The Hague Centre
for Strategic Studies

The Dutch tank storage sector

Navigating uncertainty in the energy transition

Irina Patrahau and Lucia van Geuns

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The conclusions and recommendations presented in this paper are the result of independent research. Responsibility for the content rests with the authors and the authors alone. The research was made possible by a financial contribution from VOTOB (The Dutch Association of Tank Storage Companies) to The Hague Centre for Strategic Studies.

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Executive Summary

The tank storage sector is an essential player in global energy, food and industrial supply chains. Tank storage companies store energy, feedstock and edible oils for regional consumers, safeguard strategic petroleum stocks, and contribute to international trade. The independent tank storage sector is a service provider of energy infrastructure that owns the storage tanks but not the products inside. Storage of oil, gas, hydrogen and electricity are part of the European Union's (EU) list of essential services and considered a vital process by the Dutch Government.[1]

Energy security is a priority for the Netherlands and Europe in the current uncertain geopolitical setting with volatile energy markets. In the coming 10-15 years, tank storage facilities remain essential for matching the imbalance between domestic production of crude oil and oil products and imports. The Netherlands is an energy hub in global value chains, which allows for constant supply for refineries, chemical manufacturing companies, energy intensive industries, food industry and households in the Netherlands and the North-Western European hinterland. Tank storage companies support this function, while also safeguarding strategic reserves.

To reach net zero goals by 2050, low-carbon energy supply chains must be developed and scaled up. This is clear. What is less clear is the way in which these goals will be achieved. Even though momentum for the deployment of low-carbon fuels has been high, a gap remains between commitments and implementation. The Netherlands has been betting on becoming a key European hub for green hydrogen, but concrete projects with final investment decisions have not advanced as fast as expected. New energy markets are slow to develop, certain technologies have not reached full maturity yet, and the coordination between supply chain actors and potential consumers remains suboptimal.

Tank storage companies and other types of energy infrastructure are stuck between a rock and a hard place. The current energy landscape requires both energy security – mainly of oil and oil products – and an accelerated move to net zero. The business case for low-carbon energy remains an issue as technologies tend to not be cost-competitive and the markets remain underdeveloped. Contrastingly, oil consumption is still significant, and so is the demand for oil services. This is causing issues with the social license to operate of tank storage but also with long-term investment decisions.

Moreover, uncertainty regarding the speed and character of the energy transition has the potential of worsening industrial competitiveness in the Netherlands and the European Union. The delay in flagship infrastructure projects like Porthos for carbon storage, the Delta Rhine Corridor connecting the supply of hydrogen, ammonia and carbon between the Netherlands with Germany, the Shell biofuel plant in Rotterdam, and the slow move to address net congestion, is decreasing investors' confidence in the Dutch and European business climate. It is also impacting the investment decisions of private infrastructure companies, creating a negative feedback loop that can ultimately hurt the speed and cost of the energy transition in the Netherlands, Northwestern Europe and the entire EU.

1 Ministerie van Justitie en Veiligheid, 'Overzicht vitale processen - Vitale infrastructuur', https://www.nctv.nl/onderwerpen/vitale-infrastructuur/overzicht-vitale-processen.

To help the tank storage sector navigate an uncertain energy landscape, this paper makes the following recommendations to Dutch policymakers:

1. **Dutch climate policies should support an incremental approach to the transition for tank storage and other energy infrastructures**, in order to maintain energy security and affordability. This can be operationalised through optionality and flexibility in new market developments. There is no singular energy transition taking place in the Netherlands and in Europe, so 'one-size-fits-all' solutions that fit narrowly defined pathways are not fit for purpose. For now, storage of oil and oil products remains as important as ever, especially strategic reserves. As new markets with niche products are emerging, their needs should be integrated into infrastructure projects as well.

2. **The Dutch government should take a more active role in stimulating and coordinating supply chain-wide actions** to accelerate the energy transition. A pragmatic yet flexible approach from the government helps tank storage companies as one of the links in complex low-carbon supply chains. Different approaches are required for different markets. On the one hand, without clear commitments from suppliers and consumers as well as regulations from the government, making large private investments in infrastructure remains difficult for some carriers. For others, there are already opportunities to kick-start the market at a small scale by involving the entire supply chain, which should be pursued.

3. **Dutch policymakers and state-owned companies with commercial tasks should invest in creating the enabling conditions for a sustainable and competitive business climate**. This can start with infrastructure for low-carbon energy (hydrogen pipelines, electricity grid, etc.). The way in which governments choose to govern the energy transition also brings up the dilemma of how the public and private sectors are splitting roles in this difficult task. It is essential to find efficient ways to synergize efforts.

1. Introduction

The tank storage sector is an essential player in global energy supply chains, storing energy for regional consumers and industrial players, safeguarding strategic petroleum stocks, and contributing to international trade. Storage of oil, gas, hydrogen and electricity are part of the European Union's (EU) list of essential services as part of the Directive on the Resilience of Critical Entities.[2] Storage of oil and oil products as well as electricity is also considered a vital process by the Dutch Government.[3]

The tank storage sector, like other energy infrastructure players, finds itself in transition. The Netherlands as well as the EU aim to significantly reduce greenhouse gas emissions by 2030 and achieve carbon neutrality by 2050.[4] Instead of fossil fuels, the energy mix will consist of renewable electricity, green hydrogen and its derivatives, and sustainable biofuels. The supply chains of these new energy carriers are still being developed and require significant scale-up in order to match the demand of households, transport and industry.

Yet the phase-out of fossil fuels is not going as fast as initially expected, as the first ever stocktake of the Paris Agreement during COP28 showed.[5] Europe, although moving at a faster pace than other regions, is also not on track to reach its 2030 climate goals.[6] The Netherlands, although aiming to be a leader in the transition, has been hit by outcries from the industry that competitiveness and the business climate are suffering due to insufficient guidance in shifting to low-carbon energy. At the same time, energy security remains on top of the political agenda.

