Ministry of Foreign Affairs

Hydrogen in the Baltic States

Commissioned by the Netherlands Enterprise Agency

>> *Sustainable. Agricultural. Innovative. International.*

Hydrogen in the Baltic States

An investigation into opportunities for Dutch companies in the emerging hydrogen sectors of Estonia, Latvia and Lithuania

PONDERA

Introduction

The Baltic States, comprising of Estonia, Latvia, and Lithuania, have recently emerged as promising regions for the development and adoption of hydrogen innovations. This report aims to provide a comprehensive analysis of the opportunities for Dutch companies in the Baltic States' hydrogen sector by examining four crucial elements: The hydrogen value chain, policy, regulation and projects, stakeholders & actors, and translating those to opportunities for Dutch companies.

The first section of the report delves into the current state of the hydrogen value chain in the Baltic States, including current production and end-uses. We will also discuss the potential applications of hydrogen across various industries, such as transportation, power generation, and industrial processes.

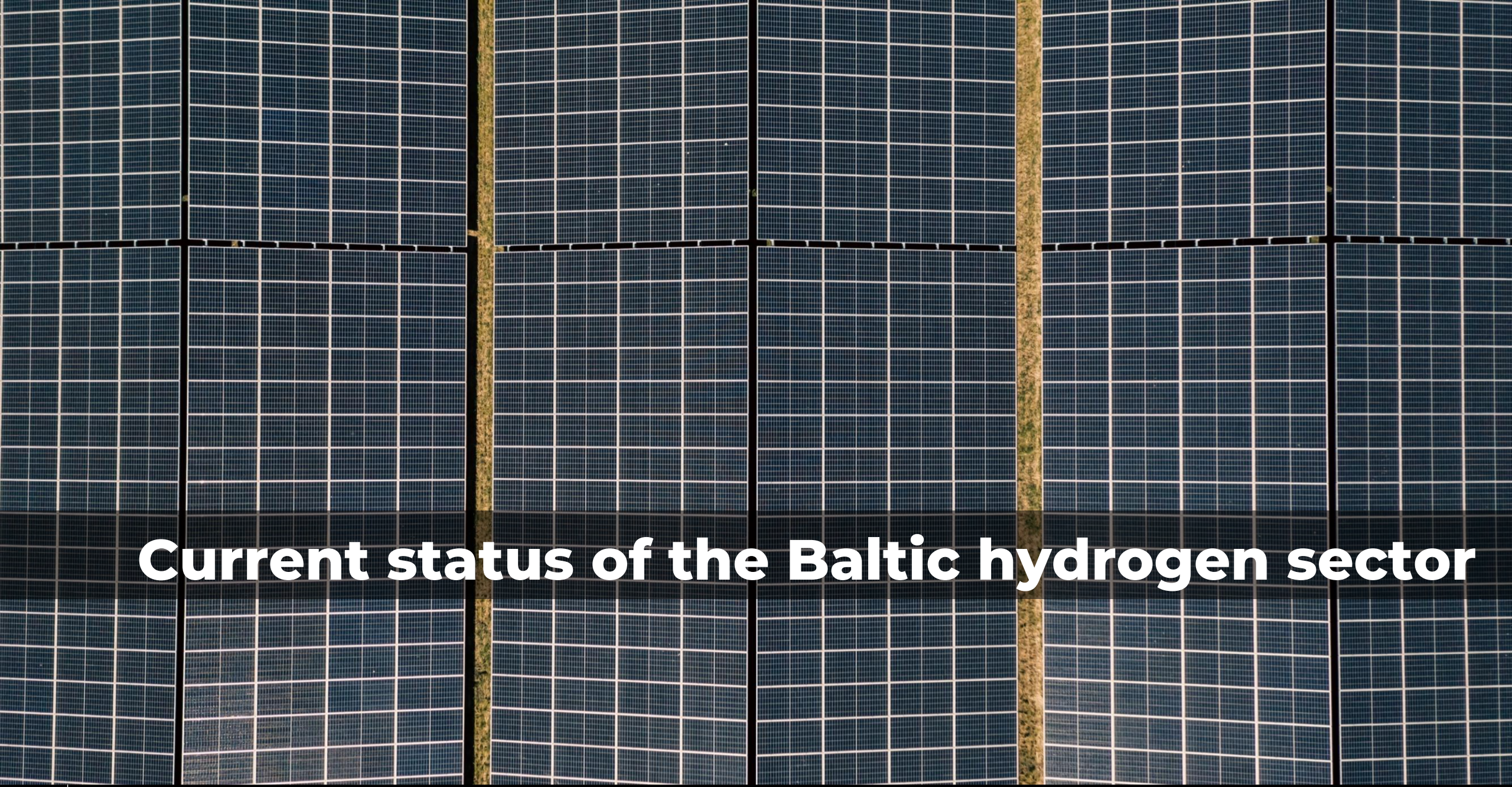
Next, we assess the policy and regulatory landscape in the Baltic States, focusing on the governments' commitments to renewable energy targets, initiatives to foster hydrogen infrastructure, and policies supporting the transition to a hydrogen economy. This analysis will enable Dutch companies to understand the environment in which they can operate and identify potential incentives and support mechanisms.

In the third section, we provide an overview of the key stakeholders, actors and projects shaping the hydrogen sector in the Baltic States.

Finally, we explore opportunities for Dutch companies to participate and thrive in the Baltic States' hydrogen sector. This will encompass market elements, potential collaboration with local players, and the identification of niche areas where Dutch expertise and technology can make a significant impact.

By presenting a holistic picture of the hydrogen sector in the Baltic States, this report aims to equip Dutch companies with the knowledge and insights required to capitalize on the emerging opportunities in this emerging market.

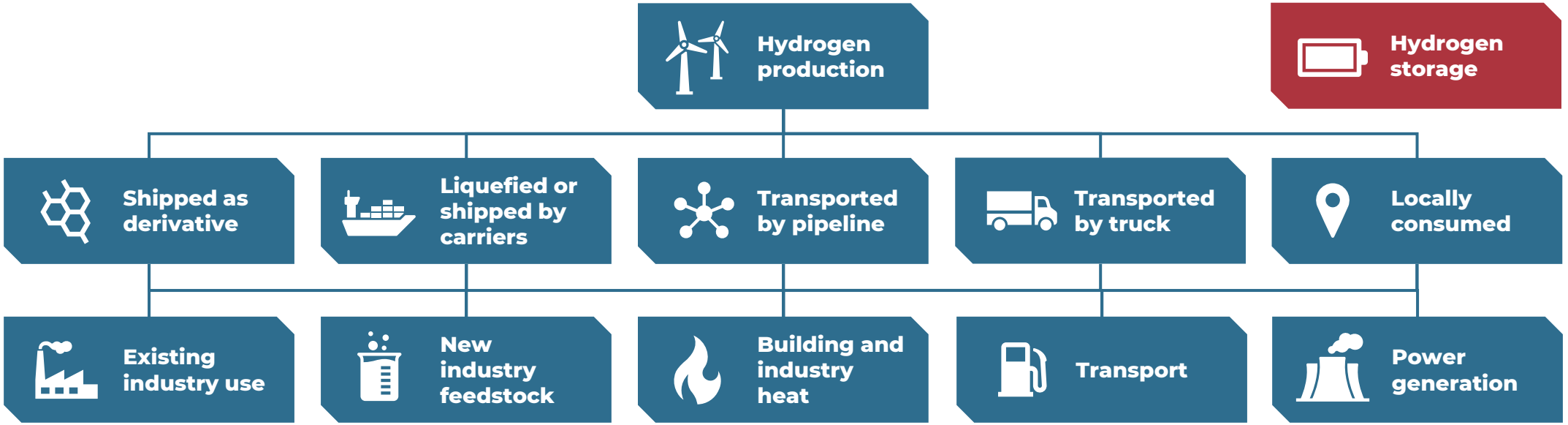
Table of contents



Current status of the Baltic hydrogen sector

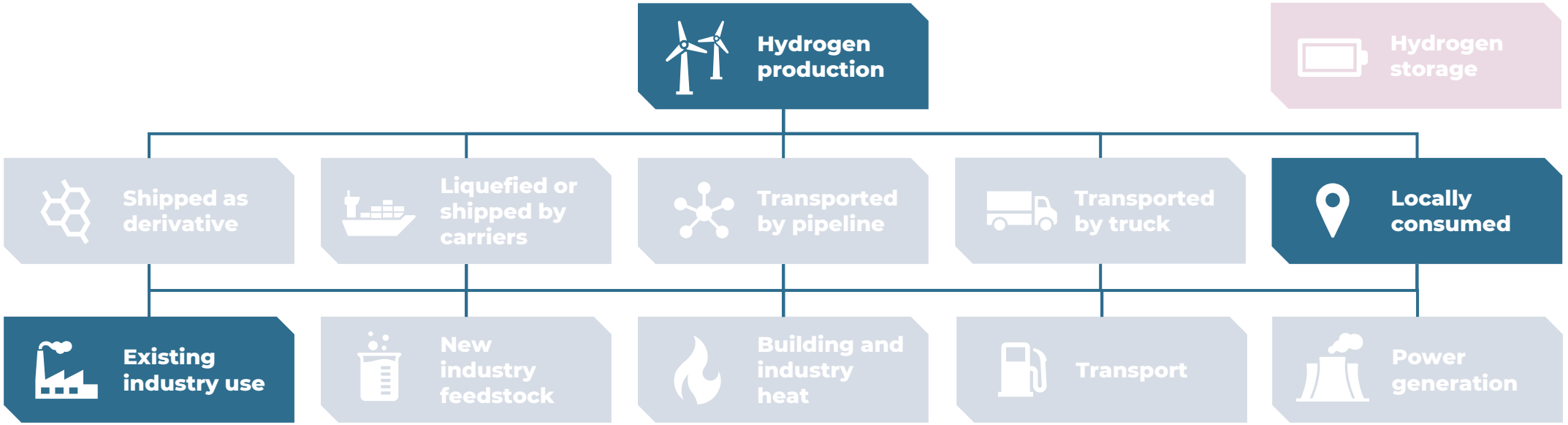
The hydrogen supply chain

The hydrogen supply chain is a complex network that involves several steps, from production to end-uses. There are different methods for producing hydrogen, including steam methane reforming (SMR) (grey hydrogen), electrolysis (green hydrogen), and biomass gasification (green hydrogen). Once produced, hydrogen can be compressed or liquefied and transported via pipeline, truck, or ship to its destination. It can also be transported as a derivative, like ammonia or methanol or be locally consumed as is often the case in the current hydrogen supply chain. Hydrogen end-uses include existing industry use as a feedstock in the fertilizer, petrochemical and steel industries, new industry feedstocks, the combustion of hydrogen to produce heat for building and industry uses, uses in transport and end-uses in power generation and demand response. Along the supply chain hydrogen can also be stored providing mainly seasonal storage flexibility to the energy mix.



The status quo

Over **50 percent** of current global hydrogen demand is from the production of **nitrogen fertilizers**, over **44 percent** originates from the **petrochemical industry** and around **5 percent** is used in the **direct reduction of iron** to produce steel leaving around 1% of current hydrogen production for all other hydrogen uses. These other hydrogen end-uses include numerous end-uses in the chemical industry including hydrogen peroxide production, chlorine production and the production of renewable hydrocarbons. In the food industry hydrogen is used in the production of sweeteners and the hydrogenation of animal and vegetable fats and oils. Other hydrogen applications are common in flat glass production and semiconductor manufacturing. Most hydrogen is currently locally consumed without the need for complicated transport infrastructure.



Baltic hydrogen use

Estonia

Estonia currently has no companies that use or produce significant amounts hydrogen. The Estonian nitrogen fertilizer company AS Nitrofert has had a declining production since the fall of the USSR. Currently, they have paused their production efforts in the wake of high gas prices and have stated that they will potentially close for good.

Latvia

In Latvia, current hydrogen use is mostly limited to use in the hydrogen trolleybus project in Riga. In this project 10 trolleybuses are equipped with hydrogen-powered range extenders. To accompany the project, public transport operator Rīgas satiksme has deployed a hydrogen refueling station (HRS) with the capacity to support the trolleybuses, as well as the wider development of hydrogen FCEVs in the future in the region. The HRS is the first in any of the Baltic states and is strategically located to act as a hydrogen transport hub for Latvia, Estonia and Lithuania. Riga is a key node in the core road network corridor as well as on the comprehensive network for Airports and Seaports. The HRS has the capacity to produce 300 kilograms of hydrogen per day by means of SMR.

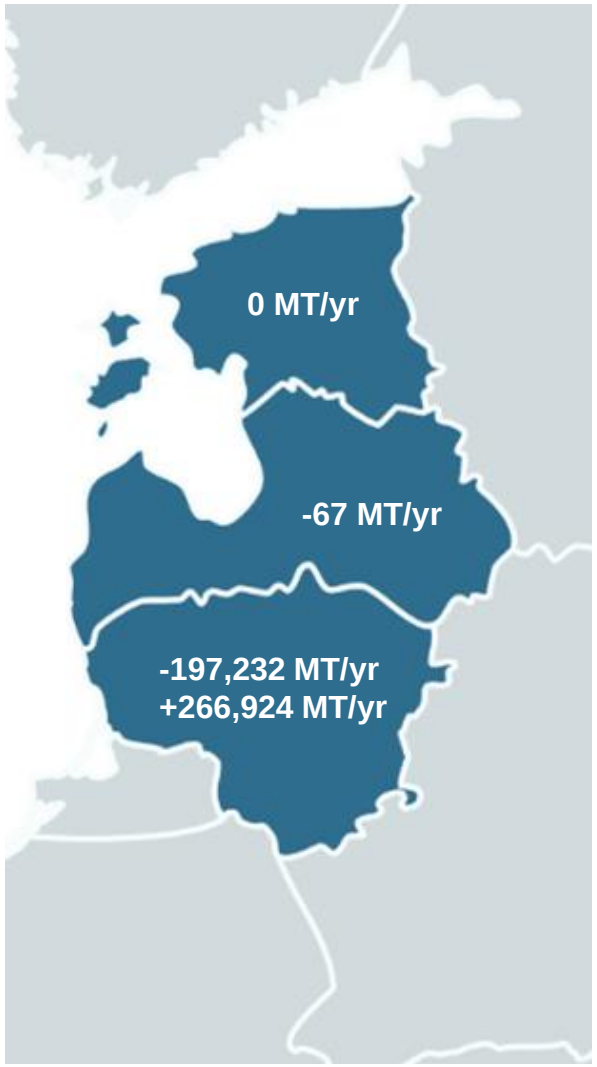
Lithuania

Lithuania is the country that currently has the largest hydrogen supply chain in terms of volume. The Achema Factory in Janova produces hydrogen locally by means of steam methane reforming and uses the hydrogen and heat produced in their own nitrogen fertilizer production. Orlen Lietuva is the only active petrochemical refinery in the Baltics and locally produces hydrogen by means of SMR that they use as a feedstock in the production of petrochemical products.

