership.com/nextwave

VÄTGAS
SVERIGE

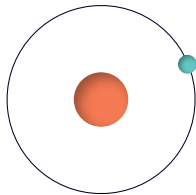
Brintbranchen
Hydrogen Denmark





What is hydrogen?

The name hydrogen is derived from the Greek words for water; hydro and former; genes. Hydrogen (H) has atomic number 1 and is the lightest element in the periodic table. The most common isotope of hydrogen consists of one proton and one electron. Estimates show that hydrogen is the most common element in the universe and, despite its lightness, makes up three quarters of the mass in the universe.



On earth, the hydrogen atom mostly appears as part of the water molecule, H_2O . Hydrogen is also a part of many other substances, for instance in hydrocarbons, carbohydrates, and ammonia (NH_3).

Hydrogen is an energy carrier and must therefore be produced from energy resources. The most used production methods are electrolysis and reforming of fossil energy e.g., natural gas. When hydrogen is produced from renewable energy, it is categorized as green hydrogen, while when generated from gas reforming with Carbon Capture and Storage (CCS) or Carbon Capture Usage and Storage (CCUS) it is known as blue hydrogen. Both green and blue hydrogen are categorized as clean energy carriers and when utilized in a Fuel Cell the only emissions are clean water and heat.



SINTEF is a leading R&D and innovation actor in Europe within hydrogen technologies, with more than 30 years' experience and significant activities.

Almost a hundred years of large-scale hydrogen production

In Norway, Norsk Hydro have produced and utilized hydrogen for large scale fertilizer production since 1927. Their electrolysis technology is being further developed and supplied by Nel Hydrogen. Norsk Hydro, Statkraft and Statoil (now Equinor), together with Raufoss Fuel Systems (now Hexagon Purus) and Norwegian research institutions, brought hydrogen from the industrial and research domain to the public refueling arena in the beginning of 2000 through the HyNor-project, which was established to demonstrate the readiness of hydrogen as an alternative fuel for passenger cars. Some hydrogen refueling stations were established through public and private investments.

Norwegian companies, research institutes, and universities have over the last decades developed strong competence and long experience within hydrogen technologies. New companies along the entire value chain from hydrogen production and distribution to end use and system integration are being established building competence, experience, products and solutions. Today, both new and more established companies are heavily engaging in hydrogen, either as a small part of their business or having hydrogen as their core business. The frequency with which new initiatives and projects are established has increased tremendously over the past few years, leading to increased public awareness and eventually a nationwide deployment of hydrogen solutions in the coming years.

With 98% of renewables share in Norwegian power production and an increasing exploitation of small-scale run-off rivers, solar and wind power, the need for grid balancing and energy buffering is increasing. The growing hydrogen infrastructure could play a crucial role in meeting these challenge as well as contributing to meet the ambitious climate targets. Regional authorities and public financial support agencies have for many years supported the development of hydrogen technologies. Lately, large industrial players are investing substantially in scaling up and deploying hydrogen for emission reductions in industry as well as in road and maritime transport.

The Norwegian Hydrogen Forum (NHF) is facilitating further development of these skills and capabilities so that Norwegian stakeholders can maintain their pioneering role and take an adequate share in the growing global market for hydrogen and ammonia technologies. NHF aims to be a visible actor in the hydrogen community in Norway and abroad and has an important coordinator and facilitating role in fostering this growing industry.

Meråker Smelteverk, 1957





Members



agri-e

Agri-e AS

Agri-e is a turnkey provider of decentralized energy systems producing hydrogen, electricity and heat, including CO₂ capture.

Our modular production units utilize biogas and natural gas to produce emission-free energy without emissions, providing customers with improved production flexibility relative to demand.

With control and analyzing systems, our standardized production units are scalable to meet the hydrogen demand and reduce customers' CAPEX and OPEX costs and risks.

The green CO₂ from the production can be utilized for food production, cooling and other processes contributing to increased circular solutions.

The outcome is sustainable utilization of our resources and increased energy efficiency, flexibility, and delivery security.

Our decentralized solutions for hydrogen production contribute to improved hydrogen infrastructure by producing the hydrogen close to the customer. Short distance energy.

agri-e.no

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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| | | Commercialization |
| | | Components |
| | | R&D |
| | | Services |
| | Portable | |
| | Stationary | |
| | Transportation | |
| | Control systems | |
| | Distribution | |
| | FC/ICE | |
| | Production | |
| | Storage | |
| | System Integration | |

Air Liquide Norway AS

Air Liquide (AL) is the world leader in gases, technologies and services for Industry and Health, Air Liquide is present in 80 countries with approximately 65,000 employees and serves more than 3.5 million customers and patients. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy. They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902.

Regarding hydrogen, the company is present in the entire hydrogen production chain from hydrogen production, storage, transportation and delivery to end users. AL currently produces more than 1 million tons of H₂ per year for steel, glass, chemical, food industries and mainly for refineries. The Group operates a large distribution network, which includes gaseous tube trailers, liquid trailers, cylinders and bundles but also the largest European hydrogen pipeline network. Air Liquide also designs and operates hydrogen fuelling stations in Europe, North America and Asia and has been actively involved in R&D projects aiming to strengthen the safe usage of hydrogen in a hydrogen based economy.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
| | | Components |
| | | R&D |
| APPLICATION | | Services |
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| | | Stationary |
| HYDROGEN CHAIN | | Transportation |
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| | | System Integration |

Aker Horizons

Aker Horizons develops green energy and green industry to accelerate the transition to net zero. The company is active in renewable energy, carbon capture and hydrogen, and develops industrial-scale decarbonization projects. As part of the Aker group, Aker Horizons applies industrial, technological and capital markets expertise with a planet-positive purpose to drive decarbonization globally.

Aker Horizons is listed on the Oslo Stock Exchange and headquartered in Fornebu, Norway. Across its portfolio, the company employs approximately 1,200 people in 18 countries on five continents. The company develops, builds, owns and operates clean hydrogen at industrial scale globally, continuously working on making hydrogen affordable, safe and easy.

Aker Horizons' approach is to leverage standardization, digitalization and partnerships across the value chain, applying HSSE culture, toolbox and solutions from more than 180 years of industrial heritage from the Aker Group, and understanding the end-users' technical and commercial hurdles. Targeted end-use markets are hard-to-abate sectors such as ammonia, methanol shipping and refineries.

A K E R

H O R I Z O N S

akerhorizons.com

Commercialization

Components

R&D

Services

Portable

Stationary

Transportation

Control systems

Distribution

FC/ICE

Production

Storage

System Integration

Aker Solutions ASA

Aker Solution offer engineering and construction services for the renewable energy transition with key focus on hydrogen and derivatives. Utilize its strong project execution experience and methodology and a strong culture of solving problems, we deliver complex energy projects in a safe, predictable, and sustainable way.

The offering ranges from early phase studies and design to EPC for both onshore and offshore. It covers the value chain from production to storage and transportation to end use of hydrogen and hydrogen derivatives like ammonia, e-fuel and methanol. Aker Solution work in an integrated and collaborative way to ensure cost efficient execution with world class quality.



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
| | | Components |
| | | R&D |
| APPLICATION | | Services |
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| HYDROGEN CHAIN | | Transportation |
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| | | Storage |
| | | System Integration |

Akershus Energi Infrastruktur AS

Akershus Energi is an energy company for renewable energy and green infrastructure. We are invested in renewable sources such as hydro-power, district heating, solar and wind.

Our ambition in hydrogen is to contribute to the decarbonization of transport sector in our region through industrial scale hydrogen production. We aim for integration of hydrogen production in the energy system for utilization of flexibility and waste heat to increase competitiveness of hydrogen.

Akershus Energi mainly do development and business together with partners. We do our development of industrial project within the hydrogen business through our partnership in Viken Hydrogen AS.

Commercialization

Components

R&D

Services

Portable

Stationary

Transportation

Control systems

Distribution

FC/ICE

Production

Storage

System Integration

Aneo AS

Aneo is looking into possibilities to produce green hydrogen for use in transport on land and at sea.

Together with Statkraft we are engaged into the hydrogen hub at Hitra as one the five which Enova support.

We like to mention that Aneo has completed EU-project REMOTE with success which was a off-grid electricity project where hydrogen was the main energy storage. Hydrogen was produced by electricity from renewable sources as windpower and PV. The project was led by POLITO – Polytechnical University of Turin. The project has given us knowledge for how we could commercialize this kind of solution.

ANEEO

aneo.com

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| | | System Integration |

Applied Hydrogen AS

Enabling emission free construction sites. We provide conversion kits for excavators to replace diesel engines with Fuel Cell based Hydrogen Power sources.

We also build portable hydrogen filling units for off-grid filling in construction sites.

A cloud-based fleet management system is used to control the hydrogen value chain for production site to delivery to excavators.



appliedhydrogen.no



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Storage |
| | | System Integration |



Ballard Power Systems Norway

With 40+ years of experience, Ballard is a world leader in the development, manufacture, sale and servicing of PEM hydrogen fuel cells. Ballard's solutions are used in various markets from bus and truck to critical infrastructure backup power, marine and rail applications. Ballard's fuel cell technology offers a range of benefits within each markets including lowering operating costs, longer operating lifetimes and positive environmental impacts. As a global company with presence in North America, Europe, and China, we are working to accelerate fuel cell adoption around the world.

Our fuel cell modules for heavy duty transport lead the industry in performance, durability, cost and overall road experience with more than 1,300 buses and 2,200 trucks in service as well as 100million km of commercial operation. We work with commercial vehicle industry leaders to bring zero-emission fuel cell powertrain on the road, and we continue to improve our solutions to deliver fuel cell electric vehicles with engineering excellence. We provide advice, project development and support in integrating fuel cells and offer training and service for all products.