This paper takes stock of trends and developments in the Dutch and European energy markets since 2022. It assesses the impacts for the Dutch tank storage sector and makes recommendations for Dutch policymakers about ways to support storage infrastructure in an uncertain time. The focus lies on three central themes: energy security, new energy markets and industrial competitiveness.

This paper is part of the *Energy storage in transition* series of *The Hague* Centre for Strategic Studies, together with six other papers. They are all available online.

2 'Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the Resilience of Critical Entities and Repealing Council Directive 2008/114/EC', No. 2022/2557 (2022), https://eur-lex.europa.eu/eli/dir/2022/2557/oj.

3 Ministerie van Justitie en Veiligheid, 'Overzicht vitale processen - Vitale infrastructuur'.

4 Ministerie van Economische Zaken en Klimaat, 'Klimaatakkoord' (Ministerie van Economische Zaken en Klimaat, 28 June 2019), https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/klimaatakkoord.

5 United Nations, 'Global Stocktake | UNFCCC', accessed 30 September 2024, https://unfccc.int/topics/global-stocktake.

6 European Commission, 'EU Climate Action Progress Report 2023', 24 October 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023DC0653.

2. The Dutch tank storage sector in European and international supply chains

The tank storage sector

Tank storage companies store liquid bulk in large above-ground tanks.[7] The products stored as liquid bulk as of 2024 are (1) energy-related, like crude oil and oil products, but also low-carbon fuels like sustainable aviation fuels or biodiesel; (2) chemicals, including base and specialty chemicals used for plastics, fertilizers, hygienic products or healthcare; and (3) edible oils, like soybean oil, palm oil or sunflower oil. While petroleum products represent the largest quantity for the sector, this is expected to change and transition towards more biofuels, e-fuels and hydrogen derivatives. At the same time, some tank storage companies are exploring options for storing electricity through flow batteries as well as CO_2 as part of carbon capture and storage (CCS) plans.

Independent tank storage companies work as service providers. They do not own the product in storage, but they offer the infrastructure and related services (handling, blending etc.) to traders, industry or governments. They are active across the entire supply chain, from crude

7 Irina Patrahau et al., 'European Tank Storage in Today's Global Value Chains: What Role Does It Play in Our Economy?' (The Hague: The Hague Centre for Strategic Studies, March 2022), https://hcss.nl/wp-content/uploads/2022/03/Tank-storage-v3.pdf.

oil to refined products, feedstock for chemicals, final products and reused oils. Contrastingly, dependent storage companies do own the products they store and are integrated with refineries or big industrial players.

In the Netherlands, independent storage companies have a combined capacity of more than 30 million m^3 and are active participants of the Amsterdam-Rotterdam-Antwerp (ARA) trade hub. Dependent storage companies, i.e., integrated with refineries or industry, have a capacity of 17.2 million m^3 for oil and oil products.[8] As the Netherlands is a European hub supplying energy, feedstock and edible oils not just to its industries but also neighbouring countries, the country has a notably high storage capacity compared to other European countries. They account for more than 16% of Europe's total storage capacity of about 244 million m^3.[9]

The role of tank storage in liquid bulk supply chains

Broadly speaking, tank storage companies fulfil four roles in liquid bulk supply chains, illustrated in Figure 1.

Figure 1. The role of tank storage companies in liquid bulk supply chains.
Figure based on Patrahau et al., 2023[10]

Logistics	Tank storage is part of the logistics networks that supply liquids to industries, households, ports, airports and military assets.
Regional industry	The close proximity of tank storage to industrial centers ensures the availability of supplies and enhances productivity and efficiency.
Strategic storage	Strategic reserves of crude oil and products are stored by tank storage companies.
International trade	Tank storage acts as a buffer in global markets, contributing to price stability and reducing uncertainty.

8 Centraal Orgaan Voorraadvorming Aardolieproducten, 'Stockholding Obligation', COVA, accessed 30 September 2024, https://cova.nl/en/stockholding-obligation/.

9 'The Hottest Terminal Locations of 2020', Insights Global, 5 December 2019, https://www.insights-global.com/the-hottest-terminal-locations-of-2020/.

10 Irina Patrahau, Lucia van Geuns, and Michel Rademaker, 'European Tank Storage and Changing Geopolitical Landscapes', 2023, https://hcss.nl/wp-content/uploads/2023/06/European-tank-storage_Changing-geo-political-landscapes-HCSS-2023-1.pdf.

First and foremost, they are an essential link in logistics networks, storing liquids that are then supplied to households, industries, ports and airports. For instance, Schiphol Airport receives more than half of its kerosene through a pipeline from storage units in the Port of Amsterdam. The other half comes from refineries and tank storage companies in Rotterdam.

Tank storage companies in the Netherlands are part of industrial clusters between Antwerp, Rotterdam and the Rhine-Ruhr Area, known as the ARRRA petrochemical cluster. More than 40% of European chemical production takes place in Germany, Belgium and the Netherlands.[11] Within the cluster, companies share storage units, electricity, heat, wastewater treatment and steam, making its functioning very efficient and cost-effective.[12] Notably, the Rotterdam industrial cluster is the largest in the Netherlands and one of the largest in Europe, including five oil refineries, five power plants, several biofuel production sites – including sustainable aviation fuel, biodiesel or bioethanol, chemical companies, and refineries for vegetable oils and fats.[13] The services provided by storage companies support this ecosystem.