1. Hydrogen refueling station, Riga
2. Orlen Lietuva petrochemical refinery
3. Achema fertilizer production facility

1. Fuel cell and hydrogen observatory: https://www.fchobservatory.eu/observatory/technology-and-market

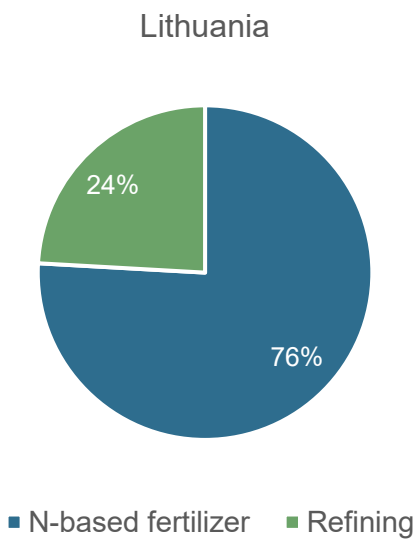
Baltic hydrogen use in numbers

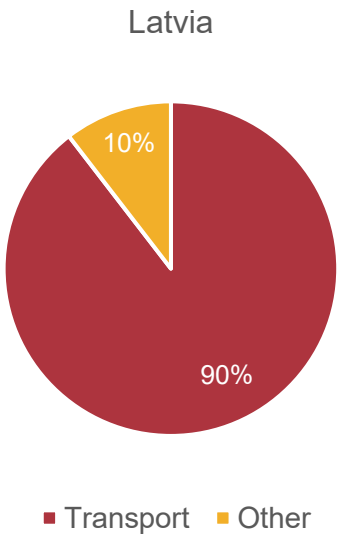


Data from the Fuel Cells and Hydrogen Observatory (FCHO)[1] provides a more detailed overview of the current hydrogen demand in the Baltics.

In Lithuania 197,232 Metric Tonnes (Mt) of hydrogen is used per year in the production of nitrogen-based fertilizers (149,687 Mt/yr) and petrochemical refining (47,545 Mt/yr). In Latvia, hydrogen use is 67 Mt/yr and used in transport applications (60 Mt/yr) and other small-scale applications (7 Mt/yr).

The FCHO puts current hydrogen productioncapacity in the Lithuania at 266,924 Mt/yr[1]. They state two production sources for this hydrogen: the Achema fertilizer production plant in Janova and the Orlen Lietuva oil refinery. Both are Steam Methane Reforming installations powered by Natural Gas, thus producing grey hydrogen.





1. Fuel cell and hydrogen observatory: https://www.fchobservatory.eu/observatory/technology-and-market

Infrastructure

There are currently no hydrogen pipelines operational in the Baltic States. On the right-hand side, you see an image of natural gas infrastructure in the Baltic States. As of now, there are no concrete plans to repurpose this infrastructure for hydrogen transmission. However, the gas TSOs of all the Baltic countries have signed a commitment to develop infrastructure for hydrogen transmission in the region. Currently a feasibility study is being performed that will might result in concrete infrastructure conversion plans, depending on conversion feasibility.

The project, called the Nordic-Baltic hydrogen corridor, is an international hydrogen transmission infrastructure project and was signed by Gasgrid Finland, Estonian TSO Elering, Latvian TSO Conexus Baltic Grid, Lithuanian TSO Amber Grid, Polish TSO GAZ-SYSTEM and German TSO ONTRAS.

Estonia

Estonian natural gas TSO Elering operates 977 km of high-pressure transmission pipeline. This includes the subsea Balticconnector.

Latvia

Conexus, the Latvian gas TSO, manages 1,190 km of high-pressure transmission pipelines. It operates Inčukalns UGS, which is the only functional natural gas storage in the Baltic countries with active gas capacity of 24 TWh. The Latvian capital, Riga, is home to the only public refueling station currently operational. It currently services 10 electric trolleybuses with hydrogen extenders.

Lithuania

Lithuanian gas TSO Amber Grid operates 2285 km of high-pressure transmission pipelines. It is the most highly developed gas grid in the Baltic states and the connection of the Baltic states to the EU backbone.

Source: Websites of the respective TSOs

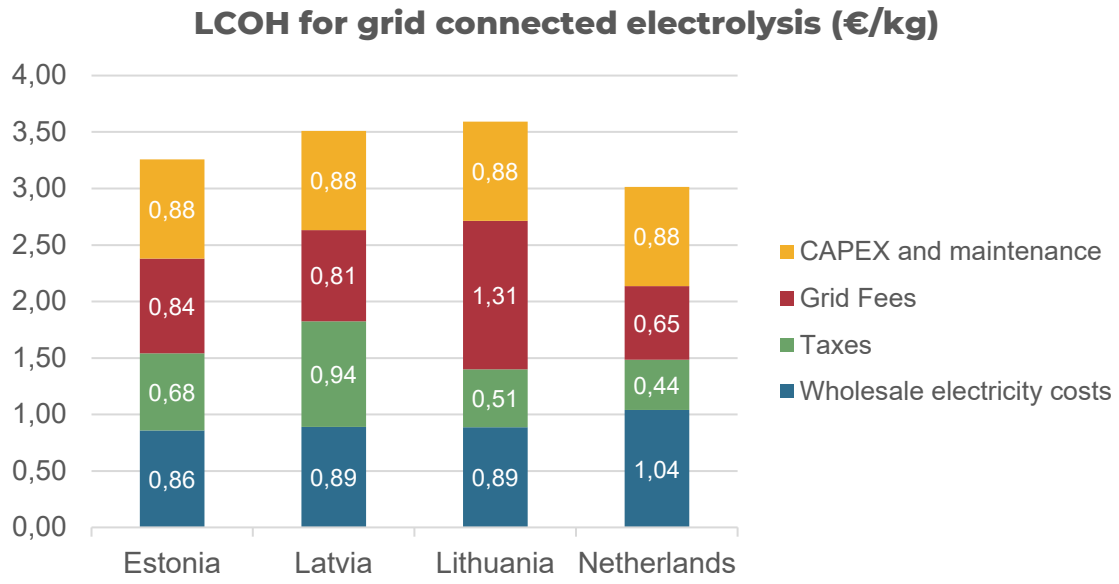
Levelized cost of hydrogen

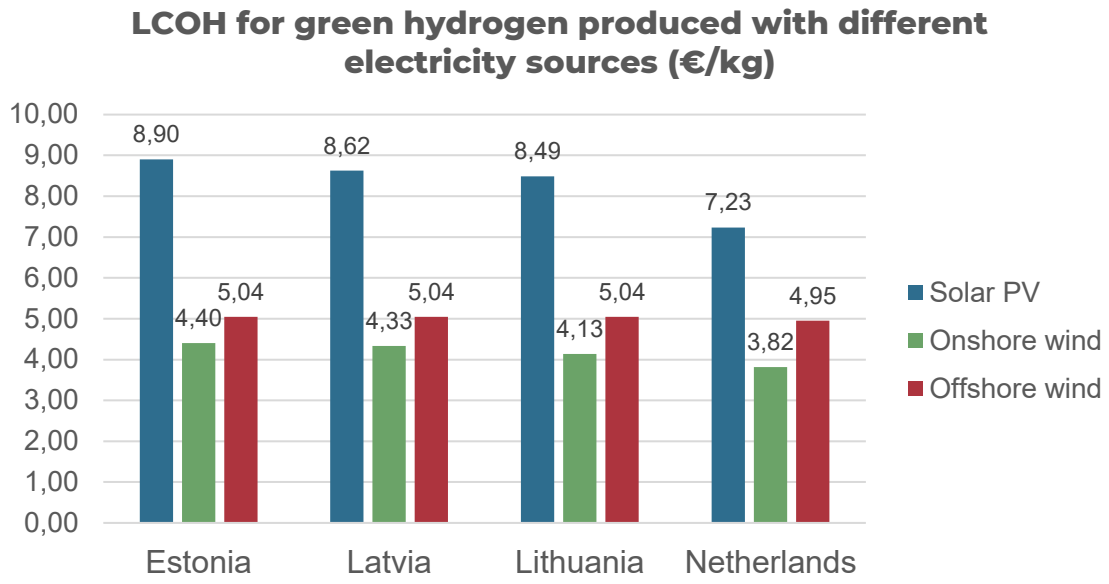
The Fuel Cells and Hydrogen observatory (FCHO) has calculated the Levelized Cost of Hydrogen (LCOH) for a number of EU countries[1]. In their calculations the FCHO have had to make assumptions and these numbers are best estimates based on available information. For a specification of their approach please refer to the source document.

The chart on the left shows estimated production costs of hydrogen produced via water electrolysis powered with electricity sourced from the national power grid.

The chart on the right shows estimated production costs of renewable hydrogen, covering three potential sources of renewable energy - PV, onshore wind, and offshore wind (where possible), directly connected to the electrolyzer (without grid connection).

These estimations are based on data compiled in March 2022.





1. Fuel cell and hydrogen observatory: https://www.fchobservatory.eu/observatory/technology-and-market

Renewable electricity prospects

The prospects for the future hydrogen economy in the Baltic states is highly dependent on future renewable electricity production. This section provides a summary of electricity production prospects.

Renewable energy production Estonia

Estonia is planning to produce all electricity consumed in Estonia using 100% renewable energy sources by 2030. Currently, the share of final electricity consumption is 27%. Most of the missing capacity is expected to come from solar and wind energy. With many offshore wind projects in the pipeline, onshore solar development gaining momentum and onshore wind making a comeback, integration of electricity into the existing market is expected to be difficult. [1]

Renewable energy production Latvia

Latvia is planning to produce 50% of its gross final energy consumption in 2030 from renewable energy sources. The share of gross final energy consumption from renewable sources was at more than 44% in 2021 in Latvia due to substantial hydroelectric capacity. An increase of this percentage is “difficult to reach” according to the National Climate and Energy Plan. Much of Latvia’s heat and electricity still comes from imported natural gas but there are some developments regarding offshore energy. The expectation is that Latvia will remain dependent on imports.[2]

Renewable energy production Lithuania

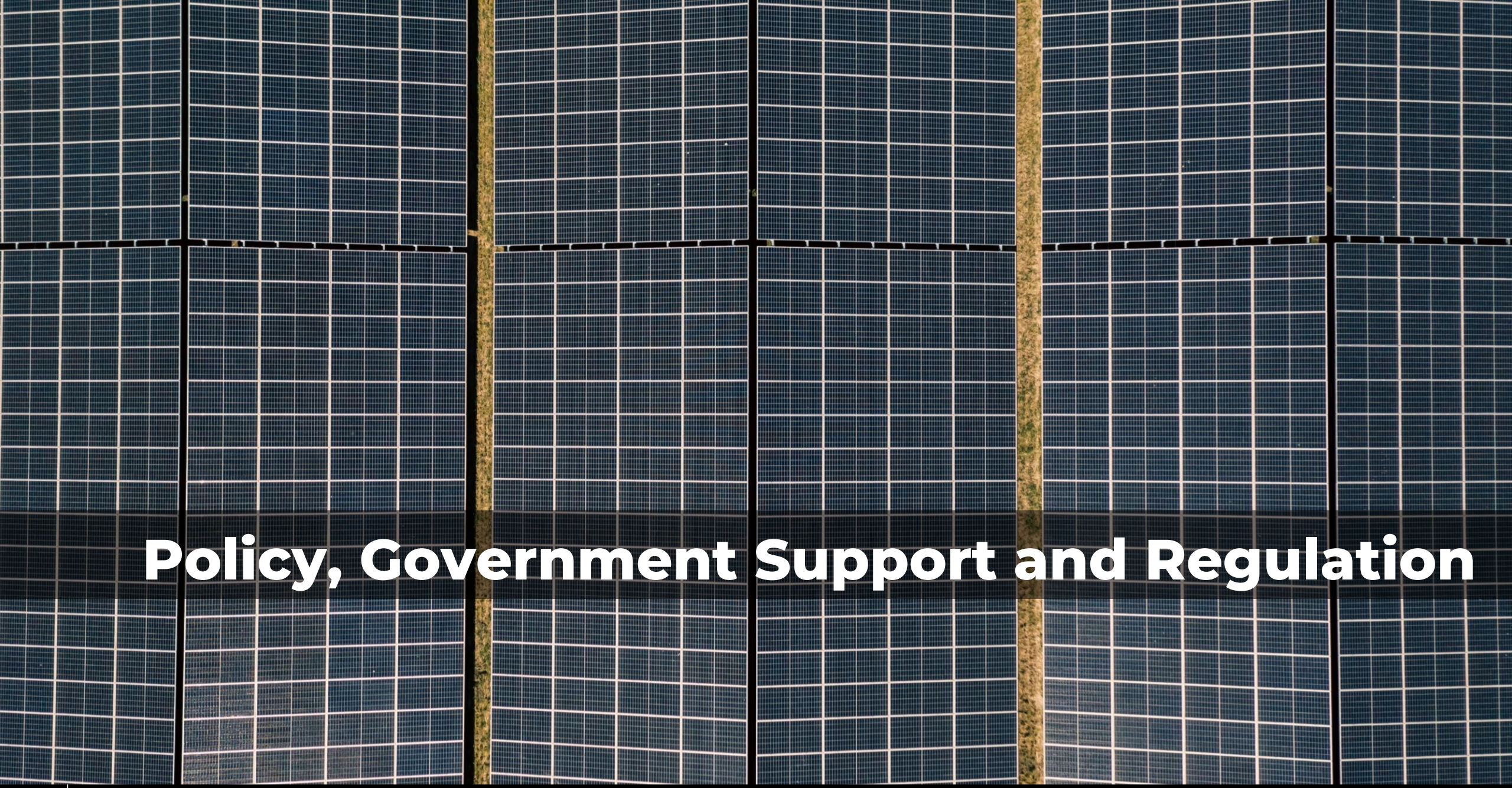
Lithuania aims to have a share of 45% of renewable energy of gross final energy consumption in 2030. Lithuania depends on imports as around 25% of production of current total energy supply comes from renewables. Solar energy is expected to account for only 3% and wind will account for 70% of the renewable share.[3] Lithuania is working towards a renewable energy mix with a focus on onshore and offshore wind, but this will mean it has to deal with possible surpluses.