We are engaged in several Norwegian hydrogen projects including projects for ferries and coastal cargo carriers, hydrogen trucks and buses as well for stationary backup power solutions.

ballard.com

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Bilimportørenes Landsforening

Bilimportørenes Landsforening (BIL) is the Norwegian Association of Car Importers representing the international car industry in Norway.

BIL is a member of NHF (The Norwegian Hydrogen Forum) as we recognize their important role in this growing industry. The process of commercializing the hydrogen technology for vehicles is in progress, and we see huge possibilities in joining forces working for a cleaner global environment.

There are already several vehicles containing this technology on Norwegian roads, and we expect the number to grow for the years to come.

BIL is continuously working towards the authorities. We are glad to see that the Norwegian government now is quite ambitious to provide infrastructure for hydrogen road and sea transportation.

bilimportorene.no

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Ceramic Powder Technology AS

Cerpotech (Ceramic Powder Technology AS) is developing and manufacturing high quality advanced ceramic oxides for a broad range of applications. Application areas are within environmental technologies, energy and electro ceramics. Powder for lead free piezo, membranes for various technology areas, solid oxide fuel or electrolyzes cells and batteries by use of spray pyrolysis. The manufacturing method spray pyrolysis is very flexible and robust and are also very reproducible and easy to scale up as it semi continuous. Cerpotech specializes in the manufacturing of multicomponent oxide powders according to the customers' specifications regarding composition and powder morphology. In addition to commercial sales to industry and R&D-purposes, Cerpotech is partner in national and EU funded R&D projects.

Cerpotech as a spin off from NTNU from 2007 have in 2013 established an industrial size manufacturing line located at Tiller, just outside the city center of Trondheim. The company have customers worldwide within a broad range of market areas from basic R&D to commercial products.

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Clara

Clara Venture Labs AS

Clara is a venture platform backed by Aker to develop disruptive technologies and solutions within Clean Energy Solutions, New space, Advanced materials, Resource Scarcity, Circular Economy, and Biochemistry.

Clara – former Prototech – has been involved in fuel cell development since 1990, and develops fuel cell systems for different applications using commercially available components. Clara has competence within design, analysis, manufacturing and testing of stack components, stacks, balance-of-plant and complete systems. Clara has participated in a number of national as well as EU projects related to fuel cells and fuel cell systems. In 2021, Clara launched the venture Alma Clean Power for further development and commercialization of high-temperature fuel cell systems for ocean industries. Clara has also carried out projects for the European Space Agency related to hydrogen storage and compression systems as well as regenerative fuel cell systems for satellites and spacecraft.

Clara supplies balance-of-plant components and complete systems for test and demonstration. Testing and demonstration are carried out in our own fuel cell and hydrogen laboratories.

claraventurelabs.com

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DNV AS

DNV is a leading, independent advisor and verifier covering “all colors” of hydrogen and full value chains with a global operation. Core industries that DNV serve are maritime, offshore, pipeline, as well as land-based industrial hydrogen (smelters and ammonia production) and hydrogen for land-based transport.

Core services within advisory is safety assessments, HAZID’s, experiments, Joint Industry Projects, and R&D related to hydrogen safety with a world leading large scale explosion test facility at Spadeadam, UK. Analyses also includes new technologies and value chains for renewables and hydrogen carriers, life cycle analysis and GHG footprint including forecasting and advisory regarding long-term hydrogen development.

DNV Maritime Class is pioneering developments with hydrogen and ammonia as fuel for ships and on carriers, including rule developments, handbooks, guidelines and standardization.



dnv.com

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Equinor ASA

Equinor is an international energy company present in more than 30 countries worldwide, including several of the world's most important oil and gas provinces. Founded in 1972 under the name Den Norske Stats Oljeselskap AS – Statoil (the Norwegian State Oil company), we changed our name to Equinor in 2018.

Our headquarters are in Stavanger, Norway, and we have over 21,000 employees committed to providing affordable energy for societies worldwide and taking a leading role in the energy transition. We're on a journey to net zero emissions through optimising our oil and gas portfolio, accelerating growth in renewables and pioneering developments in carbon capture and hydrogen.

equinor.com

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Everfuel Norway AS

Everfuel is the leading European integrated green hydrogen company with a clear purpose and a strategy to unlock competitive hydrogen in the energy transition. Everfuel develops, owns and operates hydrogen infrastructure to create the most efficient production, distribution and delivery solutions for compressed hydrogen for all forms of mobility and industrial applications where hydrogen can replace fossil energy carriers. This positions Everfuel to capitalize on the emerging hydrogen market and create long term value for all stakeholders.

Everfuel has its headquarter in Herning, Denmark, and with activities in Norway, Denmark, Sweden, The Netherlands, Germany and Belgium, and a plan to grow across Europe. Everfuel is listed on Euronext Growth in Oslo under the ticker EFUEL.



everfuel.com

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
| | | Components |
| | | R&D |
| | | Services |
| APPLICATION | | Portable |
| | | Stationary |
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| | | Control systems |
| | | Distribution |
| | | FC/ICE |
| | | Production |
| | | Storage |
| | | System Integration |

The Norwegian Defence Research Establishment (FFI)

FFI is the prime institution responsible for defence-related research in Norway and is the chief adviser on defence-related science and technology to the Ministry of Defence and the Norwegian Armed Forces' military organization.

Hydrogen and fuel cell activities at FFI have mainly focused on power systems for underwater applications, especially for the autonomous underwater vehicle HUGIN. FFI has developed a sea water battery, an aluminium/hydrogen peroxide semi-fuel cell and a PEM fuel cell system for this purpose. Fuel cells and hydrogen are also a relevant technology for Norway's new submarines, which will be delivered from 2029 and onward. On this basis, FFI is investigating fuel cell systems used for air-independent propulsion on submarines, including hydrogen storage in metal hydride containers. Production and storage of hydrogen is also a relevant technology segment due to this application.

Reforming of liquid fuels to hydrogen is an important field for FFI due to the military community's interest in power generation from military fuel (kerosene/JP-8). FFI has investigated available auxiliary power units based on diesel reforming and fuel cells for use on military vehicles. FFI also tests commercially available fuel cell systems for soldiers.



FFI Forsvarets
forskningsinstitutt

ffi.no

Commercialization

Components

R&D

Services

Portable

Stationary

Transportation

Control systems

Distribution

FC/ICE

Production

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System Integration

Flowtec AS

- Norwegian company within instrumentation, pumps and solutions
- Target areas in new development, maintenance & modification, and after market activities within the oil & gas and Hydrogen industry
- Stockist and distributor for internationally leading instrumentation and pump manufacturers (valves, fittings, tubing, regulators, pumps, level, enclosures, etc.)
- Technical Department covering engineering, design, performance, testing, documentation and delivery of control systems and cabinets
- Typical control systems; high pressure system, filling systems, local control panels, valve actuation, sampling, distribution, chemical injection, testing, boosters, HPU, pump systems, etc.
- Commissioning, service and maintenance, onshore / offshore
- Offshore expertise with deliveries of products and systems in hazardous areas to land-based systems
- Our suppliers develop products especially for the Hydrogen market
- Located with office, inventory stock and workshop at Sola, Stavanger
- High level of knowledge and experience within all level of company product segments
- Great emphasis on quality at all levels, and have implemented quality system according to the requirements of ISO 9001:2015, EPIM JQS and Achilles

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Transportation |
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| | | Distribution |
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| | | System Integration |

Fortescue Future Industries

Fortescue Future Industries (FFI) is a global green energy company committed to producing green hydrogen, containing zero carbon, from 100 per cent renewable sources. FFI is a subsidiary of the Australian company Fortescue Metals Group (one of the world's largest iron ore companies). We are decarbonising heavy industry and creating jobs globally. FFI is developing technology solutions for hard-to-decarbonise industries, while building a global portfolio of renewable energy, green hydrogen and green ammonia projects. FFI is also leading the world effort to decarbonise hard-to-abate sectors and is responsible for the proposed decarbonisation of one of the biggest resources companies in the world by 2030 – our parent company Fortescue Metals Group.

FFI has offices in all continents are developing some key regions of focus. Norway is an important location for FFI as we see an attractive potential to develop large scale green hydrogen projects. FFI recently announced the green ammonia project in Holmaneset in Bremanger municipality where we shall production in 2027 based on 300 MW capacity. FFI will continue to develop more projects and opportunities in Norway and look to become an integrated part of the industry.



ffi.com.au

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Fuella AS

Fuella is an independent development company of green ammonia projects in Norway.

At our facilities, we will produce green hydrogen through electrolysis and immediately convert it to ammonia by means of the Haber-Bosch process. This green ammonia is an excellent hydrogen carrier, as it has favorable storage and safety properties compared to pure hydrogen. Furthermore, Ammonia is already today a globally traded and transported good. The technologies for transportation and storage, as well as the regulations for handling and safety, are available and well proven.

We are committed to significantly reduce production cost of green ammonia and thereby facilitate an increasing decarbonization in different industrial sectors such as shipping, fertilizer and offshore power generation.

Our projects are scheduled to deliver increasing quantities of green ammonia over time. Starting with 100'000 t in 2025 and subsequently expand production by 100'000 t/year in 2026 and 2027 respectively, with further expansion potential at each of our locations.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Gen2 Energy

Gen2 Energy (G2E) is planning and preparing for large-scale production, sale and distribution of green H₂ produced in Norway from hydro power. The H₂ will be produced on locations near the power production and with access to deep seaports for exports. G2E is developing production sites in Mosjøen and Suldal. G2E work for using the by-products of hydrogen production (heat and oxygen) in fish farming and agricultural industries.

In the first phase, 70–80% of the H₂ produced will be exported to Northwest Europe using hydrogen container vessels. Agreements with clients in Germany, UK and Scotland give clear indications of strong offtake interest of green H₂ in Europe.

G2E is developing an intelligent “plug and play” concept that will reduce costs for the consumer and make the switch easier for the clients. To ensure safety and efficiency in the supply chain, the containers will use IOT and other instrumentations to track and survey the H₂ in the containers, and monitor the end-user’s H₂-consumption. G2E plans to have a zero-emission seaborne transportation of the containers to markets in Europe.