The third function of tank storage companies is maintaining strategic stocks of crude oil and products. All EU member states as well as signatory countries of the International Energy Agency (IEA) are required to hold strategic petroleum reserves.[14] In case of a supply disruption or sudden price increase, these reserves can be used domestically or released into the market to balance prices. Especially in the aftermath of Russia's invasion of Ukraine, strategic oil reserves were essential in mitigating some of the immediate price spikes.[15]

The Netherlands is, furthermore, a key actor in the international trade of crude oil and oil products, liquefied natural gas (LNG), as well as biofuels and edible oils. This is an advantage for domestic and regional industry and households, as these fuels and feedstock are widely available, diverse in specs and relatively affordable.[16] Large-scale storage capacity supports this trading function and can be used to influence global prices. When prices are too low, traders may choose to store products to reduce the supply in the market. When prices are high, they tend to remove products from storage and provide it to the market, to balance prices.

Together with the Port of Antwerp, the Ports of Amsterdam and Rotterdam function in a close-knit system as the ARA region (Antwerp-Rotterdam-Amsterdam) and are internationally recognized as a key player in liquid bulk trade. Outside of ports on the US Gulf Coast (USGC), ARA and Singapore store oil stocks of similarly large sizes, followed by Fujairah in the Middle East (Figure 2). The Port of Rotterdam is the largest port outside of Asia and

Independent tank storage companies work as service providers. They do not own the product in storage, but they offer the infrastructure and related services (handling, blending etc.) to traders, industry or governments.

11 'Refining and Chemicals', Port of Rotterdam, accessed 16 August 2021, https://www.portofrotterdam.com/en/setting/industry-port/refining-and-chemicals.

12 'Process Industry', Port of Rotterdam, accessed 31 July 2024, https://www.portofrotterdam.com/en/setting/industry-port/process-industry; Patrahau et al., 'European Tank Storage in Today's Global Value Chains: What Role Does It Play in Our Economy?'

13 'Industry in the Port', Port of Rotterdam, accessed 31 July 2024, https://www.portofrotterdam.com/en/setting/industry-port.

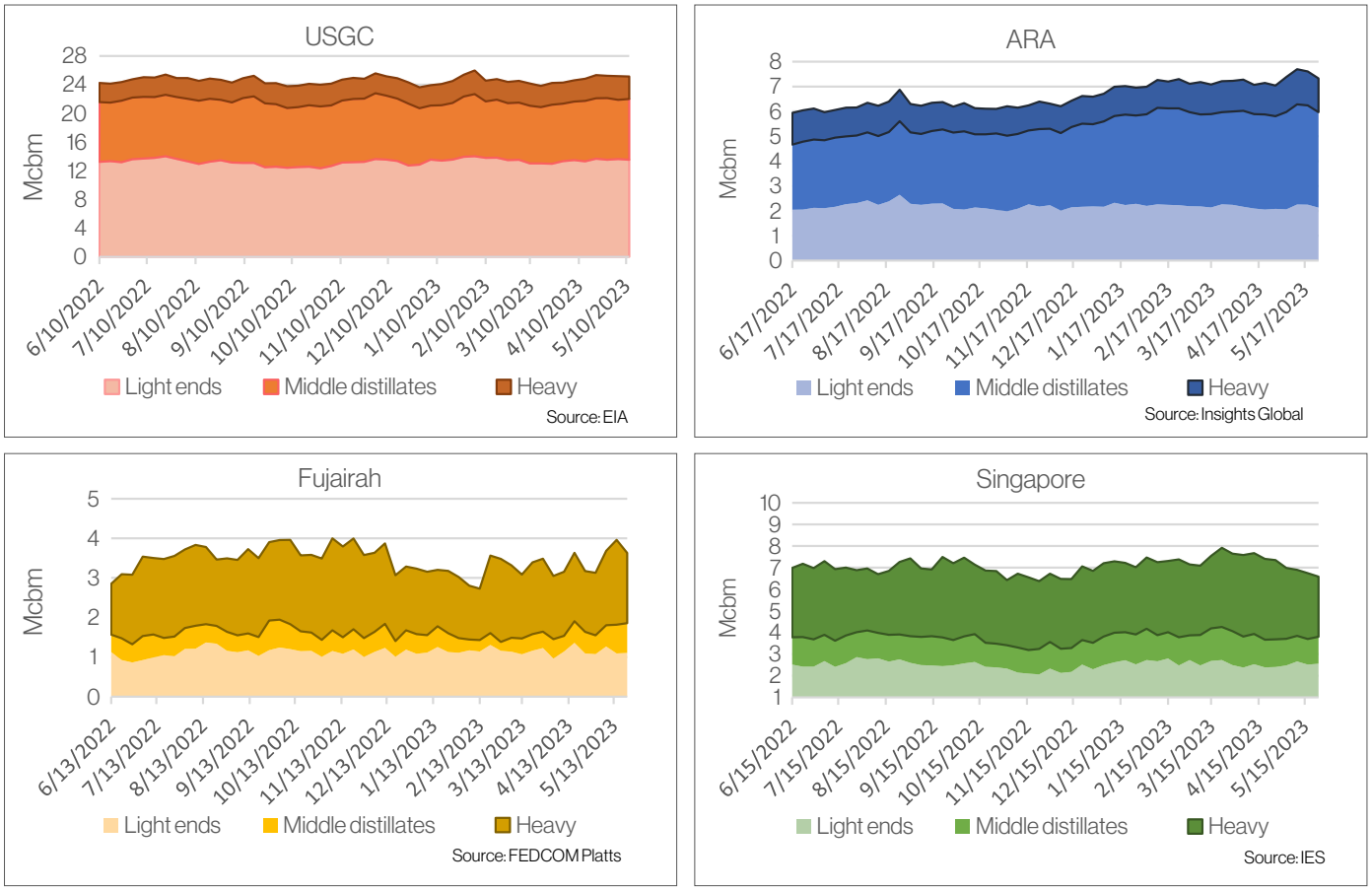
14 European Council, 'Council Directive 2009/119/EC of 14 September 2009 Imposing an Obligation on Member States to Maintain Minimum Stocks of Crude Oil and/or Petroleum Products', 2009, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0119; IEA, 'Oil Stocks of IEA Countries', 12 August 2021, https://www.iea.org/articles/oil-stocks-of-iea-countries.