Offshore wind targets

Following the Maritime Spatial Plans, the Baltic States have very high ambitions for offshore wind:

- Estonia could allocate 1,850 km2 (5% of its EEZ) to develop 9 GW of offshore wind and specifically stated that in the future it will use this to produce hydrogen. Estonia’s all-time peak consumption was 1.587 GW.
- Latvia could allocate 300 km2 (1% of its EEZ) to develop 4 GW of offshore wind
- Lithuania could allocate 644 km2 (9.4% of its EEZ) to develop 2.4 GW of offshore wind with the potential to increase this to 3.4GW as Lithuania wants to become less dependent

1:https://bankwatch.org/blog/100-per-cent-renewable-electricity-is-a-realistic-and-necessary-target-for-estonia-and-europe#:~:text=Currently%2C%20the%20share%20of%20renewable,potential%20is%20many%20times%20greater.
2: Latvia’s National Energy and Climate Plan: https://energy.ec.europa.eu/system/files/2020-04/lv_final_necp_main_en_0.pdf



Policy, Government Support and Regulation

Estonia - Market overview and regulation

The Hydrogen Strategy

As part of the EU Recovery Plan, Estonia is creating a Hydrogen Roadmap to map the current situation and develop hydrogen in the future. Around €50 million of the total REPowerEU funds will be invested in hydrogen developments as hydrogen technology is one of the main pillars of economic and sustainable recovery and has been identified as one of the development targets for the country's long-term strategy "Estonia 2035". [1]

The €50 million funding from the REPowerEU is limited to hydrogen usage in the transport sector and for hydrogen as chemical feedstock. Emissions from the transport sector accounted for the largest share of greenhouse gas emissions in 2018, namely 12% of Estonia's total GHG emissions. [2]

The focus of the Roadmap will be on supporting green hydrogen integrated circuits, from production, delivery solution (infrastructure included) and end use. The upcoming years will be used to test pilot projects and small-scale demonstration of the potential for the deployment of hydrogen.

Pilot projects will be selected through open calls and support for pilot projects that aim to test and evaluate:

- The capacity and performance of integrated chains in Estonia
- Reduction of negative environmental impact of the introduction of hydrogen
- Scalability of the project

Pilot projects will be integrated in the circuits when green electricity is expected to reach widespread system integration, in 2026.

Plans and regulation

Within Estonia, the Hydrogen Valley Estonia (HVE) was established. The HVE is a close cooperation between three regions, one university and five of the largest companies in energy and industry in Estonia. Thirty projects, almost all currently in the idea and feasibility phase, have been identified in the scope. The Hydrogen Valley now tries to accelerate those projects by gathering knowledge, improving the learning curve and in the end developing projects. [3]

Estonia is preparing an institutional framework for usage and production of hydrogen. This is in development, but the focus will be on reducing emissions, export of hydrogen and the transportation sector.

1:https://www.clean-hydrogen.europa.eu/media/news/repowering-eu-hydrogen-valleys-clean-hydrogen-partnership-invests-eur-1054-million-funding-9-2023-01-31_en?utm_source=Google&utm_medium=email&utm_campaign=Hydrogen+call+22
2: https://knoema.com/atlas/Estonia/topics/Environment/Emissions/CO2-emissions-transport-percent
3: Hydrogen Valley Strategy (2022)

Estonia – Plans and subsidies

Perspective

From 2029 onwards, it is expected that at least a part of the produced electricity from the 7GW offshore wind potential will be converted into hydrogen. For this, transmission and storage infrastructure needs to be developed in the upcoming years, including import and export terminal infrastructure, refuelling stations, and storage facilities. [1]

Hydrogen can specifically provide solutions for sectors and areas where CO2 emissions from electrification are significant and where the introduction of alternative fuels, a modal shift or other measures are not (cost) efficient.

Green hydrogen can play a significant role in reducing emissions from heavy duty vehicles, long distance buses and ferries, and in some cases also locomotives. This will require the development of H2 production from renewable energy sources, promote hydrogen consumption, and put in place appropriate infrastructure. [2]

Subsidies

The Estonian Islands and Tartu City have been identified by the Clean Hydrogen Partnership (EU) to receive support for R&I activities. The selected regions will receive targeted support from hydrogen consultants starting in 2023 in the form of help rather than funding. [3]

The deployment of new technologies requires significant investment, as the whole value chain must be built up. The Hydrogen Roadmap is still under development, but there is a subsidy scheme which grants €5 million to a partnership of companies willing to invest in hydrogen pilot projects.

There is a European subsidy, IPCEI, that supports innovative projects involving more than one Member State. Three Estonian companies have been selected to receive subsidy, which are Elcogen, Stargate and Skeleton.[4] [5]

1: Hydrogen Valley Estonia (2022)
2: https://www.sei.org/wp-content/uploads/2022/07/reaching-climate-neutrality-in-estonia-a-progress-update-report.pdf
3: https://www.h2regions.eu/
4: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4544
5: https://h2est.ee/en/estonian-government-backs-hydrogen-ipcei/

Estonia – Targets and plans per sector

The Estonian Energy and Climate Plan has set out how hydrogen can serve multiple goals in four different sectors.[1]

Transportation

The Estonian Energy and Climate Plan has set the targets for the use of electric transport and generation of biofuels. Hydrogen specifically should serve as direct energy carrier for public and heavy-duty transport and ferries or as a component of advanced fuels like green methanol or ammonia for heavy transport.

Industry

Hydrogen could be used in processes that utilise high temperature heating or as a direct feedstock. Although Estonia does not have a lot of industry and only 20% of it currently uses natural gas for heating, a part of the Estonian industry could decarbonise their processes by using the existing methane infrastructure.

Hydrogen storage

Hydrogen could be used as an energy carrier when the electricity grid is unable to absorb electricity production. Electrolysers can be used to convert energy into hydrogen. However, efficiency is low. Excess wind energy is expected to be developed so seasonal storage is needed to mitigate mismatch, but infrastructure investments are required.

Heating for buildings and infrastructure

Hydrogen could be used purely as a source of heat for buildings through the gas grid, but this is only viable when green hydrogen is available in abundance, which is not expected before 2040. [2]

1. https://energy.ec.europa.eu/system/files/2022-08/ee_final_necp_main_en.pdf
2. https://civitta.com/articles/analysis-of-the-hydrogen-usage-in-estonia
3. https://www.ts.ee/wp-content/uploads/2021/08/HydrogenStrategy_PortofTallinn_ByFlux-002.pdf

Latvia - Market overview and regulation

The Hydrogen Strategy

Latvia is planning to develop a Hydrogen roadmap by mid 2023 and a hydrogen strategy by the end of 2023. This strategy should contain the guide to make the transition by identifying key areas for investment and research and development and by creating regulatory frameworks.[1]

Latvia will receive around €4.6 billion from the REPowerEU for sustainable recovery fund but has no specific hydrogen strategy so far. The recovery plan does state that large onshore and offshore wind farms need to be balanced by storage technologies.[2]

Regulation

Latvia's Recovery Plan following REPower EU states there is a need to improve the regulatory framework and provide support for storage technologies such as green hydrogen.[3]

Currently, there are legislative and technical obstacles to the introduction of hydrogen such as the allowed threshold of hydrogen for allowance in the Natural gas networks (NG). However, Latvia is focusing on its NG system and is conducting studies on the role of gas storage and greening its supply including the role of hydrogen in the longer-term. Even in 2030, infrastructure is expecting to be lacking.[3]

In 2022, bureaucratic aspects of investments in renewable energy were managed by a new government initiative and an Amendment to the Electricity Law was adopted as well. This Amendment takes into account the potential of the hydrogen and biomethane production. Most regulation is in Latvian and is subject to changes and local contacts are needed to deal with this regulation.

Perspective

The transport sector in Latvia is the most difficult to decarbonize and the country is looking for opportunities to decarbonize this sector using hydrogen rather than electrifying public transport, specifically the railway transport system. The public transport operator in Riga has already introduced hydrogen fuel cell range extenders in its electric trolleybus system as a pilot project. From 2030 onwards, there are plans to use hydrogen and CCS to push e-fuels and stimulate decarbonisation in this sector. [3]

At the end of 2022, a Memorandum of Understanding was signed by the Freeport of Riga and representatives of Latvian energy, technology & transport companies and higher education and state institutions to strengthen the cooperation for the development of hydrogen. Latvia has two times overbooking of onshore wind energy applications for its grid and hydrogen will be looked at in the future, but it is a long process. [4]

The Riga City Council has joined the European Hydrogen Alliance to ensure the transition to clean technologies by 2030. The City Council is planning to learn more about the production and use of hydrogen and will include action plans for implementation of hydrogen technologies in its long-term development strategy.

1: https://fleishmanhillard.eu/wp-content/uploads/sites/7/2022/02/FH-National-Hydrogen-Strategies-Report-2022.pdf
2: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6249
3: https://www.nordicenergy.org/wordpress/wp-content/uploads/2022/06/Final-pdf-Baltic-Nordic-Roadmap.pdf
4: https://labsoflatvia.com/en/news/hydrogen-technology-development-consortium-to-be-established

Latvia - Subsidies and targets/plans

Subsidies

Riga has been identified by the Clean Hydrogen Partnership (EU) to receive funding of R&I activities. The selected regions will receive targeted support from hydrogen consultants starting in 2023 in the form of help rather than funding.

Following the Horizon Europe program, the EU has provided approval for the implementation of the Cross-border Hydrogen Valley project around the Baltic Sea including the granting of support and funding to the Freeport of Riga for research on a cross-border hydrogen Valley.

Considering the huge potential for biomethane and hydrogen production in Latvia, producers of biomethane and hydrogen can receive a guarantee of origin (GO). The GO can be requested and received for the gas produced from renewable energy sources and injected into the gas network. A GO can be requested as well of producing, trading and using gas outside the gas network.

The intention of Latvia is that this motivates investors in existing Combined Heat and Power systems to produce biofuels and green hydrogen in the future.

Financing is expected not to be the problem in Latvia due to (European) funds, according to the Latvian Hydrogen Association. A changing government and changing regulation are expected to be more of an issue.

Targets and plans

In 2022, Latvia had the third highest share of Renewable Energy with more than 40% of total energy consumption being from renewable energy sources. The Latvian operator and government want to maintain this place and direct all the renewable energy produced to its own consumption and only surplus energy that is left at any time can be allocated to hydrogen production.[2]

In 2030, the Nordic & Baltic corridor should emerge as part of the larger European hydrogen corridor. The corridor should connect industrial clusters, ports and hydrogen valleys to regions of abundant hydrogen supply. The hydrogen infrastructure can then grow to become a pan-European network, with a length of almost 53,000 km by 2040, largely based on repurposed existing natural gas infrastructure. Conexus Baltic Grid, Latvian grid operator, signed an agreement to work on this initiative and this should bring Latvia and its NG network up to date to accommodate future hydrogen use. [3]

The National Climate and Energy Plan covering 2021-2030 does not include specific targets for the production or use of hydrogen in specific sectors and hydrogen application is considered as a long-term perspective. [4]

1: https://www.h2regions.eu/
2: https://www.roedl.com/insights/baltic-states-estonia-latvia-lithuania-projects-renewable-energy
3: https://www.conexus.lv/press-releases/sesi-gazes-parvades-sistemas-operatori-paraksta-sadarbibas-ligumu-ziemelvalstu-un-baltijas-valstu-udenraza-koridora-attistibai
4: https://www.em.gov.lv/en/national-energy-and-climate-plan-2021-2030

Lithuania - Market overview and regulation

The Hydrogen Strategy

Lithuania will receive around €2.2 billion in EU Recovery Funds of which 37.8% will support climate objectives. Around €218 million is reserved for reforms in energy efficiency and €242 million in generation and storage of renewable energy.[1]

Lithuania will invest its REPowerEU funds in sustainable mobility supporting the replacement of polluting road transport vehicles, improving public transport services, establishment of charging/refilling infrastructure for vehicles using alternative fuels, and developing alternative fuels sectors such as hydrogen. Lithuania is promoting the integration of its industry into European strategic value chains and hydrogen, selected by the EU as one of nine strategic value chains, is relevant for Lithuania according to its NCEP. [2]

Lithuania does not have a hydrogen market or specific infrastructure in place but following the National Climate and Energy Plan (NCEP) for 2021-2030, research and development in hydrogen to stimulate export growth and the creation of new forms of business is important. Hydrogen in the energy sector, industry and transport sector could be used for this stimulation.[2]

Regulation

In 2010, Lithuania became a net importer of electricity and by 2030, the government aims to reverse import dependency and produce 70% of its electricity needs domestically. To start renewable energy and hydrogen developments specifically, Lithuania's Hydrogen Platform was established in 2020 and "Lithuania's Hydrogen Sector Development Roadmap and Action Plan" was established in 2022. Following the Action Plan, the Ministry of Energy should set up the regulation required to create clarity on rules of market participates and promote open markets and competition within the hydrogen sector. On top of this, the Ministry of Environment is tasked with creating safety regulation.[3]

According to the Government's Program in Energy 2021-24, the focus of energy R&D needs to be prioritized on the development the hydrogen value chain, including the blending into the natural gas grid. To stimulate technologies, start-ups and system integration, the Alternative Fuels Law was adopted in March 2021. [4]

Perspective

According to the Action Plan, there is an incentive to prioritise hydrogen from domestic renewable power because of the need for hydrogen to displace gas in the fertilizer, refining and power sectors. To cover the estimated hydrogen demand from new uses and from substitution of fossil-based hydrogen, 0.1-0.5GW of renewable electricity needs to be installed. This means that part of the 2030 hydrogen demand will still be grey.[5]

Although Lithuania has little experience in the commercialization of technology and does not currently produce any value-chain components, it is very active in research on hydrogen technology. The Lithuanian Energy Institute (LEI) and the Vilnius Gediminas Technical University follow all hydrogen and fuel initiatives and developments closely at the EU level. Lithuania became part of the European Clean Hydrogen Alliance to stimulate clean hydrogen production and gain knowledge on the topic.