G2E have 14 employees. The staff is highly competent, mainly PhD and master-level. A NOK 70 million capital raise carried out in March 2021 brought in strategic owners such as Vitol, the world’s largest energy trading company, Høegh LNG and TS Invest, and gave the company a solid financial platform. G2E has no debt.

gen2energy.com



Commercialization

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Glomfjord Hydrogen AS

Production of hydrogen gas by electrolysis, localized in the Glomfjord Industrial Park, Nordland County. The production startup is scheduled to take place at the end of 2024.

The company has signed a MOU with Air Liquide, who will liquefy hydrogen gas in a plant next to the electrolysis plant.

The plan is to offer the market both compressed and liquid hydrogen.



glomfjordhydrogen.no

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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GreenH AS

GreenH AS is a Norwegian company dedicated to the development of infrastructure for production and distribution of green hydrogen. GreenH develops projects and will build, own and operate hydrogen production facilities. We aim to establish a network of hydrogen hubs with medium sized hydrogen production facilities strategically located in direct proximity of regional end-users. As such, we supply green hydrogen with no, or minimal, transportation costs and emissions.

Our customers are the maritime sector, heavy road transport and industrial buyers. GreenH is a subsidiary of Infranordic AS. Infranordic origins from transactions and capital markets and 25 years of business development, financing, construction and operating renewable energy plants.



greenh.no

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Greenstat ASA

Greenstat ASA is a company that develops, operates, and owns green hydrogen plants and industrial wind- and solar plants, primarily through its subsidiaries. Furthermore, Greenstat delivers analysis and insights into the green energy markets and develops and operates concepts for energy distribution through energy stations. Greenstat was established by Christian Michelsen Research (now a part of NORCE) in Bergen in 2015 and has since evolved to become independent with more than 1800 unique shareholders (2021).

Greenstat's purpose is to find, develop and operate hydrogen-related projects to create green growth and profitability. At the time, these include Glomfjord Hydrogen AS, Meraker Hydrogen AS, Viken Hydrogen AS, Stord Hydrogen AS and more.

Greenstat has, after working dedicated towards the hydrogen market for several years, seen an increase in inquiries related to hydrogen as an energy carrier in various sectors. Greenstat is currently in dialogue with dozens of different initiatives, all of which can result in commercial projects for green hydrogen production and supply. This applies to projects in the transport, maritime and industrial sectors.

GREENSTAT

greenstat.no

Commercialization

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H2CARRIER AS

H2Carrier is the designer and owner of a proprietary floating energy production and storage system, the P2XFloater™, an industrial-scale floating green hydrogen and green ammonia facility. The concept is based on proven floating production, storage and off-take technologies from the oil & gas industry. The design has a fully integrated electrolyser and Haber–Bosch system. H2Carrier will build, own/lease and operate a fleet of P2XFloaters™. The company has developed the P2XFloater™ concept in close co-operation with leading maritime and process engineering companies in Norway, thus building on decades of experience and competence from the oil & gas sector, the maritime industry, and the offshore wind installation industry.

h2carrier.com

Commercialization

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Pushing Performance
Since 1945

HARTING

HARTING is a family-owned German company and a world leader of manufacturing Industrial connectivity solutions. More than 75 years of experience with a great engineering innovation strength.

We deliver efficient energy saving connectivity solutions for hydrogen market. Standard components as well as custom made cable harnesses for power, signal, and data communication.

High power pcb connectivity and high-speed data transmission solutions for indoor and rugged environments.

We are engaged in various hydrogen projects including projects for ferries and coastal cargo carriers, hydrogen trucks and buses as well for stationary backup power solutions.



harting.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Hexagon Purus ASA

Hexagon Purus is a global leader of zero emission mobility solutions. We produce high-pressure Type 4 composite cylinders, hydrogen fuel systems and hydrogen distribution systems. Our offering also includes the complete vehicle systems and battery packs for fuel cell electric and battery electric vehicles.

Our type 4 composite cylinders' lightweight, corrosion resistance and long lifetime, reduce operational costs and total cost of ownership – and in sum makes them ideal for storing hydrogen.

Hexagon Purus has pioneered hydrogen fuel systems in the automotive industry and our solutions are in operation across a wide range of mobility applications, such as heavy-duty trucks, transit buses, trains, light-duty vehicles and even on a snow groomer. We are now taking our experience from the automotive industry to accelerate and develop hydrogen fuel solutions in the maritime industry. In order to serve this market, we have established an own company – Hexagon Purus Maritime AS – which purpose is to apply already existing technology into maritime use applications, either being as hydrogen fuel storage or sea transport of hydrogen.

hexagonpurus.com

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Hoerbiger Service Nordic AS

HOERBIGER – a global leader in performance defining components for reciprocating compressors. Our products, services and solutions enable our customers and partners from various industries to improve the performance and safety of their products and operations, save energy, and reduce emissions. This is how HOERBIGER enables change. For a better tomorrow.

Together with our partners, HOERBIGER is on a mission to deliver the most cost-efficient and flexible hydrogen compression package available. To allow wide use of hydrogen for mobility applications and trailer filling, equipment must be able to evolve from small demonstration projects into industrialized and efficient solutions, enabling you to meet your total cost of ownership expectations. Reciprocating compressors play a key role in reaching this goal. Together with Ariel, we have the technology to enable the most economic and reliable package for high pressure hydrogen compression.

HOERBIGER – advancing sustainability together.



[hoerbiger.com](https://www.hoerbiger.com)

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Horisont Energi AS

Horisont Energi (EURONEXT: HRGI) is a Norwegian clean energy company that will provide clean energy and carbon transport and storage services. Horisont Energi will transform water, renewable electricity and gas into clean ammonia and hydrogen and offer CO₂ transportation and storage solutions using proprietary technology, paving the way for a low carbon economy. The company was founded in 2019 and is headquartered in Sandnes, Norway.

Our mission is to accelerate the transition to carbon neutrality through pioneering projects.

Barents Blue project will be Europe's first world scale clean ammonia plant with best-in-class life-cycle carbon footprint, achieved through carbon capture in excess of 99% carbon capture and other measures. We cooperate with the Spanish ammonia specialist Ferti-beria to become a partner in the Barents Blue project.

Together with St1 Oy we are exploring possibilities to develop a green ammonia project in Finnmark. The plant is envisaged as a hybrid concept with hydrogen production from renewable electricity and other renewable energy sources.



horisontenergi.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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HOW Energy AS

Production of green hydrogen from offshore wind.

50MW wind turbine integrated with floating hydrogen/ammonia production units. Autonomous unmanned production in deep waters at remote locations. Independent of electric grid and pipelines. Minimum environmental footprint.

We have the rights to use the patented, modified Ramform hull designed to rotate around a bow mounted turret. The wind turbines are mounted on top of a balanced mast. As the hull is designed to turn towards the wind direction, there is no need of a rotating windmill 'head', allowing to harvest power from higher wind speeds. Wind turbines feed energy to the hydrogen/ammonia production. Each unit has the capacity to store up to one month of production. The produced Hydrogen / Ammonia will be collected by Tanker vessels and delivered to any shore location with facilities to offload. Designed for depths 200 – 1000 meters. Each unit can produce 4000+ tons of hydrogen per year.



how-energy.com

| HYDROGEN CHAIN | ACTIVITIES |
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H Y 2 G E N

Hy2gen

Hy2gen develops, finances, builds, and operates plants to produce green hydrogen, green ammonia, and hydrogen-based e-fuels worldwide. Currently, the company has activities in France, Germany, Norway and Canada, and the first green hydrogen will be produced later this year.

A \$200 mln funding round was completed last year, which was the world's largest private investment in green hydrogen. The investors included both strategic partners and financial investors, setting the company up for further growth and capability to develop large projects. Hy2gen has a team with deep technical knowledge and has strategic access to a global network of leading commodity traders and industries for offtake.

Norway is a key country for Hy2gen, and the company sees a large potential to decarbonize maritime and industrial sectors and export to the European market. The company is currently developing a large-scale green ammonia project in Sauda together with partners CIP and Trafigura and will continue to pursue more opportunities in Norway.

hy2gen.com

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HydePoint AS

HydePoint is providing a solution to optimize the value of offshore wind farms by allowing for large scale hydrogen production from wind power.

Offshore wind resources will become a significant source of renewable energy. However, the current onshore grids are not prepared to receive neither the large amounts of power nor the peaks expected from renewable energy sources. It will require significant and long-term infrastructure investments to allow full utilization of power from new wind resources without curtailment limiting full wind farm production.

HydePoint is an **offshore hydrogen producing substation** which can utilize wind resources efficiently and allow new wind farms to be located where the wind resources are strongest, even though the grid infrastructure is poor or missing. It is an unmanned, modularized, and industrialized platform which can be delivered both to floating or bottom fixed wind farms, and it can convert wind power fully or partly to hydrogen. If a HydePoint is connected to an onshore grid, it can also help balancing the overall power systems, and improve the total energy system utilization.



Commercialization

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HydraServ AS

Supplier of High-Quality Regulators, Fittings, Valves tubing and other process and instrumentation parts for Hydrogen applications.

Hydrogen Fuel Cell Pressure Regulators from ultra-lightweight regulators (down to 200g) and onboard vehicle regulators, to high-pressure refuelling solutions and self-closing cylinder valves, the product portfolio covers a wide range of applications on Hydrogen service. This includes the EC79 approved AUTO438 for hydrogen powered buses and trucks.

The extensive approval process put the AUTO438 through over 100,000 cycles – this equates to 10 years lifetime on a typical installation.

HydraServ

hydraserv.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Hydro Havrand

Hydro Havrand offers green hydrogen made from renewable energy to help bring the world to net-zero emissions. We develop, operate and own green hydrogen facilities, and provide our industry and energy expertise to customers within heavy industries, maritime sector and heavy transport to enable them to transition to renewable energy.