15 Patrahau, Van Geuns, and Rademaker, 'European Tank Storage and Changing Geopolitical Landscapes', 2023.

16 Irina Patrahau, van Geuns Lucia, and Michel Rademaker, 'Energy Trade in the Netherlands: Past, Present and Future', 2023, https://hcss.nl/wp-content/uploads/2023/01/Energy-trade-in-the-Netherlands-HCSS-2023.pdf.

accounts for 6.2% of the Dutch GDP.[17] It is also Europe's largest bunkering port, meaning that ships of all sizes call in Rotterdam to refuel.[18] This fuel is stored in tanks. Moreover, the Port of Amsterdam is the largest gasoline trading port in the world, which is a functionality supported by storage companies and pipeline networks.

Figure 2. Global oil stocks 2022-2023.
Figure from Insights Global[19]



17 Port of Rotterdam, 'Facts & Figures', 2020, https://www.portofrotterdam.com/sites/default/files/2021-06/facts-and-figures-port-of-rotterdam.pdf.

18 Irina Patrahau et al., 'Decarbonising Maritime Bunkering in the Netherlands and the Embargo on Russian Oil', HCSS, March 2023, https://hcss.nl/report/decarbonising-maritime-bunkering-netherlands-embargo-russian-oil/.

19 PJK International, Insights Global. *Insights Global Tank Terminal Week Report* (Breda, 26 May, 2023), https://www.insights-global.com/wp-content/uploads/2023/06/Tank-Terminal-Weekly-Market-Report-Sample.pdf .

3. Energy security

In an uncertain geopolitical setting, energy security remains essential for the Netherlands and Europe. This means that the governments and the EU are working hard to ensure that energy is affordable and accessible to everyone. Especially after the war in Ukraine and the European boycott on Russian oil, energy prices skyrocketed and governments all over Europe were forced to allocate enormous budgets to ensure that all social groups, especially the most vulnerable ones, could heat and power their homes. It is estimated that European spending to mitigate the energy price crisis amounted to €1000 billion.[20]

To prevent such a situation from happening again, EU countries are making sure that their strategic stocks are filled before winter. In 2023, the final energy consumption in the Netherlands is still dominated by oil products and natural gas (Figure 3). Since the closure of the Groningen gas field, the Netherlands has also become dependent on imports of natural gas (Figure 4), so it is essential for stocks to be filled well in advance of the winter season. For natural gas, 90% of the target has been fulfilled as of August 2024 at the European level.[21]

For oil stocks, this task is coordinated by national agencies such as COVA *(Stichting Centraal Orgaan Voorraadvorming Aardolieproducten)* under legislation of the EU and the International Energy Agency, and implemented by tank storage companies.[22]

20 Jeff D. Colgan, Alexander S. Gard-Murray, and Miriam Hinthorn, 'Quantifying the Value of Energy Security: How Russia's Invasion of Ukraine Exploded Europe's Fossil Fuel Costs', *Energy Research & Social Science* 103 (1 September 2023): 103201, https://doi.org/10.1016/j.erss.2023.103201.

21 Directorate-General for Energy, 'EU Reaches 90% Gas Storage Target 10 Weeks Ahead of Deadline', 21 October 2024, https://energy.ec.europa.eu/news/eu-reaches-90-gas-storage-target-10-weeks-ahead-deadline-2024-08-21_en.

22 Centraal Orgaan Voorraadvorming Aardolieproducten, 'Stockholding Obligation', https://cova.nl/.

Figure 3. The energy mix (sources and final consumption) of the Netherlands. Figure from EBN, 2024[23]

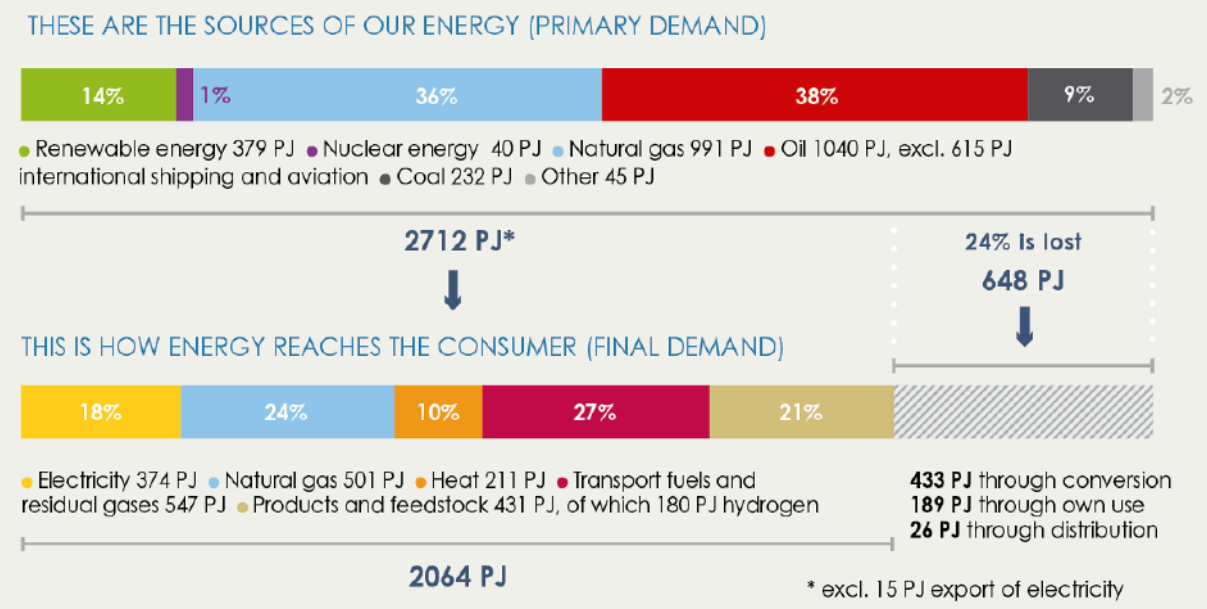
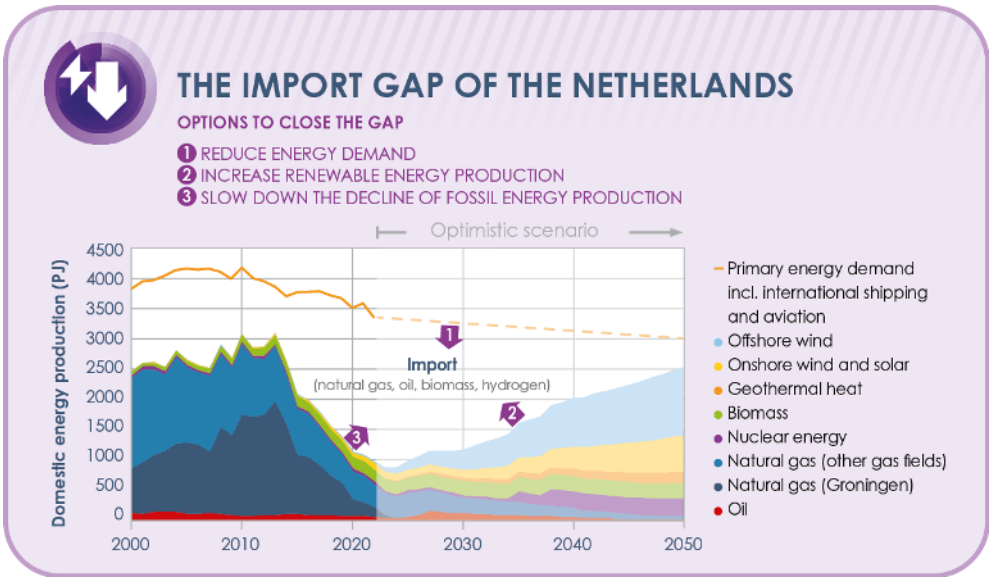