1: https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/lithuanias-recovery-and-resilience-plan_en
2: https://enmin.lrv.lt/uploads/enmin/documents/files/AmberGrid_Draft_Lithuania_Hydrogen_Strategy_vFinalPresIndustry.pdf
3: ttps://enmin.lrv.lt/uploads/enmin/documents/files/AmberGrid_Draft_Lithuania_Hydrogen_Strategy_vFinalPresIndustry.pdf
4: https://iea.blob.core.windows.net/assets/4d014034-0f94-409d-bb8f-193e17a81d77/Lithuania_2021_Energy_Policy_Review.pdf
5: https://www.h2lt.eu/wp-content/uploads/2020/11/Brochure_FCH_Opportunities_for_Lithuania.pdf

Lithuania - Market overview and regulation

Perspective - continued

In 2022, the Lithuanian Energy Agency signed a Memorandum of Understanding with the National Renewable Energy Laboratory (USA) for a multi-year study to develop pathways for how Lithuania can achieve a carbon-free electricity system. One of the four pillars this is built around is “opportunities for Hydrogen Production and Utilization”. This study will be conducted in the upcoming years. [1]

Future hydrogen demand will initially be centred around the Kaunas region because of the demand from fertilizer production which makes up a large part of the total demand, as seen on the right. [2]

From 2025 onwards, road transport will become targeted by the EU ETS regulation meaning that companies must pay for emitting. This will influence the demand for hydrogen as seen on the right in the figure. Demand for hydrogen will increase due to a network of hydrogen refueling stations based on hydrogen fuels and due to increase in the use of hydrogen in the fertilizing and oil refining industry. Besides fertilizers, most demand is expected to come from heavy goods vehicles. [2]

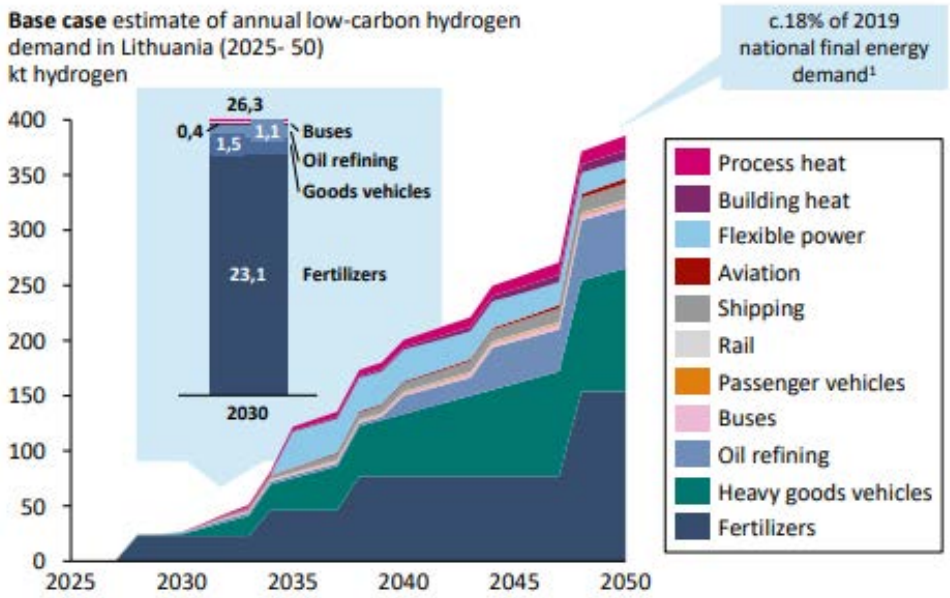
Investments in energy network infrastructure are needed to support pilot projects at first. In Lithuania, only 2% hydrogen blending in the natural gas network is possible. Additional investments could make the blending of hydrogen at 10% or higher possible. [3]

After 2030, dedicated hydrogen pipelines are required to facilitate offshore production of hydrogen. This domestic hydrogen gas network is aimed to be connected to the EU’s hydrogen backbone before 2040.

Subsidies

Around €1 billion will be needed according to the Lithuanian Action Plan with investments coming from both the private and the public sector. The government is advised to fund a significant amount of pilot projects and make use of EU investments for the roll out of hydrogen buses in the five largest cities. Moreover, there is a call announced of 20 million euros for green hydrogen in the transport sector which will be opened at the end of 2023.

Under the Law of Alternative Fuels, new support schemes have been launched with feed-in premiums and technology-neutral auctions promoting system integration. Planned investments in grid connection, storage and hydrogen are planned to stimulate hydrogen developments. [4]



1: https://www.nrel.gov/news/program/2022/nrel-lithuanian-energy-agency-partner-to-launch-100-renewable-energy-study.html
2 and figure: https://enmin.lrv.lt/uploads/enmin/documents/files/AmberGrid_Draft_Lithuania_Hydrogen_Strategy_vFinalPresIndustry.pdf
3: https://enmin.lrv.lt/uploads/enmin/documents/files/2021-06-30_KN_Development%20of%20Hydrogen%20Value%20Chain_JSV_send.pdf
4: https://iea.blob.core.windows.net/assets/4d014034-0f94-409d-bb8f-193e17a81d77/Lithuania_2021_Energy_Policy_Review.pdf

Lithuania – Targets and plans

On the short term, Lithuania is focusing its energy plans on local energy security. After 2030 Lithuania is planning to become a hydrogen exporter to industry-intensive countries like Poland and Germany. [1]

At the end of this decade, Lithuania has the target to begin testing hydrogen blending in the gas network and prepare for market-based scale up . From 2030 onwards, the focus is on the use of alternative fuels in the transport sector and the development of non-polluting energy production, storage/accumulation and consumption technologies.

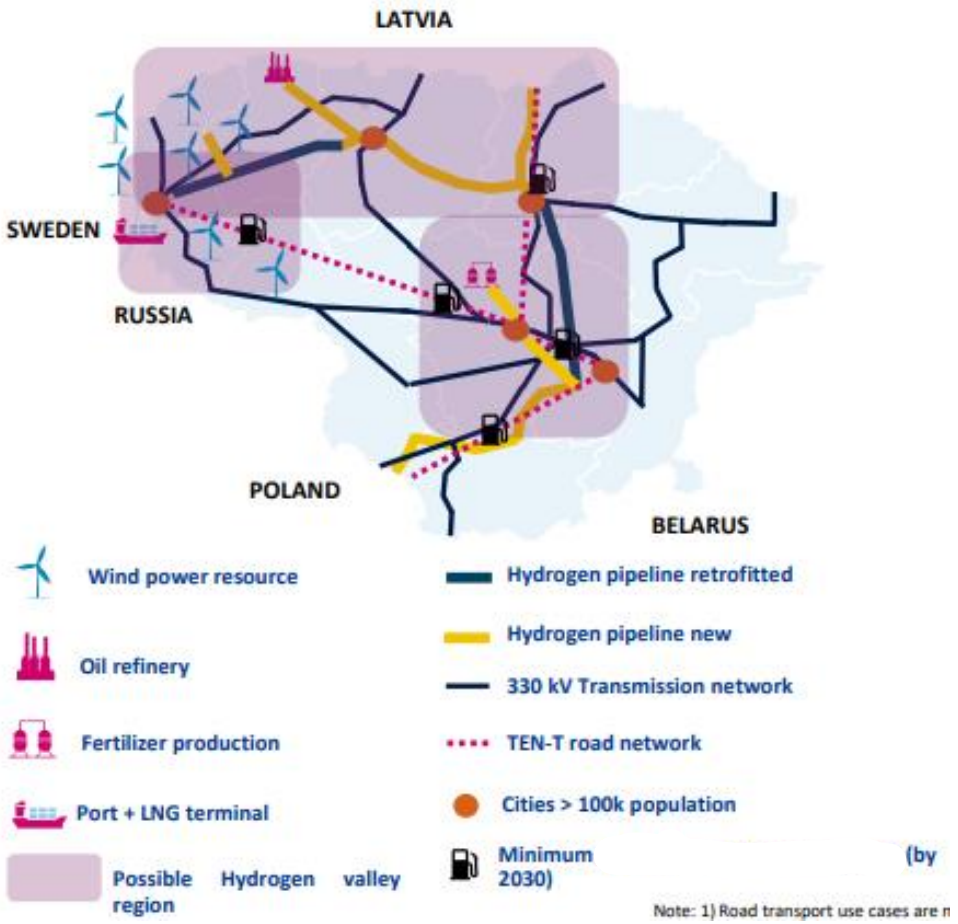
According to its action plan, Lithuania targets 300-350 MW of Electrolyser production capacity and 30 kt of low-carbon hydrogen production by 2030. Additionally, the goal is to produce ammonia domestically using low-carbon hydrogen.

Lithuania has the target to have hydrogen buses in place wherever they are the right solution for cities to become carbon-neutral. To incentivize this, they target to have 50 to 100 heavy goods vehicles powered by hydrogen in the mid-2020s and at least 5 refueling stations in place to accommodate the roll out of the hydrogen network

They plan to connect the domestic hydrogen network internationally by connecting it with Latvian and Polish hydrogen networks, creating a regional hydrogen corridor connecting Finnish, Estonian, Latvian, Lithuanian and Polish networks.

The figure on the right visualises ambitious Lithuanian plans, being [2]:

- Before to 2030, green hydrogen demand will be situated in the Kaunas region
- As hydrogen pipes become a more cost-effective high-volume transport option than electrical transmission, it may be preferred to locate production near renewable energy sources
- The Klaipeda region in the West, with its port and large wind power resources could become a hydrogen hub. Hydrogen supply from wind can be linked to the hydrogen pipeline



1: https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1634740424.pdf
2: https://enmin.lrv.lt/uploads/enmin/documents/files/AmberGrid_Draft_Lithuania_Hydrogen_Strategy_vFinalPresIndustry.pdf

Important Stakeholders, Actors and projects

Selection of important stakeholders - Estonia

Grid Operator

Elering is the electricity and natural gas TSO.

Energy companies

- Eesti Energia
- Alexela
- Utilitas
- Nelja Energia (4Energia)
- Enefit Green
- Viru Keemia Grupp

Knowledge institutes

- Estonian Association of Hydrogen technologies

Public Sector

The Hydrogen Valley Estonia (HVE) is the primary hydrogen engagement partner for the national government on policy development and aims to facilitate the hydrogen learning curve to develop hydrogen in six regions the upcoming six years. The HVE steering group consists of:

- Municipality of Tartu, Municipality of Pärnu and the Island of Saarema)
- the University of Tartu
- Some of the largest companies in energy and industry: Port of Tallinn, Tallinn Airport, Eesti Energia, Baltic Workboats, Saare Wind Energy and Terminal

The Ministry of the Environment is the responsible ministry for hydrogen developments and the main initiator for studies and developments.

Ports

- The Port of Tallinn is the biggest port in Estonia and recently signed a letter of intent to cooperate with the Port of Gdynia to collaborate on hydrogen.
- The port of Kunda
- Muuga Harbour is the largest cargo port in Estonia.

Transport companies

- Tallinna Linnatransport is the bus operator in Tallinn planning to use EU's Innovation Fund to use hydrogen buses.
- AS Tallink Grupp
- Omniva
- Eesti
- Ideal Master

Selection of important stakeholders - Latvia

Grid Operator

Augstsprieguma Tīkls AS (AST) is Latvia's grid operator and main shareholder of Conexus Baltic Grid, a unified natural gas transmission operator in Latvia.

Energy companies

- Latvenergo
- Enefit Latvia
- AJ Power

Public Sector

The Ministry of Climate and Energy was created in 2023 and took over energy-related matters from the Ministry of Economics.

Knowledge institutes

- The Green Tech Cluster is a cooperation platform for the development of green and smart technologies in Latvia.
- The Latvian Hydrogen Association
- The Latvian Hydrogen Alliance

Ports

- Riga Port is the largest port of Latvia and the second biggest port in the Baltic region. It takes part in BalticSeaH2.
- Ventspils Port sees large prospects in exporting hydrogen through the Port.
- Liepaja Port is the third largest port and completing port dredging for future offshore wind developments.

Transport companies

- Rigas Satiskme, run H2 bus pilot in Riga.
- Latvian Railways is the largest railway operator in Latvia and signed a Memorandum of Understanding on cooperation in the development of electric hydrogen-powered locomotives .
- HRX-Latvia is a Latvian subsidiary of Finnish company HRX and operates internationally in shipment services and freight transport.

Selection of important stakeholders - Lithuania

Grid Operator

State owned energy company EPSO-G holds all shares of electrical TSO LitgridAB and gas TSO AmberGrid.

Energy companies

- Orlen Lietuva
- Enefit
- Ignitus

Knowledge institutes

- Hydrogen Energy Association
- Lithuanian Energy Institute

Public Sector

The Ministry of Energy was restored in 2009 and has the mission to develop Lithuanian policy in fuel, electricity, thermo-energy production and supply for the Lithuanian economy. The Ministry coordinates the National Hydrogen Strategy preparation.
The Ministry of Transport and Communications is responsible for public transport and has the goal to install 4 publicly accessible hydrogen filling stations by 2026.

The National Lithuanian Energy Association tries to form common positions of the energy sector and represents energy companies in state institutions, public and international organizations.
The Lithuanian Hydrogen Platform was established after the Minister of Energy signed a cooperation agreement with nineteen business associations and companies. The format brings together national research institutions, businesses and the public sector.

Ports

- Klaipeda is the only seaport of Lithuania and is specialized in shipbuilding and the construction of floating docks.
  Companies operating in the port are looking at the feasibility to produce green hydrogen.
- Butinge Marine Terminal is an oil facility exclusively dedicated for importing crude oil for the domestic refinery.

Transport companies

- JSC Transimeksa is one of Lithuanian's largest transportation companies.
- Vikunija is one of Lithuanian's oldest transport companies operating on international transport.