Hydro Havrand has partnership agreements in place with Hydro and with Speira, previously Hydro Rolling, which gives us access to a global network of sites with large predictable offtake and competitive power sourcing agreements. This also gives us a significant offtake platform to scale from so that we can offer green hydrogen to industries beyond these two companies' international footprint. To achieve this, we will often work with partners so that we can build projects at scale, bring together experience and capabilities to enable new value chains and drive down costs.

Hydro Havrand is an industrial venture with global ambitions, building on our owner company Hydro's 115 years of experience within renewable energy and industrial development.

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HydrogenPro AS

HydrogenPro designs and supplies customized hydrogen plants in cooperation with global partners and suppliers, all ISO 9001 certified. Hydrogenpro are being ISO 9001:2015 (QMS), 14001:2015 (EMS) and 45001:2018 (HS) Certified.

The Company was founded in 2013 by individuals with background from the electrolysis industry which was established in Telemark, Norway by Norsk Hydro in 1927. We are an experienced engineering team of leading industry experts, drawing upon unparalleled experience and expertise in the hydrogen and renewable energy industry.

Our core product is the alkaline high-pressure electrolyser. With our new electrode technology, we are able to increase the efficiency of each unit by 14 % to reach 93 % of the theoretical maximum. This is a significant step forward as the cost of electric power, depending on market prices, amounts to 70–90 % of the cost of producing hydrogen, the value of such increased efficiency equals approximately the investment cost for the entire plant in a Total Cost of Operation perspective.

The Company is targeting a production cost for green hydrogen of USD 1.2 per kg in 2022.

Hydrogen pro

hydrogen-pro.com

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Hydrogen Solutions AS

Hydrogen Solutions (HYDS) mission is development, building, operate and own facilities for production of green hydrogen and deliver distribution and bunkering facilities when needed.

HYDS will become a serious player within hydrogen production, –storage and –bunkering with a maritime specialty, but also focus on industry, building and construction and other users.

HYDS deliver a flexible and modular production facility for production of green hydrogen based on technological solutions in operation today. We partner with serious suppliers with own technology, tested and fully operational today and work together with partners to further develop technology through our projects. This opens ground-breaking opportunities for local production and consumption, enabling complete local hydrogen ecosystems – TODAY.

HYDS will have its first site for hydrogen production up and running within early 2022 and can in cooperation with our partners display several reference projects.

HYDS has secured multiple production sites and is actively participating in several tenders and project possibilities within hydrogen and hydrogen derivatives.

hyds.no



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Hynion AS

Hynion AS is an experienced Hydrogen fuel provider and possesses and has Know-How in hydrogen production and purification, as well as in design, building, certification, and operation of hydrogen refuelling stations. The company builds on experiences from the last 20 years, including world-leading projects such as HyNor, CUTE, Utsira wind/hydrogen, CEP Berlin, SHHP, NewBusFuel and H2ME. The company's management also has extensive experience establishing and operating start-up companies and years of experience in the automotive industry.

Hynion operates hydrogen stations in Sweden and Norway, where the Oslo station at Høvik outside Oslo is among the busiest hydrogen stations in Europe. The company has an ambitious plan to establish more stations for trucks and cars in the next few years.

Hynion is listed at the Oslo Stock Exchange, Euronext Growth with the ticker HYN.



hynion.com

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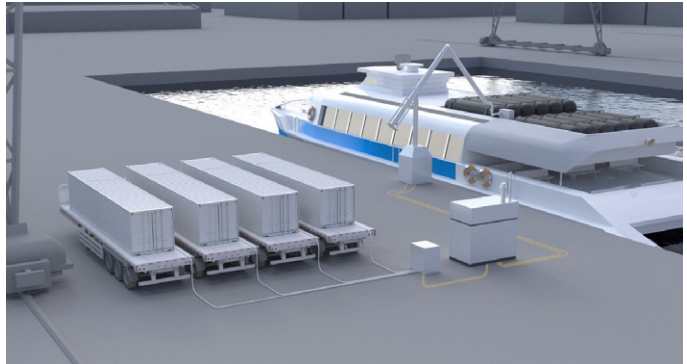
Production

Storage

System Integration

Hyon AS

Hyon is dedicated supplier of hydrogen fueling technology toward the maritime industry. Our initial focus is high flowrate solutions for compressed hydrogen.



HYON

hyon.energy

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Hyrex AS

Hyrex is revolutionizing the boating industry with cutting-edge hydrogen technology that will change the way boats are powered. Our mission is to provide boat owners with a superior boating experience that's environmentally sustainable, without compromising on performance or reliability.

With our hydrogen fuel cell range extender, boats can integrate a battery pack for short trips, providing a zero-emission, electric boating experience. Our modular setup, the HyBoost range extender, can be scaled to different sizes of boats and vessels, making our technology accessible to boat owners worldwide.

We are not just another company, we are a movement towards a cleaner, more sustainable future. At Hyrex, we are passionate about offering a way to experience the sea that's both luxurious and eco-friendly. Join us on this journey towards a brighter, more environmentally conscious future, and experience the thrill of boating with a clear conscience.

Our commitment to innovation and growth means that we are always developing new boat models and technology that take full advantage of our revolutionary system. With Hyrex, you are not just buying a boat, you are investing in a sustainable future.



hyrex.no

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Hystar

Hystar makes highly efficient PEM electrolyzers for the large-scale production of green hydrogen. Hystar's patented technology has a key role to play in decarbonizing hard-to-abate sectors and Hystar is scaling quickly to meet demand. With its game-changing technology, Hystar is a leader in achieving a greener, more sustainable future.

Located in Høvik, Norway, Hystar is building an Innovation Centre to support its R&D and manufacturing capabilities. By 2025, Hystar will install its first automated GW manufacturing facility. As a spin-off from SINTEF, a leading European research organization, Hystar has 15 years of research into PEM technology. Hystar's technology has been proven to use significantly less energy than conventional PEM electrolyzers, enabling a substantial increase in hydrogen production output.

Hystar is backed by significant global investment bodies, including AP Ventures, a major investor in breakthrough hydrogen technologies, SINTEF Ventures, the investment fund of the SINTEF research institute, Firda, a pioneering early-stage investor in Norway, as well as other notable names including Mitsubishi, Nippon Steel, Finindus, Trustbridge, and Hillhouse.



hystar.com

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Hystorsys AS

Hystorsys AS develops and manufactures hydrogen storage and compression systems based on metal hydrides (MH).

The company is based on the long-term research expertise of Institute for Energy technology (IFE), and thus possesses experience on the complete hydrogen chain from fundamental understanding of hydrogen-metal interactions to their use in hydride-based energy systems.

MH-compression:

MH-compressors enable compression of ultra-clean hydrogen without the need of a high-quality energy carrier such as electricity, exploiting heat (e.g. industrial waste-heat) for compression. Furthermore, thermal MH-compressors have a minimum of moving parts giving long maintenance intervals.

MH-storage:

One of the main advantages of MH-storage is high hydrogen density at low pressures. Some metal hydrides have volumetric storage densities higher than liquid hydrogen, without the need of maintaining a low (20 K) temperature. In the MH-system hydrogen is chemically bound – thus, not volatile or mortgaged with boil-off. The MH-system eliminates the need for expensive high-pressure compression, and has the property of an intrinsic safe system.

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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| | | Commercialization |
| | | Components |
| | | R&D |
| | | Services |
| | | Portable |
| | | Stationary |
| | | Transportation |
| | | Control systems |
| | | Distribution |
| | | FC/ICE |
| | | Production |
| | | Storage |
| | | System Integration |

Hyundai Motor Norway AS

Hyundai Motor Company is one of the world's largest automotive manufacturers, and a leader in future mobility technologies. In Norway, the company has around 60 dealers, and is firmly established as one on the largest car brands in the Norwegian market. Hyundai has a unique position in low and zero emission powertrains both globally and locally, and was on January 1st 2021 the first major brand to shift completely to chargeable, electric and hydrogen electric vehicles in the Norwegian market. Hyundai Motor Norway (HMN) is a part of Hyundai Motor Company, and a spearhead for electric vehicle sales. HMN's head office at Alna in Oslo has a staff consisting of 30 people. During the last years, Hyundai have built a strong reputation for zero emission vehicles, and the company aims to be among the top zero emission vehicle providers in the world. This includes mobility in a wide sense of the word, from a metauniverse, via cars, busses and trucks, to Urban Air Mobility (UAM). All with a leadership on zero emission technologies, in an aim to create progress for humanity. Hyundai has achieved some of the most important hydrogen milestones in FCEV history. The company was the first manufacturer to mass produce an FCEV, the ix35 Fuel Cell, starting in 2013, and continued the leading position with the introduction of NEXO in 2018. Since then, Hyundai has commercialized FCEV trucks in the Swiss market, and are expanding the operations to new countries and through new companies. By 2030, Hyundai plans to build 700.000 FCEV systems annually, which can be utilized in everything from cars, to trucks, heavy machinery and ships.



hyundai.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Transportation |
| | | Control systems |
| | | Distribution |
| | | FC/ICE |
| | | Production |
| HYDROGEN CHAIN | | Storage |
| | | System Integration |

Haakon Ellingsen AS

Haakon Ellingsen AS delivers a wide range of quality products within valves, actuation, filtration, and instrumentation. We supply fully assembled and tested solutions for pneumatic, electric, and hydraulic systems. We perform installation, maintenance, and service of all our products.

Haakon Ellingsen AS has offices and workshop facilities in Oslo, Bergen and Stavanger and our main markets are oil & gas, marine and general industry. Our product portfolio consists of a combination of self-produced products and products produced by our international partners.