Figure 4. The import gap in the Netherlands energy mix. Figure from EBN, 2024.[24] The figure shows a significant difference between domestic energy production and consumption. This gap has been growing since the 2010s and will likely remain substantial until at least 2040-2050.



23 EBN, 'Infographic 2024', 16 January 2024, https://www.ebn.nl/feiten-en-cijfers/kennisbank/infographic-2024/.

24 'Betaalbaarheid vraagt andere interventies dan betrouwbaarheid', EBN, 22 June 2023, https://www.ebn.nl/nieuws/hoe-borgen-we-zekerheid-van-energie-tijdens-de-transitie/.

The Dutch consumption of oil and oil products as of 2024 underscores the continued need of infrastructure like import terminals, pipelines and refineries for energy security in the Netherlands. Due to climate goals and increasing shares of low-carbon energy in the energy mix, the consumption of oil and oil products has decreased by 150 PJ (less than 15%) in the last decade. Still, this remains a notable share of the total energy consumption, and the largest share of it is fulfilled through imports, strengthening strategic dependencies and increasing the risk of supply shortages.

In the next years, tank storage facilities remain essential for matching the imbalance between domestic oil production and imports. They are part of the critical infrastructure ensuring energy security for the Netherlands, the hinterland, and the other European states. Their position in global value chains ensures constant availability of oil for domestic production, while also storing strategic oil reserves. Energy storage infrastructure supports resilience in times of market instability and crisis, and strengthens freedom of action for foreign policy.

In the next years, tank storage facilities remain essential for matching the imbalance between domestic oil production and imports.

A key strategy to increase energy security is to accelerate the energy transition.[25] While renewable energy production has been growing especially since 2017, it remains a small percentage of total consumption (Figures 3 and 4). Nuclear energy contributes very little as well. The advantage of low-carbon energy – including both renewables like wind, solar and biomass; as well as green hydrogen and nuclear power – is twofold. It contributes to the fight against climate change, and a significant part of it can be produced domestically. For the consumers that benefit from domestically produced low-carbon energy, the dependence on single foreign suppliers is reduced, while strengthening the ability of the Dutch and European energy systems to continue operating even in times of market volatility and high global oil and gas prices. This will likely apply to households, but industrial players may still depend on imported green hydrogen, ammonia or methanol. Until this is achieved, the transition phase comes with challenges. Issues like net congestion and volatile electricity prices may affect consumers in the short term.

Tank storage plays a role in storing low-carbon energy as well. When it comes to liquids, products like (advanced) biofuels and green hydrogen derivatives like ammonia, methanol, liquid organic carriers or liquid hydrogen can be stored in tanks. Certain companies are also expanding their portfolio to accommodate electricity storage and the emerging CO_2 market. The next section discusses key developments in new energy markets since 2022-2023.

25 Jilles van den Beukel, Lucia van Geuns, 'Een snelle energietransitie – niet alleen voor het klimaat' Mei, 2024 https://hcss.nl/report/een-snelle-energietransitie-niet-alleen-voor-het-klimaat/.

4. New energy markets

Without clear commitments from suppliers and consumers as well as an enabling environment provided by the government, making large investments in infrastructure remains difficult.

To reach net zero goals by 2050, low-carbon energy supply chains have to be developed and scaled up. This is clearly enshrined in Dutch and European legislation like the *Klimaatakkoord*, Fit-for 55 or the European Green Deal. These goals are also shared by the main industrial clusters of the Netherlands, such as the Ports of Rotterdam and Amsterdam.

What is less clear is the way in which these goals will be achieved. Oil, gas and coal could be replaced by green electricity, low-carbon hydrogen, green ammonia, green methanol or advanced biofuels. This depends, among others, on the needs of each sector, market readiness, technology readiness, financial capital and readiness to invest. Households and road transport will likely increase their use of green electricity, maritime shipping may use more green methanol or ammonia, while aviation will likely rely on sustainable aviation fuels. Heavy industry could use more low-carbon hydrogen, ammonia or methanol.