Hydrogen Projects in the Baltics [1/3]

Project	Description	Country	Sector(s)
Mixed waste into hydrogen	Hydrogen Utopia International from Poland is turning non-recyclable mixed waste plastic into hydrogen and other carbon-free fuels, new materials or distributed renewable heat and has entered into an agreement with Rocquaine Management Limited (RML) to explore opportunities for the development of waste plastic to hydrogen plants in Estonia. RML has had preliminary discussion with Port of Tallinn's project manager and believes there is an opportunity to develop a waste plastic to hydrogen plant at a new park being developed next to the port. The hydrogen could supply commercial heavy goods transportation companies. RML is expected to introduce Hydrogen Utopia International to relevant parties in the business.[1]	Estonia	H2 production
Hydrogen shuttle Auve Tech	Estonian company Auve Tech has developed an autonomous hydrogen-powered shuttle in cooperation with the University of Tartu. The vehicle is powered by low-temperature hydrogen cells that produce energy from hydrogen inside the shuttle.[2]	Estonia	Transport
BalticSeaH2	The BalticSeaH2 project is a Cross-border initiative to create the first and largest transnational hydrogen ecosystem with different hydrogen technology solutions, research production, prototyping technologies and their applications, developing basic infrastructure and promoting systematic intersectoral cooperation. The project aims to set up a hydrogen economy in the Southern Finland and Estonian regions.[3]	Estonia Latvia Lithuania	Infrastructure
Hydrogen value chain Estonia	A group of Estonian companies will create a hydrogen value chain and plan to start with a 48MW electrolyser. OU Green Technologies Development, which is spearheading the value chain concept, H2Electro OU, which is working on hydrogen production, Paldiski Sadamate AS, which is looking to introduce hydrogen ferries and AS Tallinna Linnatransport, a public transport company owned by the City of Tallinn, which wants to switch to hydrogen buses. A fuel company developing hydrogen refueling infrastructure also intends to join the association. The hydrogen will be used to fuel buses of Tallinna Linnatransport expected to be acquired in 2024 and for retail sales through a filling station network. It will also power a train ferry operating from Paldiski North Harbour, starting in the second half of 2024.[4]	Estonia	H2 Production Infrastructure Transport
H2Nodes	H2Nodes is an initiative to realize a chain of hydrogen refuelling stations and boost demand for fuel cell electric vehicles along the North Sea and Baltic corridor, co-financed by the European Union. Three regions will be linked, being Pärnu (Estonia), Riga (Latvia) and Arnhem (The Netherlands).[5]	Estonia Latvia	Transport

1: https://www.hydrogenutopia.eu/rns/19-2-23-ybwe5
2:https://ut.ee/en/content/worlds-first-autonomous-hydrogen-vehicle-granted-road-legal-status-estonia https://www.offshore-energy.biz/balticseah2-project-moves-forward/
3 https://renewablesnow.com/news/estonian-companies-plan-to-develop-green-hydrogen-value-chain-751876/
4: https://h2est.ee/en/h2value-kick-off-2/
5: https://h2nodes.eu/en/

Hydrogen Projects in the Baltics [2/3]

Project	Description	Country	Sector(s)
H2Value	The H2Value project aims to have two pilots in Estonia and Latvia that set up small-scale green hydrogen production plant based on solar energy, establishing a green hydrogen refuelling station and testing the transportation of green hydrogen via road and use hydrogen as a zero-emissions source of fuel. [1]	Estonia Latvia	H2 production Transport
Projects from the Hydrogen Valley Estonia	The HVE has identified 27 projects in different parts of the hydrogen supply chain, from generating renewable energy to several use cases.[2] Use cases cover the sectors of transport, energy systems and built environment. The goals of the valley are: • Feasibility studies done for 95% of the projects • In 2023, new projects will be added to the HVE • In 2028, 80% of the projects operational • In 2028, HVE has added at least 1 cross border projects, defined as end use project.	Estonia	Built environ. Power Transport
Projects of the Port of Tallinn	• Tallinn's Old City Harbour Onshore Power Supply: OPS for 2-5 cruise ships with max 16MW each where hydrogen is used as energy storage mechanism • TS Laevad & H2: Create a whole H2 value chain with production, trailers, busses and trains and retrofit presently operating LMG 150-DE ferries to battery/hydrogen hybrid operation • Collaboration for H2 terminal in Paldiski South Harbor: Create a hydrogen hub with production, storage, infrastructure and filling stations • Collaboration for H2 terminal in Muuga: Create a hydrogen hub with production, storage, infrastructure and filling stations • An east-west green fuel shipping corridor through the Baltic Sea from Tallinn to Hamburg.[3]	Estonia	Maritime
AliCE-WHY	AliiCE-WHy is a project from the Institute of Solid State Physics and Ministry of Education and Science Republic of Latvia. The project aims to create a technological solution for the recycling of aluminum waste, increasing the efficiency of recycling. This is done by using hydrogen in the production process. The project is co-financed by the European Economic Area.[4]	Latvia	H2 production

1: https://h2est.ee/en/h2value-kick-off-2/
2: Strategy Hydrogen Valley Estonia via &Flux
3: https://www.ts.ee/en
4:https://www.cfi.lu.lv/en/research/projects/eea-and-norway-grants/aluminium-recycling-for-hydrogen-production-from-waste-through-hydrogen-energy-to-alumina-alice-why-aluminium-in-a-circular-economy-from-waste-to-hydrogen-energy-to-alumina-alice-why

Hydrogen Projects in the Baltics [3/3]

Project	Description	Country	Sector(s)
Achema Electrolyser	Achema, Lithuania's nitrogen fertilizer producer, plans to build a 213 MW green hydrogen production facility by the fall of 2027. The electrolyser will be powered by the 248 MW Pagegiai wind park. The project is expected to cost 344 million euros and will account for around 30% of Achema's hydrogen demand.	Lithuania	H2 production
Hydrogen Refuelling infrastructure LT	Lithuania has officially announced a call for hydrogen refueling station project implementation plans, with the goal of installing four public stations by 2026. EUR 3.6 million has been allocated from the Recovery and Resilience Facility (RRF) to support this initiative. The first station is expected to be operational by late 2024, according to the Ministry of Transport and Communications. The hydrogen refueling stations will accommodate both light and heavy vehicles with 350 bar (H35) and 700 bar (H70) fueling capacities. The ministry aims to have at least 10 public and private hydrogen refueling stations operational by 2030 and have approximately 5% of all new vehicles purchased to be hydrogen-powered. In addition to financial incentives, electric and hydrogen-powered commercial vehicles will be exempt from road tax starting July 2023 and will be eligible for a 75% road tax reduction from 2026.	Lithuania	Transport Infrastructure
Green Hydrogen Production and Blending pilot project	Lithuanian gas transmission grid operator Amber Grid, distribution network operator ESO and SG dujos signed a cooperation agreement to start Power-to-gas technology implementation. During this project, the first green hydrogen production unit will be connected to the Lithuanian gas system. The first results of the pilot project will be prepared starting 2023 and the first green hydrogen will be produced (using P2G) together with the start of a research program in 2024.	Lithuania	H2 production

1: https://h2est.ee/en/h2value-kick-off-2/
2: Strategy Hydrogen Valley Estonia via &Flux
3: https://www.ts.ee/en
4: https://www.cfi.lu.lv/en/research/projects/

Project highlight – Hydrogen Valley Estonia

The Hydrogen Valley Estonia is the world's first nationwide hydrogen valley. It serves the purpose of accelerating the hydrogen transition. Within the Baltic region this is the most elaborate initiative to kickstart the hydrogen transition with thirty hydrogen projects already identified.[1]

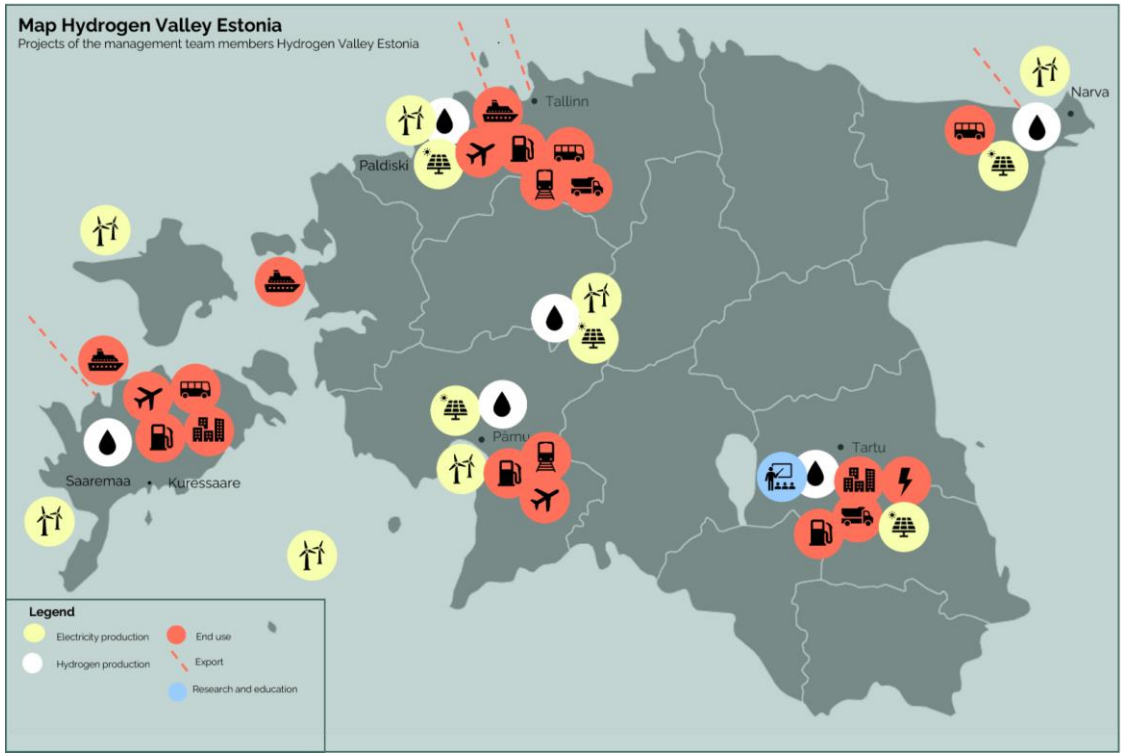
The image on the right gives an overview of all projects currently in development. Over the next six years hydrogen production will be developed in at least six locations in the country. Transport and storage infrastructure is also developed including import and export terminal infrastructure, fueling stations and storage facilities. Hydrogen end-uses currently under development include fueling stations for public transport, heavy duty vehicles, rail, shipping and aviation but also end-use of hydrogen as a feedstock for industry and net balancing solutions.

The period between 2023 and 2029 is assigned by the valley as a period of experimentation and learning from pilot projects. During this stage they need international support.

On May 25th and 26th of this year, the Hydrogen Valley Estonia organized the Estonian Hydrogen Days in Tartu. With many representatives from national and EU governments and private companies pledging for developments in hydrogen.

The founding partners of the valley include the Port of Tallinn, Tallinn Airport, Alexela, Eesti Energia, Terminal, the University of Tartu, Municipality of Tartu, Municipality of Pärnu, and the Island of Saarema.

The valley's network includes a large network of private and public organizations such as XFly, Stargate Hydrogen, Skeleton Technologies, Aviation Academy, University of Tartu, Tallinn University of Technology, TS Laevad, Liwathon, Elmo Rent, Alexela, HHLA TK, Estiko, Tallinn Airport, Skycorp, Estonian Energy, City of Tartu, Tartu Terminal, City of Keila, Saaremaa, Pärnu County, City of Põlva, and municipality of Lääne-Harju.[2]



1: Hydrogen Valley Estonia, https://vesinikuorg.ee/#Scope
2: Invest Estonia, https://investinestonia.com/estonia-launches-the-worlds-first-national-hydrogen-valley-and-h2-tech-testbed/
Picture: Hydrogen Valley Estonia, https://vesinikuorg.ee/#Scope

Project highlight – Nordic-Baltic hydrogen corridor

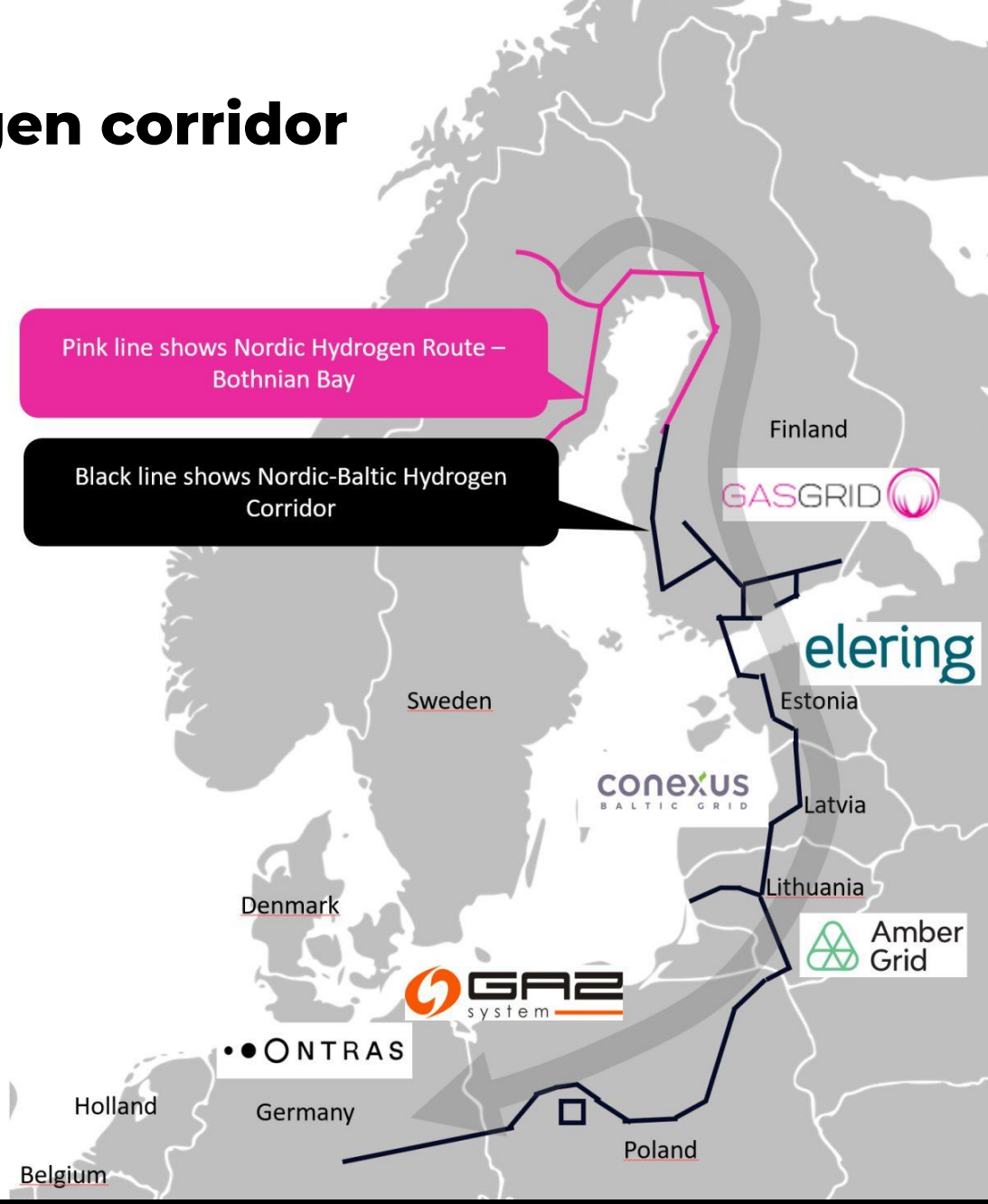
With the vision for a European Hydrogen Backbone becoming more and more materialized, European gas transmission system operators (TSOs) are starting to turn that vision into action. On December 14, 2022, TSOs from six EU countries signed a cooperation agreement on a cross-border hydrogen infrastructure project including the Baltic states, the Nordic-Baltic Hydrogen Corridor.[1]

The agreement was signed by Gasgrid Finland, Estonian TSO Elering, Latvian TSO Conexus Baltic Grid, Amber Grid of Lithuania, GAZ-SYSTEM of Poland and ONTRAS of Germany

Governments and hydrogen institutions in the Baltic states see infrastructure development as envisioned in this project as a vital part of the hydrogen transition in the region[2]. Currently a pre-feasibility study is being performed.

