Norsk Industri

Hydrogen

A report from the Working Committee on Offshore Renewable Energy *(“Fornybar energi til havs”)*

The Federation of Norwegian Industries

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Foreword

The world's energy systems are changing. Fossil fuels will be gradually phased out and replaced by sustainable, zero-emission systems. This change is clearly embodied in the European Union's policy pronouncement and followed up by national strategies and action plans.

The key question for the Working Group on Hydrogen has been: How can Norway preserve its position as an energy-producing and energy-exporting nation in a world whose demand for renewable energy and technology is constantly growing? The Working Group believes a broad national initiative in the hydrogen field can be one of the answers. Norway has the natural advantages, knowledge and expertise needed to take a leading position in this development. Hydrogen, carbon capture and storage (CCS) and offshore wind power can together form the three pillars of a larger ecosystem that ensures Norway continues to maintain its position as a leading energy nation in the decades ahead.

We observe that leading industrial nations are actively positioning themselves to lead this energy transition, and see that Norway must quickly take active and substantial steps to secure its position. A targeted programme of initiatives in Norway, with the necessary weight and focus, could help to maintain and potentially increase the number of energy-related jobs, value creation and export revenues. Hydrogen and offshore wind power could also help to significantly reduce the EU's carbon emissions.

At a time when Norway is experiencing one of its biggest crises in modern times, due to the Covid-19 pandemic, it has been inspiring to see the substantial interest both member companies and others have shown in assisting the Working Committee's efforts. The Working Group on Hydrogen is a subgroup of the Working Committee 2.0, and got underway in April 2020. The group comprises representatives from Aker Solutions, ABB, TechnipFMC, Kongsberg Maritime, Apply, Yara, Equinor, Aker BP, Petro Arctic and the Federation of Norwegian Industries.

We would like to extend our grateful thanks to everyone who has contributed to this joint endeavour.

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Working Committee 2.0

The Working Group on Hydrogen builds on the work and recommendations resulting from the first period of the Working Committee on Renewable Energy at Sea *("Fornybar energi til havs")*, which were presented in the *"Konjunkturrapporten"* issued by the Federation of Norwegian Industries in January 2020. In this report, the Working Committee envisaged that electricity generated using offshore wind power and hydrogen could help Norway maintain its position as an energy exporter when the export of oil and gas tails off in the approach to 2050. The Working Committee received its mandate from the Federation of Norwegian Industries, oil and gas branch, and started its work in April 2020. The committee's efforts have been divided into four topic-specific subgroups:

- Framework and Regulatory Conditions for Offshore Wind Power
- Hydrogen
- Offshore Infrastructure
- Supply Chain and Employment

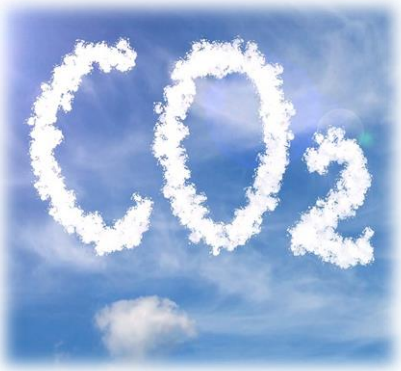
The Working Group on Hydrogen has been tasked with preparing a roadmap for the use of offshore wind power to produce hydrogen and for the export of hydrogen to Europe.

This is the group's final report.

1 Hydrogen – a future growth market

Hydrogen's energy-carrying properties make it a key factor in the transition from today's carbon-intensive energy system to a sustainable energy system. This is because power production from renewable energy sources, such as the wind and sun, is variable, prompting the need for efficient ways to store and transport the energy produced. Hydrogen is relevant primarily as a way of storing large volumes of energy, where other methods of storage – such as batteries – do not have sufficient capacity. Hydrogen could also replace fossil fuels in connection with the decarbonisation of many industrial processes.