This means that the energy transition is bringing more complexity to the energy markets. The net zero system will be characterised by a higher number of niche markets compared to the relatively large-scale fossil fuel ones. More types of actors and infrastructure across countries and continents will have to coordinate to satisfy the current demand with low-carbon fuels.

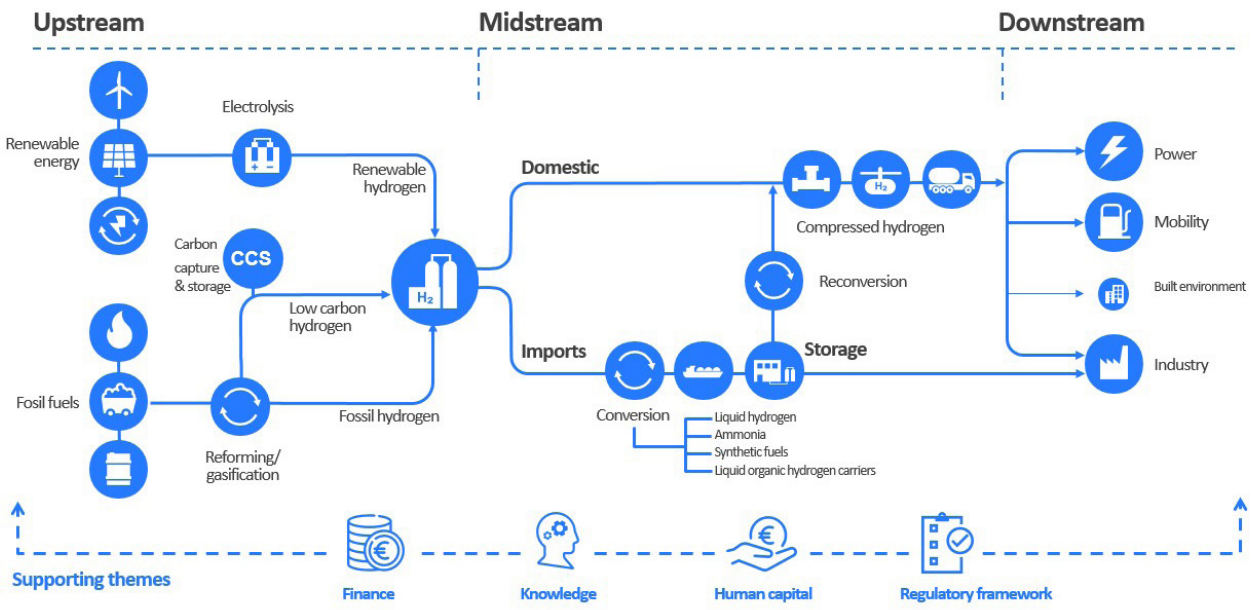
For tank storage companies and other types of infrastructure, this means a transformation of the way in which they have operated in the last decade. It requires them taking a more proactive approach in developing these supply chains. Without clear commitments from suppliers and consumers as well as an enabling environment provided by the government, making large investments in infrastructure remains difficult. The development of some of these supply chains is moving relatively fast, whereas others have encountered difficulties and delays.

The sections below discuss key developments in the new markets and implications for the tank storage sector.

Hydrogen and derivatives

The Netherlands aims to become a frontrunner in the scale-up of green (and low-carbon hydrogen) and its derivatives.[26] The 'Dutch Government Strategy on Hydrogen' from 2020 emphasizes the importance of green hydrogen to achieve climate goals.[27] It also highlights the high potential of the Netherlands to be a leader in this new market – the geographical position, leading position of harbours, industrial clusters, and existing infrastructure, make the country suitable for pursuing this new energy carrier (Figure 5). Doing so would also bring additional benefits for its competitiveness and sustainability. In support of this goal, the Dutch government is also holding an auction to offer subsidies worth €998 million to green hydrogen projects in October 2024.[28]

Figure 5. The hydrogen value chain Figure from NLHydrogen[29]



26 Renewable or green hydrogen (i.e. hydrogen produced using renewable energy sources or biomass) is one tool for decarbonising the economy. In addition to renewable hydrogen, low-carbon hydrogen is another way to reduce carbon emissions, especially in the transition period between now and the target date for climate neutrality. EU legislators defined low-carbon hydrogen as hydrogen that comes from non-renewable sources and produces at least 70% less greenhouse gas emissions than fossil fuels over its entire life cycle.

27 Ministerie van Economische Zaken en Klimaat, 'Government Strategy on Hydrogen' (Ministerie van Algemene Zaken, 6 April 2020), https://www.government.nl/documents/publications/2020/04/06/government-strategy-on-hydrogen.

28 Edwards Laity, 'Dutch Government to Hold $1bn Hydrogen Auction in October', H2 View, 20 August 2024, https://www.h2-view.com/story/dutch-government-to-hold-1bn-hydrogen-auction-in-october/2113847.article/.

29 NLHydrogen, 'H2 Facts', NLHydrogen, accessed 30 September 2024, https://nlhydrogen.nl/h2-facts/.

It is expected that a large amount of green hydrogen will be produced using electrolysers and wind power from the North Sea, in addition to imports. This hydrogen would be used both in the Netherlands as well as the hinterland. In 2023, the construction of the Dutch hydrogen infrastructure – known as the backbone – was officially kickstarted by King Willem-Alexander.[30] The pipeline network will largely rely on retrofitted natural gas pipelines, and it should be finished by 2030.[31]

The production capacity of hydrogen in the Netherlands and in Europe will not be sufficient to supply the market, so hydrogen imports will play an important role as well.[32] Transporting and storing hydrogen as a gas is not economically viable for longer distances and can best be done through pipelines on relatively short distances. For that reason, green hydrogen gas produced in Southern Europe or outside of Europe can be best transformed into a liquid form for import into the Netherlands. Some of the most promising options as of 2024 are liquefied hydrogen, liquid organic hydrogen carriers (LOHC), ammonia or methanol. Liquid hydrogen and LOHCs will likely be turned directly into gas upon arrival, but ammonia and methanol have other properties as well. Green ammonia is a key feedstock of the fertiliser industry but also a potential fuel. Likewise, maritime shipping companies are betting on methanol or ammonia as a potential fuel.