By 2030, the corridor is aimed to be integrated as part of the larger European hydrogen corridor. The corridor should connect industrial clusters, ports and hydrogen valleys to regions of abundant hydrogen supply.

The hydrogen infrastructure can then grow to become a pan-European network, with a length of almost 53,000 km by 2040, largely based on repurposed existing natural gas infrastructure.

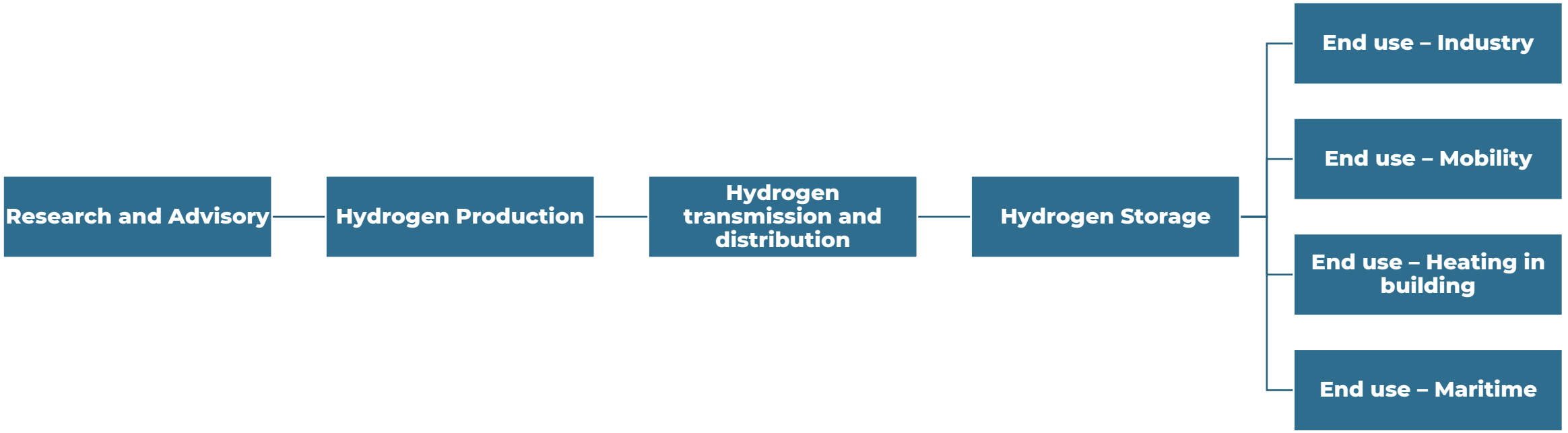


1: https://gasgrid.fi/en/2022/12/16/from-vision-to-action-six-partners-have-signed-a-cooperation-agreement-to-develop-nordic-baltic-hydrogen-corridor/
2: Interviews with Baltic government and hydrogen associations
Image: Gasgrid Finland https://gasgrid.fi/en/2022/12/16/from-vision-to-action-six-partners-have-signed-a-cooperation-agreement-to-develop-nordic-baltic-hydrogen-corridor/

Opportunities for Dutch Companies

Approach to identifying opportunities

In assessing opportunities for Dutch companies in the Baltic hydrogen sector, the NL hydrogen guide was used as an overview of Dutch hydrogen expertise.[1] The overview of hydrogen sectors below was based on the same report. For each of these sectors, short- and long-term opportunities will be identified based on policy & regulations, stakeholder interviews and supporting research. Dutch expertise will be described highlighting a selection of companies that could perform certain tasks, Potential partnership configurations are suggested for each sector. On the following slides, on the right hand side of the slide, an overview of all Dutch companies identified in the Excelling in Hydrogen report working in the sector discussed in that slide are shown.



1: Excelling in Hydrogen, Dutch solutions for a climate-neutral world, TKI Nieuw Gas,

Research and Advisory

Opportunities

In all Baltic States, knowledge of hydrogen chains and renewable energy system integration is limited. There is local knowledge and scattered experience but to develop full fledged strategies and policy, international experience is needed. Estonia, Latvia and Lithuania each have at least one hydrogen association as a source of knowledge and networking. Estonia has the most developed hydrogen plans in the form of the Estonian Hydrogen Valley.

To bring projects towards FID, project and engineering consultancy is needed according to the Estonian Association of Hydrogen Technologies.[1] Across the Baltic States, international support in terms of research and advisory is requested.[2] Several ports in the region are reaching out to international parties for strategic advisory, including possible hydrogen applications.

National and regional governments are in need of Policy support to successfully integrate their renewable ambitions into concrete legislation.[3]

Institutions in the Baltic States are motivated, with projects kicking off creating opportunities for collaboration between Dutch and Baltic parties.

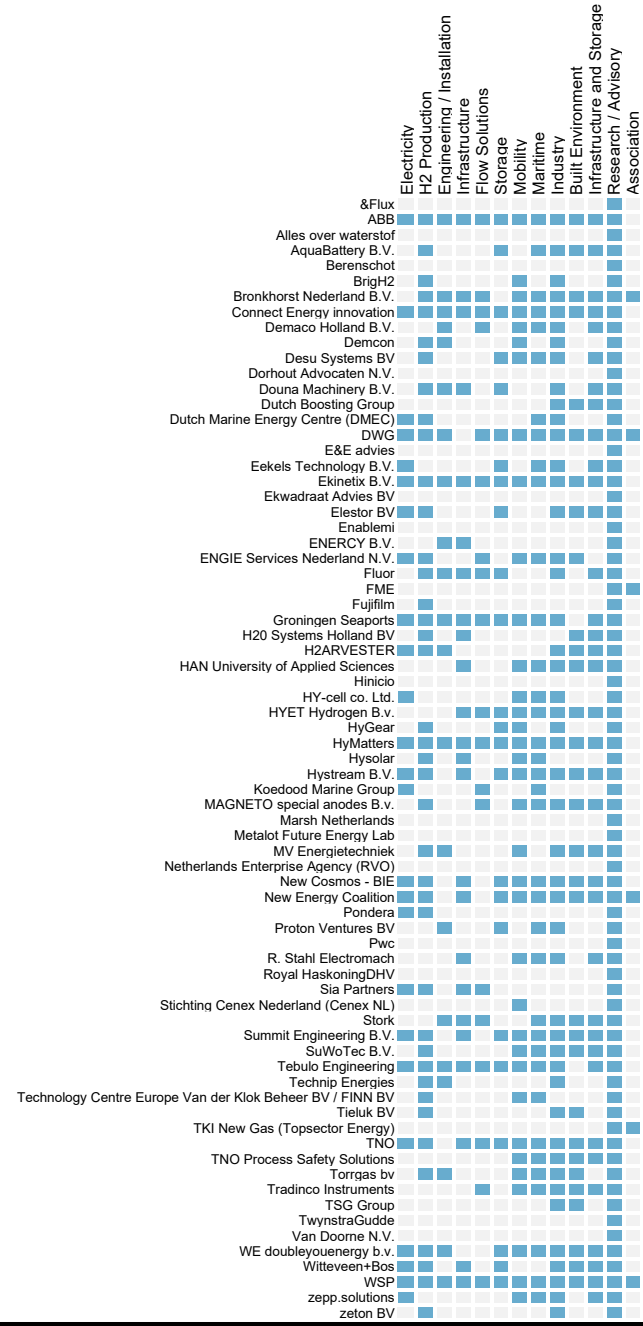
According to the Lithuanian Energy Institute, international companies including Dutch companies, are vital in providing Lithuanian companies with knowledge on how to set up the hydrogen sector and on pilot projects.

Dutch Expertise

With a small-scale hydrogen economy already in place, Dutch companies are experienced in providing advisory and research services for hydrogen developments. This Dutch system combines public and private partnerships to gather knowledge and be well-connected. Companies and organizations such as **&Flux** and **New Energy Coalition** are experienced in building hydrogen platforms and strategies. Research organizations such as **Cenex NL** develop R&D communities. Advisory companies such as **E&E Advies, Pondera, Berenschot** and **Ekinetix** can advise policy-makers and companies with developing hydrogen policy and strategy.

Potential Partnerships

- Baltic governments are interested in partnering up with international parties to develop policy.
- Baltic ports request international aid in developing green strategies.
- Baltic projects in all subsectors are in need of international expertise.



1: Interview with the Estonian Association of Hydrogen Technologies
2: Interviews with Hydrogen Associations
3: Interviews with Government Actors

Hydrogen production

Opportunities

All Baltic countries have strong offshore wind ambitions that, if realized, will most certainly result in a large surplus of electricity. This excess production can not simply be integrated into existing electricity markets, creating a need for conversion. Here, opportunities arise for the development of offshore and onshore hydrogen production.[1]

In Estonia, these wind ambitions are in their furthest stages of development with many offshore wind development regions having been identified. The country plans to install up to 200 MW production capacity by 2028. Currently there are no facilities operational.[2] In Latvia, regulatory issues remain to be resolved with regards to offshore wind development. Currently, the country is focusing mainly on onshore wind producing electricity for domestic use.

In Lithuania, there are short-term opportunities in existing industry. Fertilizer production company Achema AB is planning to build a 213 MW green hydrogen production facility by the fall of 2027, a project of an estimated 344 million euros for which they already got the required funding. Petrochemical refinery Orlen Lietuva is planning to install electrolysers linked to the wind farms they are planning to build. In Estonia, the Hydrogen Valley Estonia is developing six smaller scale production facilities for end uses in mobility.

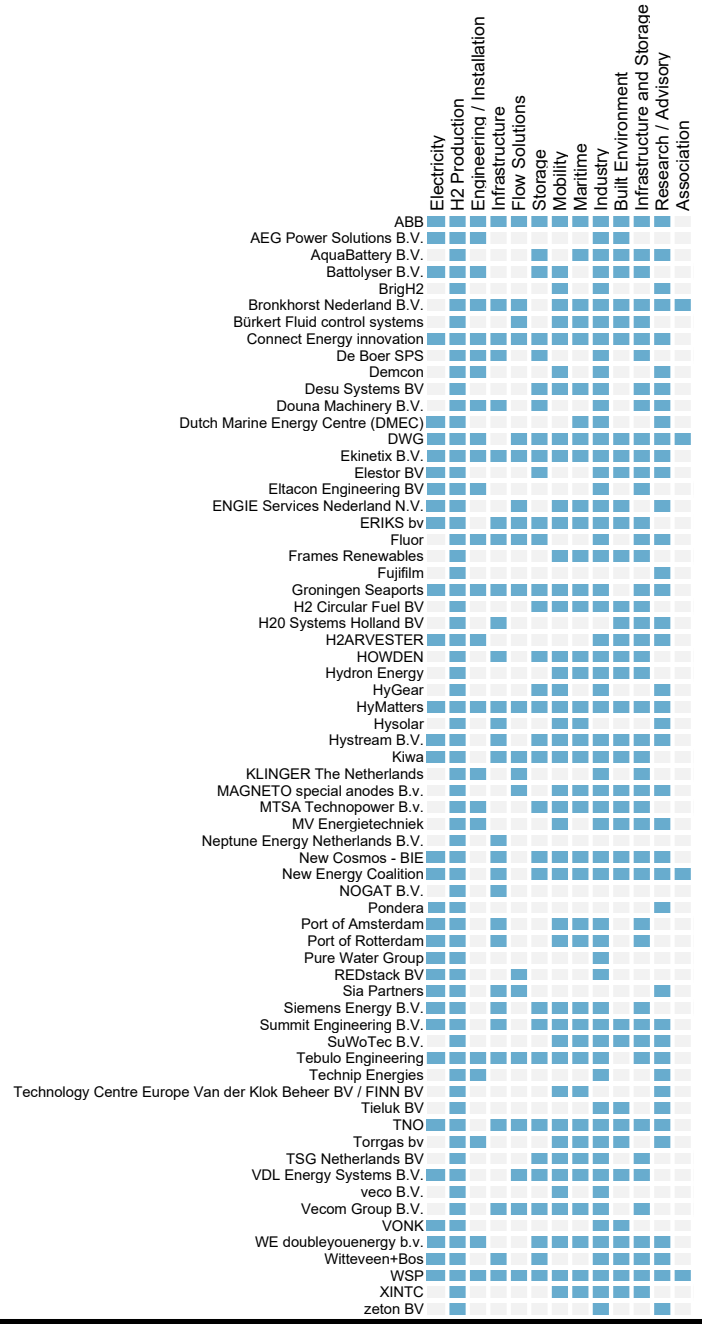
No local companies can supply parts or install electrolysers thus opportunities arise for Dutch companies.

Dutch Expertise

Whilst the hydrogen sector in the Netherlands is expected to kick-off with the production of Blue hydrogen, the required technology for green hydrogen production is being developed at a rapid pace. This highly developed industry consists of companies like **MAGNETO** that can supply parts for electrolysers, companies like **Hydron Energy** that produce electrolyser stacks and companies like **Fluor** are well equipped to design, construct and maintain electrolyser products when working together with their technology partners. Testing and certifying these systems could be done by parties like **Kiwa.**

Potential Partnerships

- In Lithuania, Dutch companies can play a role in the installation of electrolysers to decarbonise existing industry on the short term.
- On the longer term, Dutch companies can play a role in balancing electricity overproduction.
- In Estonia partnerships are possible with Hydrogen Valley project initiatives.