The EU has pledged to become carbon neutral by 2050[1], and a growing number of countries are announcing zero-emission targets, with hydrogen playing a key role in their plans to achieve this. In the summer of 2020, the Norwegian government published its hydrogen strategy[2], which made it clear that Norway views hydrogen as an important element in the effort to reduce carbon emissions by 50–55 per cent by 2030, and 90–95 per cent by 2050 compared with 1990.



Pure hydrogen can be produced using renewable energy in combination with electrolysis (green hydrogen), or by reforming natural gas with carbon emission handling (blue hydrogen). Both can be considered as good solutions and will exist side by side when various countries draw up and realise their plans for increased use of hydrogen. It has been pointed out that blue hydrogen can be produced on a large scale sooner than green hydrogen. However, green hydrogen will be a more attractive alternative in the longer term, due to a rapidly falling cost curve[3].

In its analysis "The Future of Hydrogen" from 2019, the International Energy Agency (IEA) found that more attention is currently being paid to hydrogen by the business community and governments than ever before, and that conditions are now well set for scaling up the solutions and achieving the necessary cost reductions[4]. Several indicators underpin the signals that

[1] A hydrogen strategy for a climate-neutral Europe: https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

[2] Norwegian government's hydrogen strategy: https://www.regjeringen.no/contentassets/8ffd54808d7e42e8bce81340b13b6b7d/regjeringens-hydrogenstrategi.pdf

[3] Hydrogen economy outlook, 30 March 2020, Bloomberg

[4] IEA (2019), The Future of Hydrogen, IEA (2019, Paris). Downloaded 25 May 2020 from https://www.iea.org/reports/the-future-of-hydrogen

hydrogen will become a significant and important energy form in the future. New investment plans are being announced worldwide with increasing frequency, and the scale and scope of those investments are becoming increasingly ambitious. Between November 2019 and March 2020, the European Commission's market analysts extended the list of planned global investments in electrolysis technology from 3.2 GW to 8.2 GW, of which 57 per cent is in Europe. A further indication of the gathering momentum is the fact that the number of companies belonging to the International Hydrogen Council has risen from 13 in 2017 to 81 in July 2020[5]. The direction industry is moving is also exemplified by the announcement that Airbus and Rolls Royce have shelved their plans to build hybrid planes in favour of hydrogen-only aircraft[6]. This latter initiative aims to have commercial hydrogen-powered planes in the air by 2035. The company Universal Hydrogen plans to convert De Havilland's Dash 8 aircraft to renewable energy. A version equipped with electric motors could be operational as early as 2024, making the 40-seater plane the largest hydrogen-powered passenger aircraft to date. Such strategic choices by key industrial players will have major knock-on effects in other industries and business sectors.

To reach the goals of the Paris Agreement on climate change,[7] substantial amounts of money must quickly be invested in new energy systems. This requires incentive schemes and regulations to be changed at the same pace. Financial instruments to stimulate investments in hydrogen are being established worldwide. One example is the European Commission's recovery plan "Europe's moment: Repair and Prepare for the Next Generation", which is intended to stimulate the transition to new energy sources in Europe. The European Commission has also announced plans for the production of green hydrogen, with the aim of achieving 6 GW of electrolysis capacity by 2024 and 40 GW by 2030. At the same time, it will make financial instruments worth in the region of EUR 320–458 billion available in the period to 2030. The European Commission estimates that hydrogen could meet 24 per cent of the world's total energy requirement by 2050, in which case it would constitute a market with an annual turnover of EUR 630 billion.

The Working Committee has followed the global political debate on energy transition for some time. Leading industrial countries within the EU have ambitious plans for phasing hydrogen into their energy systems, with an associated upscaling of hydrogen production and

[5] European Union, Communication from the Commission to the Council, the European Economic and Social Committee, and the Committee of the Regions; A hydrogen strategy for a climate-neutral Europe (8 July 2020)

[6] https://e24.no/den-groenne-oekonomien/i/0KE0GG/airbus-tar-en-u-sving-vil-ha-hydrogenfly-i-luften-innen-2035

[7] United Nations Association of Norway – Key provisions of the Paris Agreement: https://www.fn.no/om-fn/avtaler/Miljoe-og-klima/Parisavtalen

establishment of their own supply industries. These countries are now drawing up strategies for how future energy supplies can be safeguarded through both domestic production and imports. One effect of these plans is that energy flows across national borders will change when fossil fuels are reduced and replaced by renewable sources and hydrogen.