Tank storage companies will likely play a key role in the import of liquid forms of hydrogen to be used by industry in the Netherlands and beyond. Notable initiatives include the development of an import terminal of liquid hydrogen as well as one of LOHCs in the Port of Amsterdam.[33]

The initial expectation that one type of hydrogen (derivative) will rapidly become dominant in the Dutch and European markets at the expense of other types has shifted since 2021-2022. Rather, the understanding of pros and cons for each form and carrier of hydrogen is growing, making it difficult to take final investment decisions (FID). In Europe only 4% of announced clean hydrogen projects – including blue and green forms – passed the FID, while globally only 7% of the 1400 clean hydrogen projects have seen investments.[34] For instance, rapid scale up of green ammonia is under pressure in certain areas, especially those close to densely populated urban centres, due to high toxicity. The costs of cracking ammonia from green hydrogen are high as well, making it difficult for new users to get involved in this market. As such, the consumption of green ammonia is mainly growing in the fertiliser industry, where they already used grey ammonia. Other industries remain wary of expanding in this direction.

The Delta Rhine Corridor (DRC) is a proposed infrastructure project focused on transporting hydrogen and CO_2, crucial for Europe's industrial decarbonization and energy transition goals. The pipeline project that is supposed to connect Dutch ports to German industry has been

30 Gasunie, 'King Willem-Alexander Marks the Start of Construction of Gasunie's National Hydrogen Network', Gasunie, 27 October 2023, https://www.gasunie.nl/en/news/king-willem-alexander-marks-the-start-of-construction-of-gasunies-national-hydrogen-network.

31 'Hydrogen Network Netherlands', Gasunie, 27 October 2023, https://www.gasunie.nl/en/projects/hydrogen-network-netherlands.

32 Minister voor Klimaat en Energie, 'Energiediplomatie en import van waterstof' (Ministerie van Algemene Zaken, 2 June 2023), https://www.rijksoverheid.nl/documenten/kamerstukken/2023/06/02/energiediplomatie-en-import-van-waterstof; European Commission, 'Hydrogen', European Commission, accessed 30 September 2024, https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen_en.

33 Port of Amsterdam, 'H2A launch marks milestone in green hydrogen value chain in Amsterdam', 7 July 2023, https://www.portofamsterdam.com/nl/nieuws/h2a-launch-marks-milestone-green-hydrogen-value-chain-amsterdam; Port of Amsterdam, 'Waterstofmedaille voor Ellen Ruhotas', 9 February 2024, https://www.portofamsterdam.com/nl/nieuws/waterstofmedaille-voor-ellen-ruhotas.

34 Joanna Sampson, 'Hydrogen Insights: Hydrogen Project Pipeline Grows by 35% since January 2023 despite Macro-Economic Headwinds', *Hydrogen Council* (blog), 12 December 2023, https://hydrogencouncil.com/en/hydrogen-project-pipeline-grows-by-35-since-january-2023/.

delayed by at least 4 years due to a longer than expected process of approving spatial planning.[35] This is considered a flagship project and a way for the Dutch government to introduce some certainty in a highly uncertain market. As such, the announcement of the delay was quite discouraging for private sector actors that are looking to enter green hydrogen supply chains.[36] As discussed in section 5, these delays are also contributing to broader concerns around industrial competitiveness and a perception of insufficient action by governments in the Netherlands and Europe in facilitating and accelerating the energy transition.

Other projects are hampered by the slowly developing expansion of the electricity net. For instance, Uniper's hydrogen plant in the Port of Rotterdam was delayed by two years as the company was unable to secure a grid connection.[37]

As these markets are quite new and supply chains not yet established, there is an increasing push for optionality and flexibility in the industry. Rather than a one-size-fits-all, the hydrogen market will consist of many smaller markets that fulfil the specific needs of different consumers. Some will want to use green ammonia directly, others may use it mainly as a means of transport and crack it in Dutch harbours upon arrival. Some may rely on domestic green hydrogen production in the North Sea, while others will import liquid hydrogen from outside of Europe.

This is relevant for tank storage companies in their transition to net zero fuels. It is essential for players along the entire value chain to make coordinated investment decisions, so that infrastructure is available to support the new markets. This is especially relevant since the timelines for tanks to be converted to low-carbon energy vary.[38] Some of the storage units can be retrofitted from diesel to LOHC with relative ease. Others can be used directly, for example in the transition from grey to green ammonia. Yet other tanks must be built from scratch. At the same time, the costs for building a terminal for green hydrogen carriers – whether in liquid form or as ammonia – tend to be higher than those of oil terminals. For that reason, tank storage companies often await clear signals from offtakers before investing. Finally, as green hydrogen carriers have lower energy density than fossil fuels, more storage units are needed in order to fulfil the same industrial demand as before. Thus, supply chain wide decisions are essential for a smooth transition.

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35 Minister voor Klimaat en Energie, 'Kamerbrief over voortgang en procedure Delta Rhine Corridor' (Ministerie van Algemene Zaken, 27 June 2024), https://www.rijksoverheid.nl/documenten/kamerstukken/2024/06/27/voortgang-en-procedure-delta-rhine-corridor.

36 Pieter Lalkens and Han Dirk Hekking, 'De Nederlands-Duitse waterstofpuzzel is nog lang niet gelegd', *FD.nl*, accessed 30 September 2024, https://fd.nl/bedrijfsleven/1524652/de-nederlands-duitse-waterstof-puzzel-is-nog-lang-niet-gelegd.