1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020
2: Strategy Hydrogen Valley Estonia, &flux, Skycorp, New Energy Coalition, 2022

Hydrogen transmission and distribution infrastructure

Opportunities

Local TSO's Elering, Ambergrid and Conexus are responsible for the transmission of Gas in the Baltic States. They are currently mainly looking into the potential for blending hydrogen into their gas streams. The Nordic-Baltic hydrogen corridor project is currently in the feasibility study phase. When this study is completed, more concrete infrastructure plans are expected to follow.

Short-term opportunities in the region are limited because of a limited potential for repurposing existing infrastructure and a lack of natural storage capacity in the region.[1] In Estonia, transport of hydrogen is expected to take place by (tube) trailer transport in gaseous form until at least 2029.[2]

Local hydrogen associations state that local parties have sufficient experience to facilitate short-term developments in hydrogen transmission and distribution infrastructure, this statement is supported by Latvian TSO Elering. [3] [4]

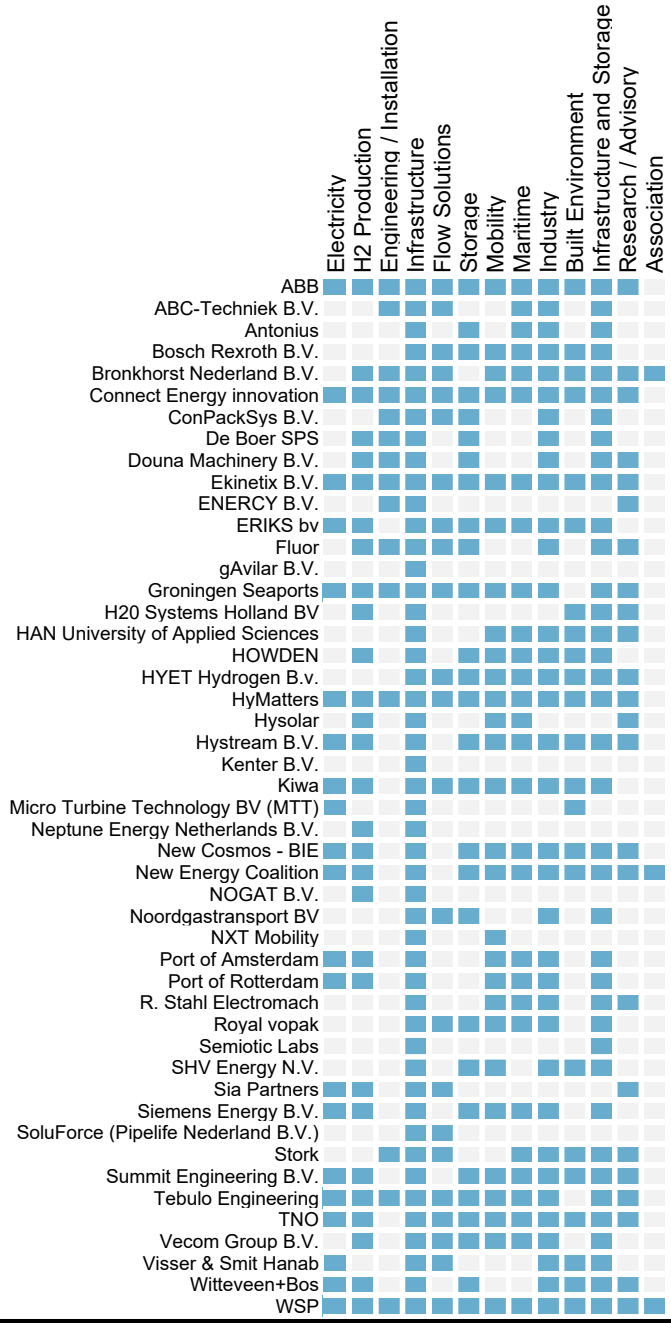
After 2030, opportunities are expected to arise from an increased production of hydrogen for export.

Dutch Expertise

A lot of activities are taking place in the Netherlands to create a hydrogen backbone which connects regional backbones. Dutch companies like **Aecom** and **Demaco** can engineer and build infrastructures. **Visser & Smit Hanab** is one of the companies that can refurbish existing gas pipeline infrastructure for industry and built environment. Companies such as **HyMatters** provide hydrogen solutions that are in line with local infrastructure for various sorts of customers. A company such as **Kenter** offers infrastructural solutions for companies to optimize their energy use and **NGT B.V.** is one of the companies that has knowledge on transforming existing infrastructure to a hydrogen backbone.

Potential Partnerships

- On the short term, potential partnerships appear to be limited to research and advisory work.
- On the longer term, partnerships are plausible with local TSOs that have to develop hydrogen infrastructure. Local knowledge is more developed in this sector, reducing need for international cooperation.



1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020
2: Strategy Hydrogen Valley Estonia, &flux, Skycorp, New Energy Coalition, 2022
3: Interviews with hydrogen associations
4: Interview with Elering

Hydrogen Storage

Opportunities

Opportunities have been identified in the hydrogen storage sector. They stem mainly from expected overproduction of electricity and high mismatches between supply and demand. The Baltic States have large potential production of renewable energy relative to their energy demands. Combined with a lack of natural storage capacity, opportunities are expected to arise in the hydrogen storage sector.[1]

Latvia has the only natural storage capacity in the region. This sandstone storage is not fit for hydrogen storage.[3]

In Estonia, two major terminals are planned to be developed. A 1,000 tons/year one by 2025 and a 10,000 tons/year one by 2028.[2]

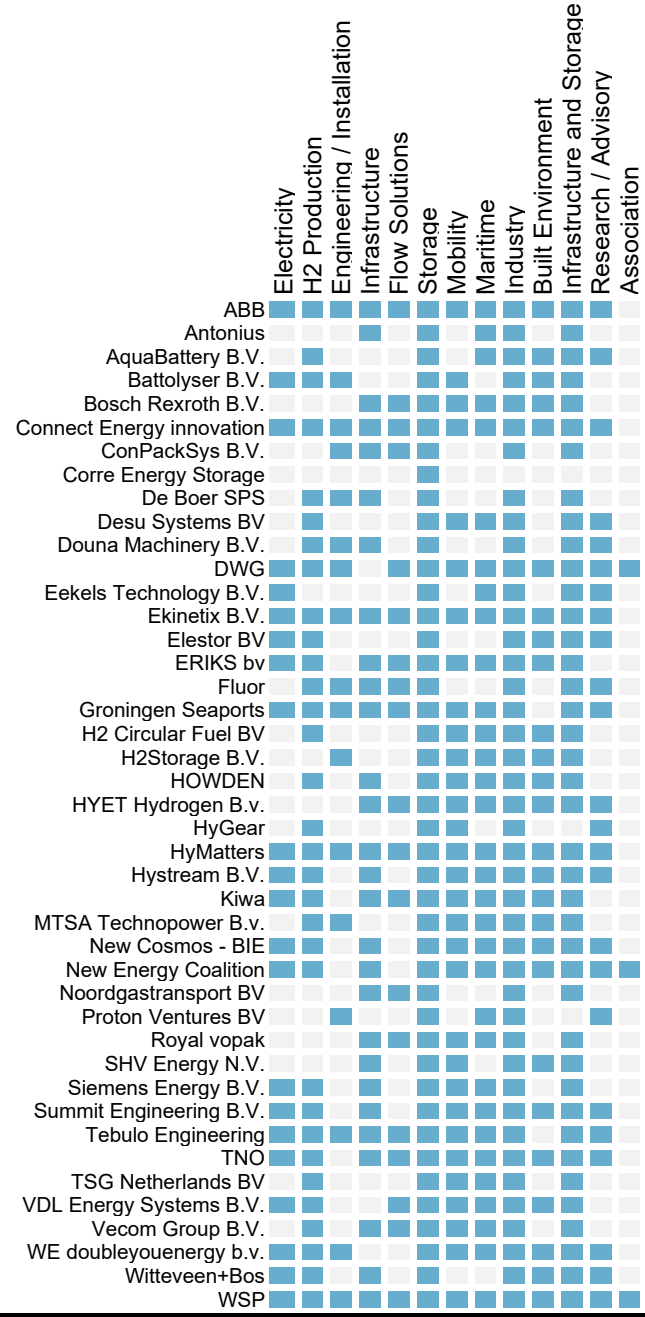
In Estonia, there are a lot of storage capabilities for diesel and petrol but not for hydrogen storage. Ground conditions do not allow for natural storage. Opportunities arise in different forms of hydrogen storage.[3]

Dutch Expertise

Dutch companies like **Battolyser**, **Aquabattery** and **H2Storage** can provide battery technologies as an alternative for natural storage. Local parties can be consulted and supported in the development of hydrogen storage projects by integrators like **ABB**, **Berenschot** and **Tebulo** Engineering. Dutch companies working in the tank terminal business like **Royal Vopak** or **Verwater** have decades of experience that they can apply to H2 storage terminals in Baltic Harbours.

Potential partnerships

- Local storage terminal companies like the Lithuanian **Klaipedos nafta** are currently looking into the potential for hydrogen storage in their terminals.
- Partnerships with local governments to develop storage strategies and locations.



1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020
2: Strategy Hydrogen Valley Estonia, &flux, Skycorp, New Energy Coalition, 2022
3: Estonian Association of Hydrogen Technologies

End use - Mobility/transport

Opportunities

In Estonia, heavy duty transport needs to move away from using fossil fuels. There are several pilot projects regarding mobility with the main one in Tartu. Opportunities arise in installing hydrogen refueling stations and bringing technical know-how and capabilities in the transport sector in Estonia to bring the projects from feasibility phase into actual projects.

The transport sector in Latvia is relatively small, but Ventspils port in Latvia is looking for hydrogen projects and collaborations to kickstart the hydrogen sector.

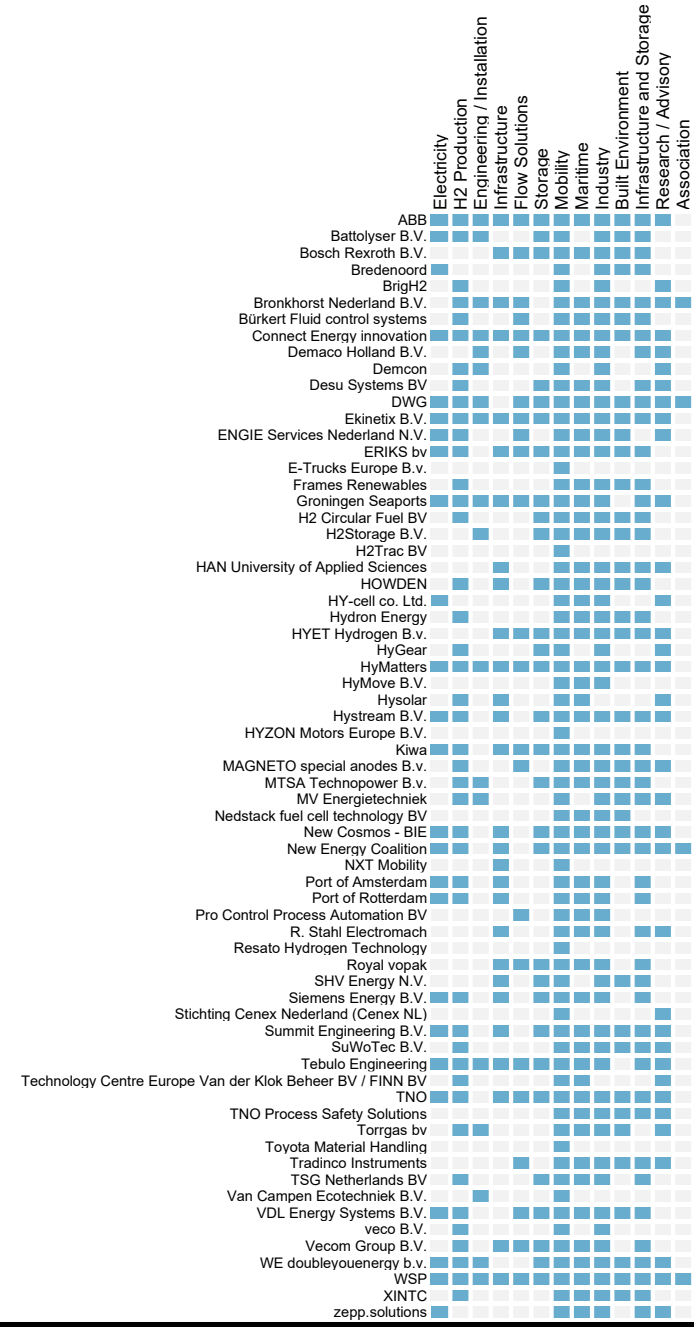
In Lithuania, 25% of public transport needs to be hydrogen vehicles in 2030 and hydrogen buses with a refueling network need to be a main part of this. The Kaunas and Vilnius region are interested in hydrogen buses, but they are waiting for a subsidy call that is opened at the end of 2023. Large opportunities for hydrogen deployment in the rail and road transport sectors. Especially in difficult-to-electrify niches like heavy duty road transport, which amount for 41% of Lithuanian road transport energy demand. Before 2030 the FCHO expects Lithuania to build between 7 and 20 H2 refueling stations.[1]

Dutch Expertise

Dutch fuel cell producers like **Nedstack** and **zepp.solutions** could support the large projected growth of the H2 mobility sector whilst companies like **VDL, EOX Tractors** or **DAF** would also be able to supply fully operational H2 vehicles. The development infrastructure like refueling stations could be co-developed by H2 tankstation developers like **Resato Hydrogen Technology** and supported by integrators like **Kiwa** or **Royal Haskoning**. In the maritime sector, **The Koedood Marine Group** and Hydro Motion are two of the companies working on zero-emission (hydrogen) boats and several companies develop hydrogen fuel cell systems, among which zepp.Solutions.

Potential partnerships

- Local public transport companies need technology to develop H2 powered public transport.
- Ports are looking for green development strategies, potential partnerships in the maritime sector.
- Local infrastructure developers need help developing H2 refuelling infrastructure



1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020

End use - Industry

Opportunities

The Baltic states have a relatively small industrial sector. Opportunities arising from hydrogen use in industry are limited as a result.