Because of Norway's natural advantages and industrial traditions, we can also play a key role in tomorrow's zero-emissions world. In the following, we will describe what we see as Norway's opportunities and the actions we consider must be taken to safeguard such a position.

2 Norway's position in a green future

Norway is a country with vast natural resources and a small population. For this reason, our export industries have largely been based on natural resources like fish, minerals, timber, hydropower, and oil and gas.

In recent decades, we have derived substantial export revenues from oil and gas production in the North Sea. Wise political decisions and cooperation across industrial sectors paved the way for the establishment of world-class Norwegian supply chains in the oil and gas sector. This has contributed to a large number of jobs and further export revenues from the supplier companies in addition to those from export of the raw materials alone.

Norway currently supplies around 20 per cent of the natural gas imported by the EU. However, the EU's decarbonisation efforts[8] will probably reduce demand for Norwegian natural gas some time before 2030. This will also reduce demand for the products and services that large portions of the oil and gas supply industry provide.

Norway should position itself to supply emission-free energy to the EU, and thereby remain a relevant energy exporter to the EU. The government and companies engaged in the extraction and transport of natural gas should quickly come together to realise blue hydrogen production with carbon storage, so that energy based on Norwegian natural gas remains relevant for the EU in the period from 2030 to 2050. The Norwegian government's "Langskip" announcement

[8] https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

on 21 September 2020 was very important and satisfying for the industry. This decision means that carbon capture, transport and storage will be undertaken on a large scale going forward[9].

Norway can offer access to gas pipelines, reservoirs for the storage of CO_2, a processing industry that can convert pure hydrogen into ammonia, as well as a supplier and technology industry that will enable such a rapid expansion to take place. We should also acknowledge that by 2050 our customers may not want even the blue hydrogen we send them along today's pipelines, and that by then our exports of hydrogen should have been switched to green hydrogen produced using offshore wind power.

Reduced costs for electricity generated using solar and wind power will contribute to the rapid expansion of generating capacity. This energy is expensive to store at scale in batteries. Electricity is often produced far from where it is consumed. Electricity for battery storage or transmission via high-voltage overhead cables is therefore not always the optimal solution. Hydrogen produced by means of water electrolysis will gain increased relevance as an alternative energy carrier. Hydrogen can be transported via pipelines under high pressure, or be converted into ammonia for storage and transport in liquid form. Hydrogen can also be used as an input factor for synthetic fuels, i.e. synthetic diesel and petrol, which can then be stored temporarily on a large scale. In addition, hydrogen could replace coal in the production of steel, and natural gas in many industrial processes.

If one follows hydrogen-related discussions in EU countries such as Germany and the Netherlands, or in the UK, it is remarkable how mature the public debate is and how ambitious the plans for the establishment of hydrogen production and infrastructure are. Germany is conscious of its role as a net energy importer, and desires that this energy be produced in a zero-carbon fashion, i.e. green electricity and green hydrogen. In the UK, the focus is on carbon capture and storage, as well as blue hydrogen, in order to continue using natural gas from the North Sea. Discussion also centres on how offshore platforms and pipelines can be repurposed for the production and transport of blue hydrogen and for carbon storage.

As the Confederation of Norwegian Enterprise (NHO) pointed out in its "Green Electricity Value Chains" document, the substantial electrification already underway in Norway has not led to the widespread development of new business opportunities, value chains, technologies or a new export-based supply sector.