Hydrogen is one important part of Haakon Ellingsen AS future strategy to expand our business into green energy and we are working close with our partners to develop products along the complete value chain. Filtration, level indication and valve systems are important products needed for different type of applications in the hydrogen chain. Our products are used for in production as well as utility systems.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| APPLICATION | | Services |
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| HYDROGEN CHAIN | | Transportation |
| | | Control systems |
| | | Distribution |
| | | FC/ICE |
| | | Production |
| HYDROGEN CHAIN | | Storage |
| | | System Integration |

Håland Instrumentering AS

Håland Instrumentering AS was founded in 1999. All employees are trained and experienced within their fields. We are a group of highly qualified engineers with many years of experience within field instrumentation, fire & gas detection and valves, both manual and actuated. Our goal is to share our product competence, experience and knowledge of the market with our customers.

Several of our manufacturers have extensive experience with their products in the hydrogen market.

Rheonik has a long history as a supplier of mass flowmeters for H₂, MSA can provide several principles of flame & gas detection for H₂, and we also have valves intended for use within hydrogen applications, including instrument valves and control valves.

In addition to this, Håland Instrumenting supply an extensive range of instruments and valves required for the continuous and safe operation of process plants.



| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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IFE – Institute for Energy Technology

IFE is an independent research foundation that has been involved in research on hydrogen for more than 70 years. The research at IFE is based on experimental activities and supported by advanced modelling. The main research focus is on hydrogen production by sorption enhanced reforming and water electrolysis (alkaline and PEM), hydrogen storage in metal hydrides, fuel cells (PEM) and hydrogen energy system analysis. IFE also specialize in other areas relevant for hydrogen: Multiphase flow, liquefaction and cooling technology, material integrity, hydrogen embrittlement, instrumentation and level monitoring, man-machine, risk and safety.

IFE also do research related to ammonia production and cracking and large-scale underground storage of hydrogen. As a leading research institutes in Norway on batteries, wind and solar power IFE also has have in depth competence on renewable energy and hydrogen system integration and optimization. IFE work in depth on the material side to increase safety, sustainability, energy efficiency and to reduce investments and operation cost of within the hydrogen value chain. IFE is the host for FME MoZEEES, a national research on environment-friendly research with focus on zero emission energy systems for transport using battery and hydrogen technology (mozees.no). Using several relevant national research infrastructures.

ife.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Control systems |
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Industri Energi

Industri Energi is a national union under the trade union confederacy LO. We have 56000 members within the oil and gas industry, pharmaceutical industry, aluminium and other chemical and metal producing industries. Industri Energi is the largest union in some of the largest Norwegian companies like Equinor, Hydro, Yara, and Ekornes.

Norsk Hydro started hydrogen production in Norway in 1927, we have organised the workers in hydrogen production in Norway from the very start. Industri Energi organises the operators working in present-day hydrogen companies. Our policy is that hydrogen and ammonia is critical to make the necessary steps towards a green future. Both to transform the petroleum sector and to reach the next milestones in making our other sectors climate neutral and carbon negative.

Industri Energi is working actively towards policymakers and the government to ensure that hydrogen gets the necessary framework to be competitive in Norway on a global scale. We do this in the culture for collaboration and teamwork that we call «The Norwegian model». Where the government, the representatives of the workers and of the companies working together.



industrienergi.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| | | System Integration |



J.S.Cock AS

J.S.Cock has been supplying valves, actuators and instrumentation to the Norwegian offshore industry since the early 1970s and valves in general since 1897. Our vision for the future is to provide the same range of products to the hydrogen industry and become a preferred supplier.

Our company already represents several manufacturers who have been heavily investing in developing products for the hydrogen industry for many years. Based on our own experience in supplying products and knowledge to a demanding industry with high expectations to quality, we are confident that we will also become a first-class supplier to the fast-growing hydrogen industry.

Currently, we can supply a wide range of control valves and on/off valves in all types of materials and pressure classes. Our valves are fire-tested and certified, and cryogenic performance and functionality are type-approved by well-known certifying bodies. Cryogenic testing can be performed in-house without any size limitation and down to -196°C.

We can also offer a wide range of instrumentation to the hydrogen industry. This includes everything from flow, pressure, level and temperature to pH, oxygen, conductivity, viscosity and turbidity measurements.

jsc.no

Commercialization

Components

R&D

Services

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Control systems

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JUMO AS

On the safe side with JUMO

Many sophisticated systems are being developed for the clean energy world around hydrogen. These range from electrolyzers, storage and transport systems to fuel cells and synthesis plants. All these systems have one thing in common: In order for them to be operated safely and stably, modern sensors are required to monitor and measure pressure, temperature, level, and conductivity. JUMO has over 70 years of extensive experience in this field, which we are happy to share with you.

jumo.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Control systems |
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Justervesenet – Norwegian Metrology Service

Justervesenet is the National Metrology Institute of Norway, ensuring global acceptance of Norwegian measurements, providing metrology services and R&D. Justervesenet is also the national regulator for metrology and a notified body for MID and NAWI directives in Norway. Justervesenet works to ensure sufficient traceability and accuracy of hydrogen measurements in the Norwegian industry and society. This traceability is ensured by new metrological solutions, including a newly developed gravimetric primary standard for verifying light-duty hydrogen refueling stations.

Justervesenet continues to be an active participant in two ongoing and one approved research projects aiming to increase the Norwegian measurement capabilities within hydrogen. The projects are financed through EURAMET – the European Association of National Metrology Institutes and their associated research programs, including the current European Partnership on Metrology. The projects are aimed at specific hydrogen applications (light and heavy-duty hydrogen vehicles), new technologies for hydrogen measurements (sonic nozzle technology) and in ensuring traceability for the entire European hydrogen value chain.

Justervesenet is a leading expert in hydrogen measurement in Northern Europe, and is an independent source of metrological expertise available to all interested parties in both Norway and elsewhere.

Justervesenet



justervesenet.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Kunnskapsbyen Centre of Innovation

Kunnskapsbyen Centre of Innovation connects cutting edge research from local research institutions, visionary energy companies and progressive local environmental policies, and facilitates public-private projects – which are locally beneficial, but also an integral part of both national and international hydrogen projects.

Kunnskapsbyen Centre of Innovation is co-located with the secretariat of The Norwegian Hydrogen Forum. We are also a partner with the Nordic national hydrogens associations in the Next Wave project on Hydrogen infrastructure for trucks and busses, financed by the Nordic Council of Ministers through Nordic Innovation. Kunnskapsbyen Centre of Innovation is the Norwegian lead partner of the Interreg project Cleancon – Clean Construction Machinery.



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Lhyfe

A Sustainable company – Lhyfe is an innovative company founded in 2017 with its headquarters in Nantes, France. The vision behind the company is to change things today, not tomorrow for the future of our children and grandchildren.

Lhyfe invests in, develops, constructs and operates innovative hydrogen production plants using renewable electricity to produce at industrial scale with a positive impact. The first onshore plant was inaugurated Sept-2021 and the first offshore plant will be in operation Sept-2022. Lhyfe is active in many European countries with a team of 80 people, with a growth to 160 people by the end of 2022.

Lhyfe is developing a unique hydrogen production know-how:

- **Renewable and sustainable Solution:** designed to be directly connected to renewable and intermittent energy sources.
- **Modular Solution:** plants designed in a modular way integrating the best technologies on the market.
- **Flexible Solution:** architecture and control system designed for flexible and intermittent operation of the entire system for optimal efficiency.
- **Intelligent Solution:** Our unique control system integrates flexible production, logistics/offtake. The system is data-based and is continuously improving.
- **Optimized financial solution:** internalized competences in project financing as well as optimizing support, to propose the lowest renewable hydrogen cost.

lhyfe.com



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Linde Gas AS

At Linde, we have been harnessing the power of hydrogen for over 100 years, and clean hydrogen is a cornerstone of our clean energy strategy. Hydrogen has been one of our fastest growing molecules for the past 10 years, and today we generate around USD 3 billion per year of global revenue through our hydrogen activities.

Linde offers technology and expertise throughout the whole hydrogen value chain; Electrolysis for green hydrogen production, cutting-edge fueling technologies for the mobility and marine sector, carbon capture technology for use and storage, hydrogen liquefaction technology for storage and transport, hydrogen pipeline services and storage of hydrogen in underground salt caverns as examples.

To continue our growth, we will use our integrated asset network, execute locally driven and focused strategies, and continue to advance and grow our technology leadership across the value chain. In addition, we are actively identifying and developing collaborations to accelerate opportunities.



Making our world more productive

linde.com

| HYDROGEN CHAIN | ACTIVITIES |
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Litra AS

Established in 1917, and with over 100 years experience, Litra group still reach for the best of quality and security in the transport market.

We operate primarily in the Scandinavian market, and offer the market transport of food / thermo goods , energy and industrial gases, and dry/wet bulk products, and we are specialized in dangerous goods.

In the Litra Group there are several high recognized daughter companies, and our strength is high quality, high safety level, large volumes, specially adapted solutions, and finding sustainable solutions.

We currently have over 320 heavy trucks with a total weight of 50–60 tonnes, of which 40 of these trucks use biogas as fuel.

Our activity generate over 38 mill km every year, and our goal is to strongly reduce our emissions, and we are absolutely certain that hydrogen will be an important part of achieving this goal.



litra.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Meraker Hydrogen

Meraker Hydrogen is a private company based in Kopperå, Norway. The core business is the production of green hydrogen from available local hydropower. The hydrogen production will be produced, on the formerly known microsilica plant Elkem Meraker, which has a history back to 1898. The planned hydrogen plant is located close to the Swedish border and 1hr east by car of Trondheim. The plant's location can utilize the largely available hydropower and reduce the transmission losses related to the power lines to end-market.

Meraker Hydrogen is owned by large industrial owners such as NTE, Greenstat, Gen2 Energy, Aker Clean Hydrogen, and local investors. All owners are active players in hydrogen projects and bring valuable expertise to Meraker Hydrogen.