There are ambitions to attract more industry to the region in order to create a local demand for hydrogen, but concrete plans are not in place.

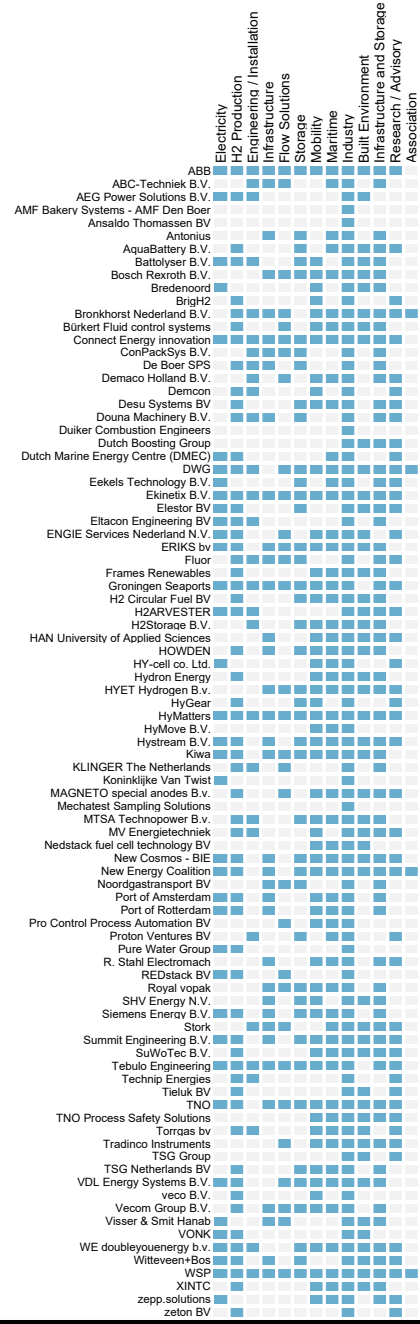
As mentioned before there are immediate opportunities in existing Lithuanian industry. For smaller industrial companies, the difficulty will be in the funding and technical feasibility for using hydrogen. Significant potential in the ammonia industry. High heat processes in industry use 26% of industrial energy demand, these processes have a high potential for hydrogen as a heat source.[1]

Dutch Expertise

In the Dutch industry, hydrogen is seen as a conventional gas replacement as well as a boost for new industry. Dutch companies, such as **Douna Machinery B.V.,** can engineer and build hydrogen machines for the industry. Dutch companies can be industry partners for storage and transport design of energy. Dutch initiatives can be an example in how to connect industrial partners and mitigate barriers in hard-to-abate industries, such as the **Deltalinqs Program**. Other companies deliver parts of hydrogen applications, like **Tradinco Instruments,** that is providing sensors suitable for hydrogen applications.

Potential partnerships

- On the short term, potential for partnerships is low because of a lack of existing industry.
- On the longer term opportunities might arise in newly attracted industry, this is as of yet unsure.



1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020
2: https://www.rvo.nl/sites/default/files/2022-05/NL-Dutch-solutions-for-a-hydrogen-economy-V-April-2022-DIGI.pdf

End use - Built environment

Opportunities

Potential for using hydrogen in the built environment in the Baltic states is low. It is not possible to repurpose most of the existing heating infrastructure to hydrogen and new infrastructure would be required. In general, electrification of energy use in the built environment and the use of district heating are superior alternatives to using hydrogen in the Baltic States.

Following the Estonian Energy and Climate Plan, hydrogen could be used as a source of heat for buildings to be fully decoupled from gas in the long term. Gas pipelines need refurbishment.

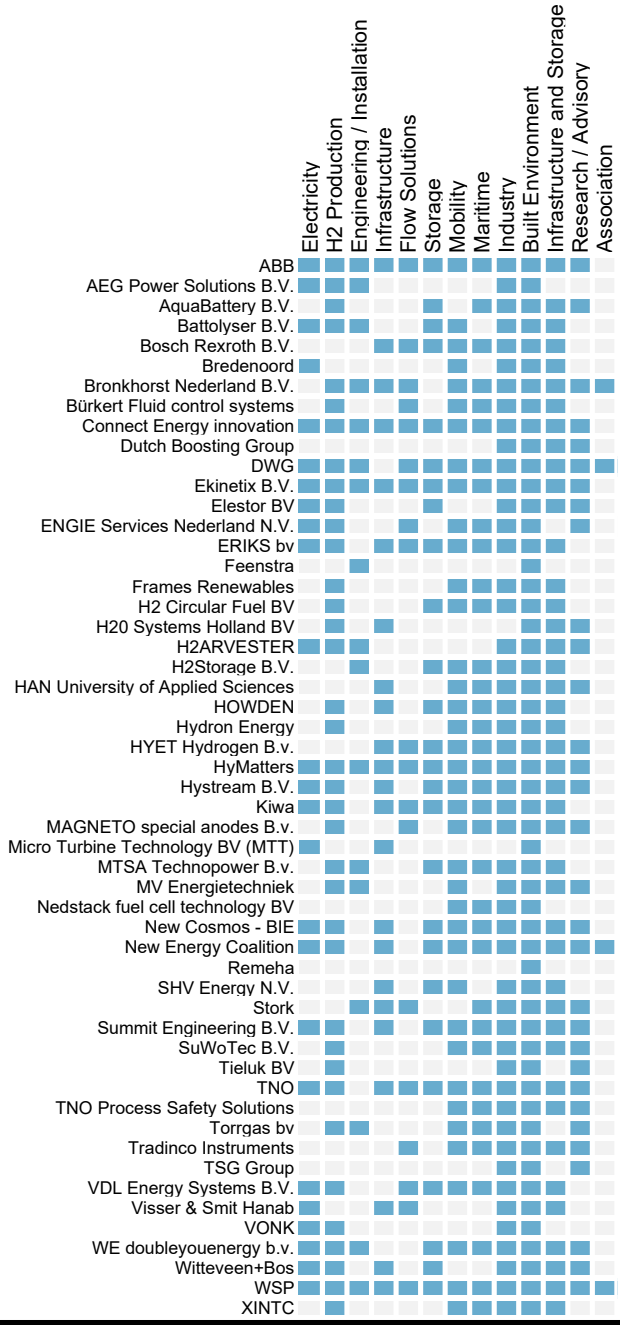
In Lithuania there are limited opportunities in the residential heating sector. Opportunities might arise from the medium to long term.[1]

Dutch Expertise

In the Netherlands, over 2 million houses must have switched to natural gas alternatives by 2030. Hydrogen in the built environment is seen as a solution for the long-term, but Dutch initiatives are already testing the use. [2] Hydrogen ecosystems are being developed and Hydrogen condensed boilers and decentralized integration of solar via hydrogen from electrolysis are being tested by Dutch companies such as **GasTerra, Stedin** and **Hydrogen Powered Solutions (HPS).** The latter is testing several hydrogen technologies for application in housing and offices.l

Potential partnerships

- Potential partnerships in the built environment are minimal

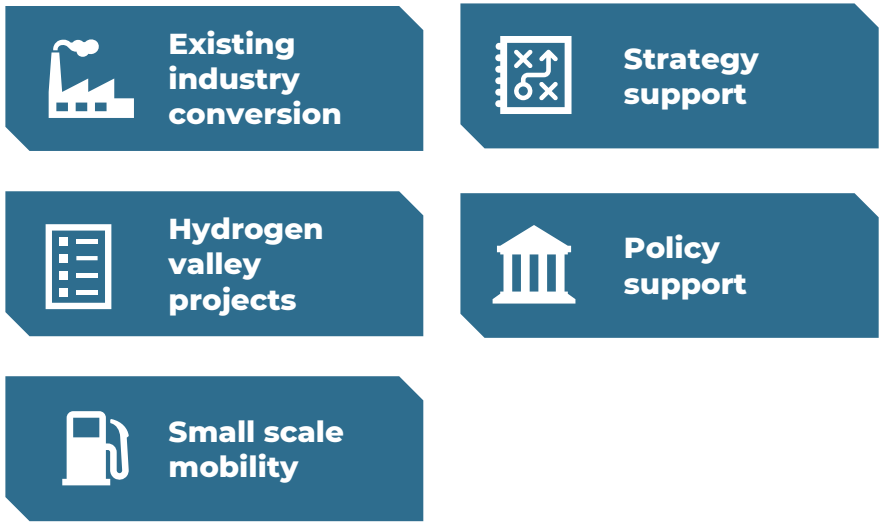


1: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans, Fuel Cell and Hydrogen Observatory, 2020
2: https://topsectorenergie.nl/documents/81/TKI_Nieuw_Gas-Overview_Hydrogen_projects_in_the_Netherlands_versie_21_-_200801.pdf

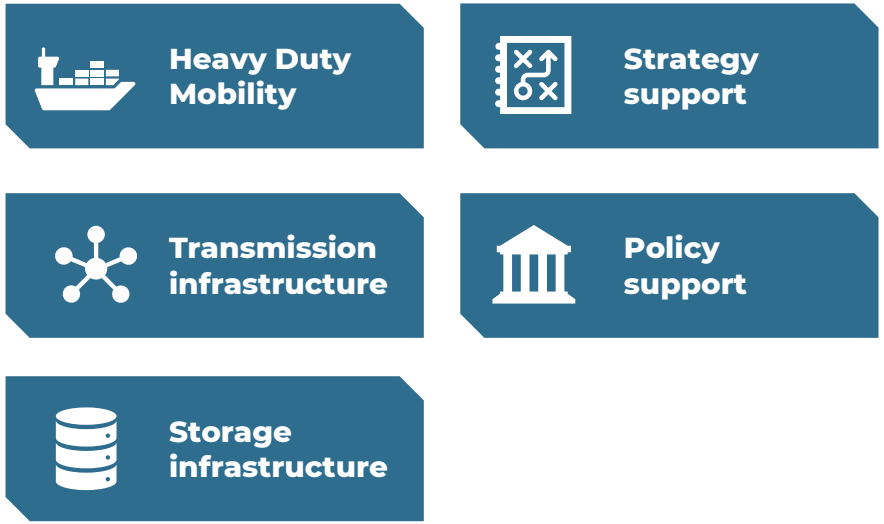
To summarise

An urgent need for reducing the region's dependence on natural gas combined with a large renewable electricity potential make the Baltic states an interesting prospect for hydrogen developments. Currently, a lack of clear policy creates an unsure climate in which initiatives remain relatively small scale. Local governments are reaching out to the international community for policy support to translate their ambitions to policy and strategy. The private sector, especially in Estonia, has taken the lead in developing the first hydrogen initiatives and need international support for their pilot projects. Ports in the region are reaching out for strategy support regarding the region's transition to renewable energy. Large offshore wind ambitions are likely to translate to large overproductions of electricity after 2030, creating a need for large scale electricity conversion to hydrogen. This requires Gigawatt scale storage capacity and transmission infrastructure. Local hydrogen markets are expected to evolve, especially in the heavy-duty mobility sector.

Immediate opportunities



Future opportunities



About Pondera

The energy transition challenges us to make difficult choices about our future energy system. At Pondera, we understand the complex challenges that governments and companies face.

As consultant and developer of sustainable energy we use our knowledge and expertise to aid in diverse energy-transition projects that contribute to a better future. Projects that rely on natural resources, such as wind, solar, hydropower and geothermal energy. We are involved in any part of a project, from feasibility studies to construction, management and exploitation.

Headquarters Nederland

Amsterdamseweg 13

6814 CM Arnhem

088 – pondera (088-7663372)

ponderaconsult.com/en/

Mailing address

Mailbox 919

6800 AX Arnhem

Office South East Asia

Jl. Mampang Prapatan XV no 18

Mampang

Jakarta Selatan 12790

Indonesia

Office North East Asia

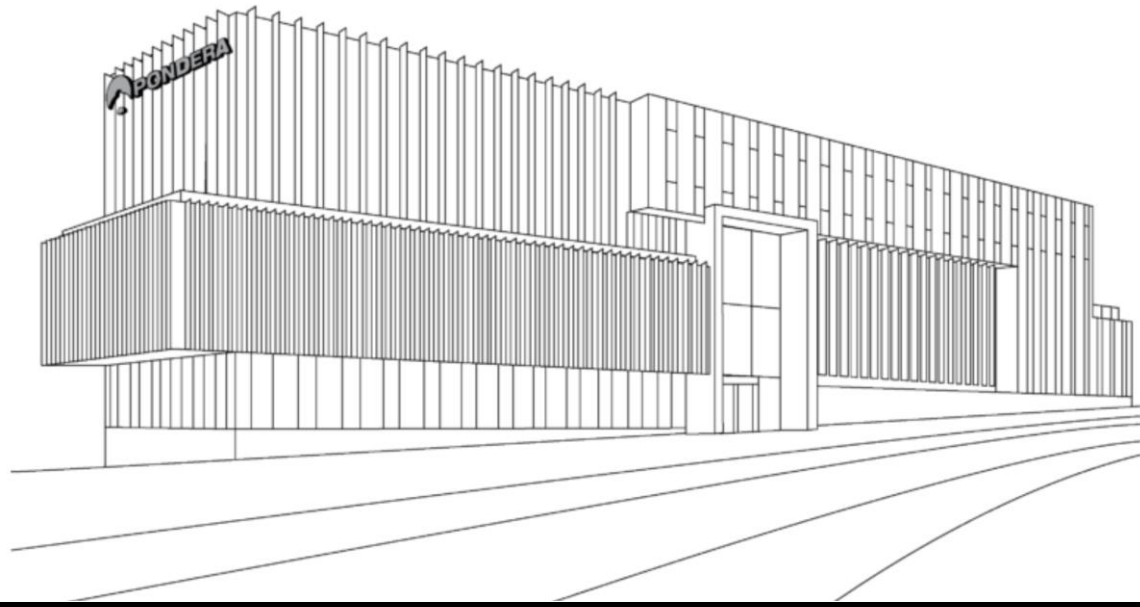
Suite 1718, Officia Building 92

Saemunan-ro, Jongno-gu

Seoul Province

Republic of Korea

EIK ISO 9001:2015 gecertificeerd



This is a publication of
Netherlands Enterprise Agency
Prinses Beatrixlaan 2
PO Box 93144 | 2509 AC The Hague
T +31 (0) 88 042 42 42
E klantcontact@rvo.nl
www.rvo.nl

This publication was commissioned by the ministry of Foreign Affairs.

Publication number: RVO-156-2023/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.