[9] https://www.regjeringen.no/contentassets/943cb244091d4b2fb3782f395d69b05b/nn-no/pdfs/stm201920200033000dddpdfs.pdf

Projects to produce green hydrogen and develop a green hydrogen supplier market are rapidly getting underway worldwide, and these projects are often linked to new renewable energy projects. The early establishment of a domestic market for offshore wind power, hydrogen and a green processing industry is therefore important for the reorientation of a Norwegian supply industry that already has expertise and technologies that are well suited to a greener energy future. The energy transition proceeds at its own pace. The question is whether Norway should invest now in hydrogen competence, build up a domestic supply market and, later, export that competence; or whether it should rely on the purchase of competence and solutions from elsewhere.

In sum, this means that the Norwegian government, in conjunction with the business community, must think big and plan projects within both green and blue hydrogen production with associated CCS. We must qualify our export system for a transition from natural gas to hydrogen, so that both existing and new pipelines can be used for the export of clean hydrogen with effect from 2030.

Growth in onshore industry can be safeguarded through the conversion of emission-free Norwegian energy into CO_2-certified products, such as fertiliser, synthetic fuels, metals and alloys. Other energy-intensive manufacturing which could advantageously be located in Norway includes giga-factories for battery production, mass production of hydrogen electrolysers, as well as data storage centres.

3 Recommendations for a national hydrogen initiative

The Working Committee considers that Norway could remain a key energy nation, based on emission-free solutions. To succeed, Norway must seek a central position in the EU's plans to eliminate greenhouse gas emissions. As a crucial element in this endeavour, the Working Committee recommends the establishment of public–private collaborations, with ambitious mandates. Such public–private collaborations must seek to "unlock" the national hydrogen market by means of the following:

1. **Establishing schemes to ensure a long-term and predictable approach to hydrogen, on both the producer and consumer sides.** There exists today a "chicken and egg" situation, where consumers dare not invest in a switch to or installation of new hydrogen-ready systems, while producers dare not invest in production equipment due

to a lack of long-term security and foreseeable sales prices and volumes. The necessary long-term approach and foreseeability can be achieved only through the active participation of the public authorities.

2. **Establishing long-term support and guarantee schemes for investment and operations, so that private actors achieve an acceptable return on investment in the transition to clean production.** Such schemes are necessary during a transitional period until the costs associated with clean production have fallen to a competitive level. The schemes must apply to the modification of existing production processes and uses, and for the establishment of new industries that come to Norway because it offers access to clean energy and hydrogen. Price guarantee contracts are currently used in certain countries, such as the UK, and we consider that such an arrangement could provide the necessary foreseeability within the hydrogen sector.

3. **Using Norway's power as a major buyer actively to create a market for hydrogen solutions.** Examples include requiring zero-emission public transport on land and at sea, and requiring steel and concrete components used in public buildings and other infrastructures to be produced in an emission-free process. By means of criteria and weighting used in public procurement schemes, the government will establish domestic markets for zero-emission products, thereby also creating a forward-looking supply industry in Norway.

4. **Engaging actively with the EU in the area of industrial policy.** Norway should engage in a dialogue with the EU regarding future exports of large volumes of clean energy (renewable electricity and clean hydrogen), with a view to the EU committing itself to long-term purchases. This will allow concrete Norwegian projects to mature towards an investment decision, analogous to the period when the Norwegian gas export system was being established.

5. **Establishing a Joint Industry Project.** The Working Committee takes the view that the opportunities and tasks relating to the hydrogen value chain are of such importance and complexity as to warrant the establishment of a Joint Industry Project (JIP) with participants drawn from both the public authorities and key industrial players. The JIP could provide the government with a solid foundation for dialogue and negotiations with the EU. A further objective of the JIP would be to prepare the way so that energy-intensive industries can be attracted to Norway, on the basis of access to large amounts

of clean energy at competitive terms and conditions. This includes hydropower, wind power, hydrogen and easy access to CCS infrastructure. The JIP is industry's response to the Norwegian government's hydrogen strategy, in that it manifests the opportunities that an energy transition can trigger if it is embraced wholeheartedly.