The main market for Meraker Hydrogen is the regional market in both Norway and Sweden in market segments such as transport, industry, railway, and maritime. In addition, Meraker Hydrogen is active in helping businesses accelerate their zero-emission initiatives and taking an active role in the region in facilitating the green shift.



merakerhydrogen.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Nel ASA

Nel is a leading, pure play hydrogen technology company with a global footprint; delivering optimal solutions to produce, store and distribute hydrogen from renewable energy. Our roots date back to 1927, and since then, we have had a proud history of development of hydrogen technologies. We serve a range of different customers and we continuously improve the product offering to maintain our leadership position and remain at the forefront of the development. Today, our hydrogen solutions cover the entire value chain from hydrogen production technologies (Alkaline and PEM electrolyzers) to hydrogen fueling stations.

Nel is currently the world's largest manufacturer of electrolyser equipment, with more than 3500 systems delivered in more than 80 countries across the world. Nel is unique in that it offers both Alkaline and PEM electrolyser technology, with attractive product offerings on both platforms. Our electrolyzers are recognized for their high efficiency, reliability, robustness and low cost.

Nel is also a leading manufacturer of hydrogen fueling station equipment with more than 110 stations delivered/in progress in 13 different countries. We have an attractive offering of compact, pre-certified equipment covering light duty vehicles, whilst developing a number of components geared towards improving our offering further towards heavy duty vehicles.

nelhydrogen.com

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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NORCE Norwegian Research Centre AS

NORCE is one of Norway's leading research institutes. We are present along the entire Norwegian coast, and conduct interdisciplinary research for both public and private sectors. Our researchers focus on how to enable and speed up the green energy transition with hydrogen as one of the key components. We help stakeholders with the insight, modelling and monitoring needed to understand, validate and make informed decisions on viable developments and investments within hydrogen.

NORCE hosts a centre for hydrogen value chain research called HyValue. The centre is a collaboration between more than 50 partners from research, industry and public sector. HyValue are looking at hydrogen production, distribution, use, regulations, safety, and commercialization. We aim for safer, greener and more efficient hydrogen production that both industry and society can trust. NORCE core hydrogen business is applied research in the following topical areas:

- Microbial hydrogen production
- Geological storage of hydrogen
- Distribution and metering of hydrogen
- Hydrogen for maritime transport
- Industrial use of hydrogen
- Hydrogen in the energy system
- Microbial use of hydrogen and fermentation
- Public acceptance and social embeddedness of hydrogen technologies

norceresearch.no



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Nordic Energy Research

Phasing out of fossil fuels and feedstocks in the transport sectors and industries is an important prerequisite for fulfilling the Nordic ambition to become carbon neutral by 2050. New alternative fuels must be produced and distributed to end-users on an unprecedented scale.

Nordic Energy Research is the platform for cooperative energy research and policy development under the auspices of the Nordic Council of Ministers. Funding of joint Nordic research project into alternative fuels (hydrogen, ammonia, and e-fuels). Special focus on maritime fuels. Initiate energy – analysis and scenario work related to energy and climate.



**Nordic Energy
Research**

nordicenergy.org

Commercialization
Components
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Nordkraft

Nordkraft is developing sites for power intensive industries in Northern Norway, including sites suitable for hydrogen production. Our aim is to offer ready-to-build sites and to be a facilitating partner within regional, power and site specific matters. Several of our sites are well suited for hydrogen (or ammonia production), offering good logistics with closeness to harbour facilities and process water.

All of our sites are situated next to strong grid connection points with available power capacity. The sites are located in Northern Norway, which has the lowest estimated power prices in addition to the lowest grid fees in Norway.



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Norwegian Hydrogen AS

Norwegian Hydrogen drives the green transition through the development and operation of green hydrogen infrastructure, aimed primarily towards heavy-duty transport and maritime customer segments. We will provide infrastructure including production facilities, distribution systems and a wide network of filling and bunkering stations.

With strong industrial owners such as Flakk Group, Tafjord Kraft, Hofseth International and Hexagon Purus, all taking leading roles in sustainable development, Norwegian Hydrogen are a large hydrogen player in the Nordics.

One of the subsidiaries, Vireon, is the leading hydrogen refueler in the Nordics for heavy-duty trucks. Vireon growth strategy includes both organic expansion and mergers and acquisitions.

Norwegian Hydrogen have several ongoing projects and activities. Hellesylt Hydrogen Hub, with a daily production of up to 1,3 tons of hydrogen a day, will be the largest producer of green hydrogen in Norway when it opens production in Q4 2023.



norwegianhydrogen.com

Commercialization
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**NTE**

NTE is a renewable energy producer located in Trøndelag. We aim to develop, build, own and operate large scale hydrogen production facilities in Norway.

nte.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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NTNU – Team Hydrogen

NTNU Team Hydrogen, founded by Professor Bruno G. Pollet and now led by Professor Nicola Paltrinieri, is a team of world experts on Hydrogen energy. The team consists of professors and researchers from different disciplines, departments and faculties across NTNU that works within the Hydrogen R&D value chain, from the development of materials and systems (mobility and stationary), to hydrogen health & safety, life cycle analysis and technico-economic assessments. NTNU has excellent state-of-the-art hydrogen, fuel cell and electrochemical laboratories as well as cleanrooms for micro- and nanofabrication and ex-situ physical characterization techniques.

We are also educating and training research leaders, innovating, providing solutions and stimulating the industry. NTNU Team Hydrogen works in line with NTNU's vision: Knowledge for a better world, the Norwegian and European Hydrogen Strategies and the United Nation's 17 Sustainable Development Goals.



ntnu.edu/energy/hydrogen

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Norwegian Maritime Authority (NMA)

The Norwegian Maritime Authority (NMA) is the administrative and supervisory authority in matters related to safety of life, health, material values and the environment on vessels flying the Norwegian flag and foreign ships in Norwegian waters. The NMA is subordinate to the Ministry of Trade, Industry and Fisheries and the Ministry of Climate and Environment. Our activities are governed by national and international legislation, agreements and political decisions.

Hydrogen could play an important role in the green shift. It is important for the NMA to be involved when new technology is developed, in order to ensure that the technology is safe, reliable and ready for marine use. Hydrogen challenges existing prescriptive regulations, and vessels fuelled by hydrogen will therefore need approval through a risk based design approval process.

The NMA is a visible and recognised participant in the international maritime regulatory work. The NMA will, together with the industry, contribute to making Norwegian innovation and solutions the standard in the international maritime regulatory work.

Norwegian Small Hydropower Association

The Norwegian Small Hydropower Association is the national organization for companies who build and operate small hydropower stations. Since year 2000 there has been built 750 such plants scattered all over the country where you will also find good potential for H₂-consumption and customers. Each of these new plants have an installed effect beneath 10 MW and all together they represent a yearly production of 5 TWh.

The small hydro industry consists mainly of entrepreneurs who are searching for new business opportunities. That's probably why our association is the first player among Norwegian organizations for electricity producers who has started to work systematically with exploring H₂ production as a new business area for its members. Among other projects we also have a R&D-project running over three years with the The Norwegian Water Resources and Energy Directorate.

Our main focus is how hydrogen can play a role in improving the Norwegian power system. We are looking into how the grids problems with peaks in consumption, capacity constraints and production can be reduced and thereby also downsize the need for grid investments. From the electricity producers point of view hydrogen production can generate added values in periods with low prices and high production.

Commercialization

Components

R&D

Services

Portable

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System Integration

Otechos AS

Innovative Norwegian company developed new technology positive displacement machines

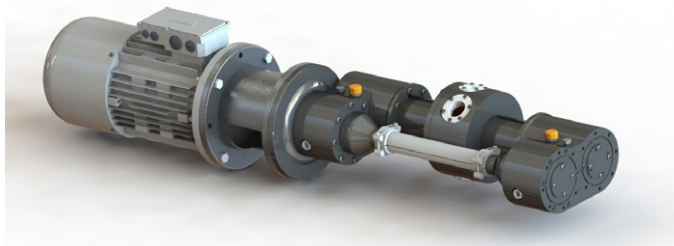
OTECHOS HYDROGEN COMPRESSION

Challenge: To reduce losses when using Hydrogen as energy carrier.

The Solution: OTECHOS CRCP Compressor has proven to be up to 65% more energy effective than existing technologies.

OTECHOS

- Increasing Hydrogen Efficiency by Increasing Compressor Efficiency

**OTECHOS**otechos.com

Commercialization

Components

R&D

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System Integration

Parker Hannifin

Global key component supplier – sealing/shielding, filtration, water production/separation, nitrogen generation, dryers, sensors, coolers, piping & fluid connectors, instrumentation



parker.com

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Renewables Norway

Renewables Norway is a non-profit industry organization representing 400 companies involved in the production, distribution and trading of renewable electricity and heat in Norway. Norwegian power production is almost 100% renewable and emission-free. 95% of the power production stems from the 1600 hydropower plants, and 3.5% is generated from wind power.

Renewables Norway is working actively to improve the regulatory framework in which our member companies operate, both in Norway and in Europe. We are a member of Nordenergi, Eurelectric and Wind Europe. We aim to increase competence and promote the competitiveness of the Norwegian renewable industry for green value creation.

Renewables Norway values hydrogen as an important energy carrier for the renewable and all electric society. Several of our member companies are involved in ongoing and planned projects for production of green hydrogen for industrial applications, maritime transport and as an alternative to power grid investments.

Renewables Norway coordinates and manages R&D projects funded by power- and network companies and by The Research Council of Norway.

Commercialization

Components

R&D

Services

Portable

Stationary

Transportation

Control systems

Distribution

FC/ICE

Production

Storage

System Integration

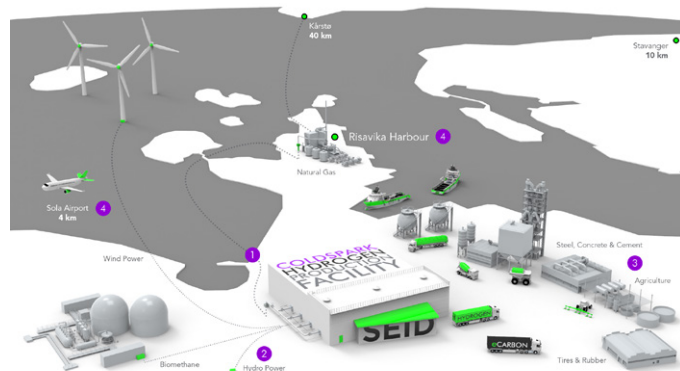
SEID AS

Cold Methane Pyrolysis for ultra-low carbon Hydrogen and solid carbon.

Feedstock natural / biogas

Production cost: Approx 15 kWh kg H₂

Modular systems 500-1000-1500 kg day



seid.no



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
| | | Components |
| | | R&D |
| | | Services |
| APPLICATION | | Portable |
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| | | Transportation |
| HYDROGEN CHAIN | | Control systems |
| | | Distribution |
| | | FC/ICE |
| | | Production |
| | | Storage |
| | | System Integration |

SINTEF AS

SINTEF is Scandinavia's largest independent contract research organization. SINTEF develops and implements technological solutions in society and thereby creates value through knowledge generation, research and innovation.

SINTEF is a leading R&D and innovation actor in Europe within hydrogen technologies, with more than 30 years' experience and significant activities. Through participation in European projects with total budget of 300 M€ over the last decade, SINTEF has built leading competence in key hydrogen areas.

SINTEF's hydrogen projects include:

- Hydrogen production from natural gas & renewable energy sources
- Membrane technologies for hydrogen separation
- Hydrogen quality analysis and standards
- Hydrogen liquefaction and storage
- Fuel cell & electrolyser materials development
- System and component testing and validation
- Hydrogen combustion (gas turbines)
- Modelling from micro to macro level
- Well-to-wheel analyses, LCA and feasibility studies
- Safety, societal and political aspects
- Techno-economic and value chain analysis
- Business models and decision support services

Commercialization
Components
R&D
Services

Portable
Stationary
Transportation

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A/S Norske Shell

Shell is a global energy company with a 110 year long history in Norway. Looking back at many decades of experience with complex developments, technology projects and safe and reliable operations, Norske Shell now powers progress towards a better energy future. As a stable and reliable energy provider to Europe we are producing our natural gas in the safest, cleanest and most efficient way. We are also using our competence from oil and gas to realise more carbon capture and storage and create new opportunities in renewables and cleaner energy solutions.

Shell aims to help build a global hydrogen economy by developing opportunities to produce, store, transport, and deliver hydrogen to end customers. Currently, Shell owns and operates around 10 per cent of the global capacity of installed hydrogen electrolyzers and have started building Holland Hydrogen I, which will be Europe's largest renewable hydrogen plant when it enters operation in 2025. Shell sees a potential in hydrogen production in Norway with export to a growing European market, and we are currently pursuing several large-scale opportunities both in green and blue hydrogen.

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES |
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| | | Production |
| | | Storage |
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Skagerak Energi AS

Skagerak Energi is entering into the hydrogen area as a natural step for evolving the renewable Energy Group with today's core activities of hydropower, grid connection and district heating. Skagerak Energi is also heavily involved in the biomethane industry with Air Liquide Skagerak.

Skagerak Energi is involved in several hydrogen activities for industrial, maritime and land transport applications. The primary goal is to develop a market for hydrogen as part of a greener future.

With Skagerak Energi's position next to some of the largest industrial sites in Norway (Grenland) consisting of Herøya Industripark, Rafnes and Frier Vest, the placing is ideal to develop a hydrogen market related to these sites. Grenland is the area with the largest consume of hydrogen in Norway today.

Grenland Havn is the third busiest harbour in Norway with a lot of international and national maritime traffic to its several terminals.

Production, storage, and distribution will be the primary goal in the hydrogen value chain for Skagerak Energi.

Skagerak Energi also developing Mobile Energy solutions for various applications and hydrogen is a part of this development.

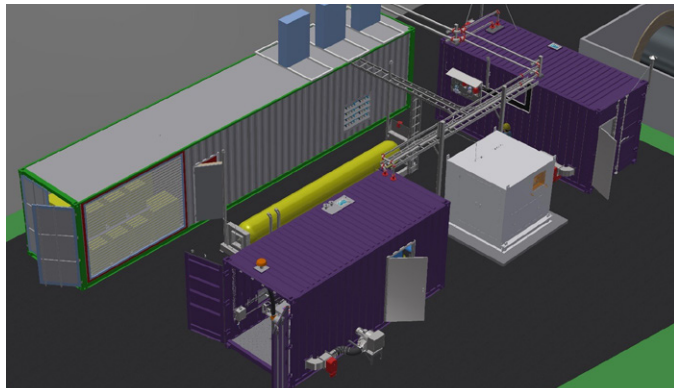


skagerakenergi.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Control systems |
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Slåttland Group AS

Engineering and fabrication of different mechanical process solutions. Member of Deep Purple hydrogen consortium for development and engineering of mechanical concept.



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Statkraft AS

Statkraft, the largest producer and trader of renewable power in Europe, have a strategy to be a producer and supplier of green hydrogen to industry and transport.

Green hydrogen will be an integrated part of the new energy market and support the hydro-, wind-, and solar- power development.

Statkraft will also be involved in other energy products like ammonia and methanol as long as renewable power and green hydrogen is the basis. In most projects Statkraft will seek partners to strengthen the business case.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Control systems |
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Swagelok Norway

Swagelok Norway

Swagelok Norway (SVAFAS Stavanger Valve & Fitting AS) has been an authorized Swagelok sales and service center since 1975, providing solutions for all fluid systems within Norwegian industry.

Systems for applications involving the storage, transfer, and use of hydrogen requires components with advanced performance capabilities. It also requires a strong understanding of materials science, fluid system design best practices, and industry certifications, standards, and approval processes.

Swagelok Norway actively supports companies developing hydrogen technologies by providing the fluid system expertise and deep understanding of application requirements they need to compete effectively in a performance-driven, safety-focused market. Our stainless-steel components are designed to deliver the seal tightness, grip strength, thermal performance, corrosion resistance, ductility, and ease of assembly needed to make hydrogen vehicles and infrastructure viable.

Swagelok Norway can also provide the support needed to overcome design challenges, select components, and troubleshoot issues while developing fuel storage, transportation, and delivery systems. We also design and assemble subsystems and assemblies built to customers exact specifications, ready to be installed. Furthermore, we offer training on fluid system best practices, trends and technology, installation, and safety.

stavanger.swagelok.com/en

Commercialization
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TECO 2030 ASA

TECO 2030 is building up Europe's first Giga production facility of hydrogen PEM fuel cell stacks and modules in Narvik, Norway. The production capacity will be built up through 2023 and early 2024, targeting an output capacity of 120 MW of fuel cells in 2024, 400 MW in 2025 and 1.6 GW in 2030.

TECO 2030 is a Norwegian based clean tech company developing zero-emission technology for the maritime and heavy industry. We are developing PEM hydrogen fuel cell stacks and PEM hydrogen fuel cell modules, that enable ships and other heavy-duty applications to become emissions-free. The company is listed on Euronext Growth on Oslo Stock Exchange under the ticker TECO and in New York, OTCQX under the ticker TECFF. TECO2030 is a spinoff from TECO Maritime Group, a group that has provided technology and services to the global shipping industry since 1994. For more information, please visit teco2030.no.



teco2030.no

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| APPLICATION | | Services |
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THEMA Consulting Group

THEMA has established itself as a sought-after group of expert advisors for the renewable energy sector. We deliver a range of services, from forecasts and models, strategical and socioeconomic analysis as well as management consultancy both in the Nordic market and in Europe. From the start, the core of our expertise has been an in-depth knowledge of, and long experience with the challenges and issues facing the power industry. Along the way, our knowledge of how the renewable energy sector and power markets work has become increasingly valuable in a variety of other areas.

We actively monitor hydrogen developments, both those related to the market and the associated technology. Using our power market model, we can simulate the market value and consequences of hydrogen's use in the future power system. In our technology report, we map the past, current and future status of hydrogen technology across the entire value chain, covering production, transport, storage and distribution.

We build on this foundation of knowledge to aid actors in facing a variety of challenges. With a strong and versatile team, we are ready to assist our clients with in-depth analysis and sound strategic advice spanning the entire hydrogen value chain.



thema.no

Commercialization

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Toyota Norge AS

Toyota Norge is a subsidiary of Toyota Motor Europe, and is responsible for the marketing and sales of their second generation Mirai Fuel Cell Electric vehicle and promotion of the hydrogen society. Toyota Fuel cells are also used in buses, trucks, ships, trains and generators, and Toyota intends to offer their components to third-parties in building hydrogen ecosystems.

toyota.no/mirai

Umo Advanced Composites AS

Umo Advanced Composites (UAC) is the leading global supplier of large fibre glass type IV pressure vessels and modules for containment, storage and transportation of Hydrogen on land-based and maritime applications. We are breaking new ground by offering safe and price-competitive solutions for optimal containment, storage and transportation of larger volumes of Hydrogen, challenging traditional steel and carbon fibre alternatives.

Competitive advantage developed from 15 years of know-how in glass fibre vessel manufacturing, R&D and close collaboration with global customers and suppliers. UAC products are in daily use world wide by our top tier customers.

UAC deliver plug&play ready modules in different sizes, highly customized, ensuring high-performance utilization with excellent fatigue properties and durable lifetime. Enabling optimized balance between product performance, CAPEX and OPEX.

Ultimate safety is granted both by the material properties of the fibre glass pressure vessels and by the structural design of our modules. We subject our products to stringent fire, fatigue, stress rupture, burst, impact and proof tests. The composite materials in the Type IV pressure vessels have lightweight, very robust, non-toxic and non-corrosive properties, elimination risk of galvanic oxidation and wide temperature tolerances.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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The University of Oslo (UiO)

The University of Oslo (UiO) offers studies at Bachelor, Masters and PhD levels in disciplines relevant to hydrogen technology; physics, chemistry, materials science, and technology systems, as well as supporting areas like mathematics, informatics, statistics/risk analysis, law, and social sciences. The materials science programs provide knowledge and training within renewable energy technologies, among these hydrogen. There are several strong and relevant activities at UiO for hydrogen technologies organized within Centre for Materials Science and Nanotechnology (SMN) with participating groups from the Departments of Physics and Chemistry. Topics include petroleum chemistry and catalysis; solid electrolytes and materials for gas separation membranes, fuel cells and electrolyzers; hydrogen storage materials; semiconductors for solar energy conversion; high temperature sensors; and fundamental research in materials science and nanotechnology. UiO partakes in a number of national and international projects within or related to hydrogen technology.

The University of Oslo commercializes its research and has founded spin-off companies through its technology transfer partner Inven2.

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University of South-Eastern Norway (USN)

University of South-Eastern Norway (USN-TNM-PEM) does research and education on hydrogen technology (BSc. / MSc. / Ph.D.) within hydrogen safety and process technology. We focus on physical effects, pre-normative research, and the safe design of hydrogen systems. USNs research is theoretical and experimental, with laboratory and field facilities for studying the impact of explosions and hydrogen behavior. We are developing tools for predicting physical effects based on experimental results. We are a member of HySafe, IEA Hydrogen Safety, IDERS – The Institute for Dynamics of Explosions and Reactive Systems.

Projects:

- FME MoZEES (NFR, 2017-2025)
- FME HYDROGENi (NFR, 2022-2030)
- HyTunnel-CS (EU, 2018-2022)
- Pre-normative Hydrogen safety in tunnels and confined spaces
- HyRESPONDER (EU, 2020-2023)
- H2Konstabel (NFR, 2022-2024)
- HySchool (Researcher school, 2022-2030)
- Gen2Energy (RFF, 2021-2022)
- H2Maritime (NFR, 2018-2022)
- Maritime hydrogen
- H2NOR (IN, 2021-2024)
- Safe maritime FCs
- HyLOCD (NFR, 2021-2024)
- SH2ift2 (NFR, 2021-2025)
- Safe use of hydrogen
- Green Platform (Technip Norge) Subsea storage
- Green Platform (Wärtsilä Gas Solutions) Ammonia



University of
South-Eastern Norway

usn.no

Commercialization

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Varanger KraftHydrogen AS

Producer of Green Hydrogen. Established H₂ plant in Berlevåg. From Q1 2024 delivery of compressed hydrogen to end-user.



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Transportation |
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Viken Hydrogen AS

Viken Hydrogen aims to be the most competitive supplier of green hydrogen in our region. Our core competence is to develop, construct and operate hydrogen plants. The company is owned by Akershus Energi, Greenstat, and Østfold Energi.

Our ambition is to increase the pace of the hydrogen value chain development and by that contributing to the decarbonisation of fossil-based industry, heavy duty and maritime transport, construction sites, etc. in our region.

We aim to develop our business through industrial long-term partnerships and welcome you to contact us to explore opportunities Viken Hydrogen AS for cooperation.



vikenhydrogen.no

Commercialization

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Western Norway University of Applied Sciences (HVL)



Western Norway
University of
Applied Sciences

At HVL we have a strong focus on education and continual education in hydrogen technology, covering technical, environmental and economical aspects of the entire hydrogen value chain. We also do applied and fundamental research on selected hydrogen technology topics such as hydrogen production, and are currently establishing HVL HydrogenLab.



hvl.no

Westgass Hydrogen AS

Westgass Hydrogen is a green energy company focused on accelerating the transition from fossil fuels in Europe and emerging markets. We will enable customers to run carbon neutral businesses by 2030.

Our purpose is to supply affordable and easily accessible green hydrogen and green ammonia, leveraging our experience, expertise and network in the energy sector.

We are fuelling the energy transition with green hydrogen by

- Building a distribution and sales network of green hydrogen across Norway
- Providing clients in the mobility sector high pressure refilling and off-grid fast charging
- Delivering off-grid power to replace high capacity diesel generators

We are safeguarding our climate with green ammonia by

- Developing green ammonia facilities in emerging markets for local fertilizer production
- Delivering zero carbon electricity to rural communities through green hydrogen fuel cells
- Supplying industries in Europe with clean feedstock

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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| HYDROGEN CHAIN | | Transportation |
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| | | System Integration |

Worley Origo Process AS

Worley Origo Process consists of 16 process engineers with broad experience that spans from basic research and technology development to practical challenges, engineering, process safety and process simulations. Since 2002, quality and job satisfaction have been central values to establish a strong in-house professional environment.

Process competence is supplied to hydrogen companies with a high degree of flexibility. Examples of deliverables are listed below.

- Facilitate hazard and operability studies (HAZOP) and design reviews.
- Assist in the development of hydrogen production plants, i.e., mass and energy balances, process simulations, process safety evaluations and engineering.
- Assist with technology development and research.

Process engineers working with Worley Origo Process have PhD or MSc degrees within the fields of chemical engineering or chemistry. Projects are performed in own offices in Stavanger, or by working full or part-time as consultants in the customers' office.

The Australian Worley concern consists of 48,000 of the world's brightest minds in energy, chemicals and resources, all working to deliver a more sustainable world.

Commercialization

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Yara Clean Ammonia

Yara Clean Ammonia

Building on its long experience and leading position within global ammonia production, logistics and trade, Yara has recently established the Yara Clean Ammonia (YCA) unit. Yara Clean Ammonia will enable climate smart agriculture, based on "green fertilizers" and Yara's farming solutions, capture growth opportunities in emission-free fuel for shipping and power, and deliver clean ammonia for industrial applications.

Yara is uniquely positioned to enable the hydrogen economy in a market expected to grow by 60 percent over the next two decades.

Yara Clean Ammonia is supported by 17 production units, operates 11 ships and 18 ammonia terminals across the world. Yara Clean Ammonia is headquartered in Oslo, Norway.

yara-cleanammonia.com

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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ZEG Power AS

ZEG delivers solutions for clean hydrogen production using the novel ZEG ICC™ Technology. The uniqueness of the technology:

- Captures the CO₂ inside the reformer where the CO₂ concentration is the highest
- Enables high CO₂ capture rate, increased hydrogen yield, and high thermal efficiency

ZEG delivers turnkey clean hydrogen production plants together with partner and owner SLB (Schlumberger).

ZEG – an answer to the energy trilemma

- **Affordable**
Leading on Levelized Cost of hydrogen
- **Reliable**
Enabling clean utilization of base load natural gas
- **Sustainable**
Clean hydrogen below EU Taxonomy threshold

Z • E • G

zegpower.com

| HYDROGEN CHAIN | APPLICATION | ACTIVITIES | Zero Emission Resource Organisation | |
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| Commercialization | Components | R&D | | |
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ZERO is a non-profit environmental organization working for zero emissions solutions. In our view, emission-free alternatives exist for all energy use, and ZERO works continuously for their realization. We are not consultants, but participate in partnerships financed by third parties. ZERO has been working with hydrogen since 2002.

The key priorities have been to get sufficient incentives for hydrogen production and infrastructure, and to establish a domestic market with large-scale users in industry and the transport sector.



zero.no



Swagelok (SVAFAS Stavanger Valve & Fitting AS) offer training on fluid system best practices, trends and technology, installation, and safety.

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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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Enova SF

Enova SF is a public enterprise owned by the Norwegian Ministry of Climate and Environment. Enova SF's goal is to contribute to reduced greenhouse gas emissions and in the development of climate technologies necessary for bringing Norway to the low emission society in 2050. Enova supports projects mainly through the granting of investment aid with an aim to reducing barriers and stimulating lasting market development. Enova's support instruments are mainly aimed at the potential users of new climate technology, who have climate gas emissions today. Both industry and transport are prioritized sectors for Enova, in which hydrogen may become an important solution for reduction of climate gas emissions.



enova.no

| HYDROGEN CHAIN | ACTIVITIES |
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| | Commercialization |
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| HYDROGEN CHAIN | Stationary |
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| | Production |
| | Storage |
| HYDROGEN CHAIN | System Integration |

Innovation Norway

Innovation Norway is part of the Norwegian governments public support system, and we contribute to sustainable growth and exports for Norwegian businesses through capital, expertise and networks. Hydrogen is a prioritized area for Innovation Norway, and our most relevant funding schemes are the environmental technology grants and innovation loan.



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| HYDROGEN CHAIN | ACTIVITIES | Commercialization |
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The Research Council of Norway

The Research Council of Norway provides funding for fundamental, strategic and applied research within the hydrogen area. This is both in terms of technologies for production, storage, distribution / transport and the use of hydrogen. The Research Council of Norway is pivotal in relation to Norwegian participation in international cooperation agreements. Projects related to hydrogen and hydrogen based solutions will mainly be funded through the Research Council's Portfolio for energy, transport and low emission

The Research Council supports both Researcher Projects, Competence projects with research organisations as contracting parties, and Innovation projects, where industry companies are contracting parties. Through Pilot-E, The Research Council is collaborating with Enova and Innovation Norway to accelerate the projects from research to demonstration and market introduction. The Research Council also supports Centers for Environmentally Friendly Energy Research (FME). FME MoZEES and FME NCCS are covering environmentally friendly transport based on hydrogen and batteries and CCS including blue hydrogen production respectively. A new Center for Environmentally Friendly Energy Research dedicated to only hydrogen activities will be launched March 2022. For an overview of public funding allocated to hydrogenrelated projects, see HEILO.



Litra have a goal to strongly reduce their emissions, and they are absolutely certain that hydrogen will be an important part of achieving this goal.



Norwegian Hydrogen Forum

Contact us

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