37 James Burgess, 'Uniper Delays Rotterdam Hydrogen Plant amid High Grid Fees, Lack of Offtake Certainty', S&P Global, 15 April 2024, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/041524-uniper-delays-rotterdam-hydrogen-plant-amid-high-grid-fees-lack-of-offtake-certainty.

38 Irina Patrahau et al., 'The European Tank Storage Sector: 2050 and Beyond' (The Hague Centre for Strategic Studies, 2022), https://hcss.nl/wp-content/uploads/2022/05/European-Tank-Storage-2050-Beyond-2022-HCSS.pdf.

Biofuels

Biofuels have been a key component of European climate goals for a long time and have played an important role in the progressive decarbonization of transport. The first Renewable Energy Directive (RED I) in 2009 set goals for 10% of renewable energy to be included in road and rail transport sectors by 2020.[39] This grew to 29% renewable energy in all transport sectors by 2030 in RED III.[40]

A lot of the European biofuel production takes place in Rotterdam, which is considered one of the world's largest biofuel clusters.[41] The Port of Rotterdam is a hub that combines production, import, trade, storage and transshipment of biofuels.

What are biofuels and how can they be used?

The EU defines biofuels as liquid fuels produced from biomass, which can be agricultural feedstock (e.g., rapeseed oil, sunflower oil, corn, wheat) producing conventional biofuels; or wastes, residues and co-products (algae, municipal waste, used cooking oils and animal fats).

Depending on the production process, chemical composition and intended use, different types of biofuels can be produced:

- To be blended in diesel engines, for instance to generate electricity or for cars: Biodiesel (Fatty Acid Methyl Esther, FAME) and renewable diesel (Hydrotreated Vegetable Oil, HVO);
- To be blended into kerosene for aviation: Sustainable Aviation Fuels (SAF);
- To be blended into gasoline engines, for instance in cars: Bioethanol.

Yet issues like high production costs and low-cost imports are harming the business case of other announced plans. Shell put on hold the construction of its 820,000 tonnes a year biofuel facility in Rotterdam due to unfavourable market conditions.[42] BP paused the construction of its biofuels production plant in Germany but is continuing with plans to integrate biofuels in its refinery in Rotterdam as of 2030.[43] Producing biofuels in Europe remains relatively expensive compared to importing from China. The availability of biomass to produce sustainable biofuels

39 European Court of Auditors, 'The EU's Support for Sustainable Biofuels in Transport: An Unclear Route Ahead', 2023, https://www.eca.europa.eu/ECAPublications/SR-2023-29/SR-2023-29_EN.pdf.

40 European Court of Auditors, 'The EU's Support for Sustainable Biofuels in Transport: An Unclear Route Ahead'.

41 '"Rotterdam Is Already Home to Europe's Largest Biofuel Cluster"', Port of Rotterdam, 7 February 2023, https://www.portofrotterdam.com/en/news-and-press-releases/rotterdam-is-already-home-to-europes-largest-biofuel-cluster.

42 'Shell to Temporarily Pause On-Site Construction of European Biofuels Facility', Shell, 2 July 2024, https://www.shell.com/news-and-insights/newsroom/news-and-media-releases/2024/shell-to-temporarily-pause-on-site-construction-of-european-biofuels-facility.html.

43 'Bp to Invest in China-Based SAF', Biofuels International Magazine, 10 July 2024, https://biofuels-news.com/news/bp-to-invest-in-china-based-saf-producer/.

is limited in Europe, meaning that costs have remained high over time.[44] Contrastingly, market prices have been decreasing. The European Commission is investigating anti-dumping measures for Chinese biodiesel, which has been harming the competitiveness of European producers who are required under EU legislation to invest significant amounts to produce sustainable biofuels.[45]

Tank storage is essential in this ecosystem, which is expected to grow further despite recent uncertainties. The EU's RED III indicates an increase in the consumption of sustainable biofuels up to 2030. This is also expected to continue attracting investments in the production of these fuels in the Netherlands and Europe. Storage is necessary both for liquid types of feedstock – e.g., used cooking oil or rapeseed oil – and for the various types of biofuels. Moreover, storage companies are involved in blending fossil fuels with biofuels, preparing the final product for use by consumers. The tank storage sector already fulfils these functions, so an expansion in this field is relatively straightforward.

Carbon capture and storage

Technologies for carbon capture and storage (CCS) and carbon capture, utilisation and storage (CCUS) have been developing rapidly over time, but this market remains nascent in Europe.

The two flagship projects allowing for permanent offshore storage underground are Porthos, in the Netherlands, and Northern Lights, in Norway. Porthos suffered quite a number of regulatory delays in the Netherlands due to the nitrogen emissions associated with its development, so its construction has started in 2024 and is expected to become operational by 2026.[46] Northern Lights had a more streamlined path that started in 2020 and should be finalised in 2024.[47] Given that neither of these projects have been finalized yet, the development of other infrastructure including storage facilities is also delayed.

Although this is a new business sector for them, tank storage companies could play a role in the temporary storage of CO_2 onshore, before its transportation to the offshore permanent storage or to processing sites for re-utilisation. In the case of Northern Lights, CO_2 would be liquefied onshore and stored temporarily, before being shipped to the underground location. In the case of Porthos, CO_2 will remain in a gas form and taken by pipeline to the North Sea. CCUS projects are emerging in the Netherlands as well. Value Carbon is investing in a CO_2 recycling plant collaborating with storage company Evos who is building tanks for liquefied carbon.[48]

44 European Court of Auditors, 'The EU's Support for Sustainable Biofuels in Transport: An Unclear Route Ahead'.

45 European Biodiesel Board, 'EBB Initiates Anti-Dumping Proceedings against Chinese Biodiesel Imports', December 2023, https://ebb-eu.org/wp-content/uploads/2023/12/2023_EBB_PR_AD_China.pdf.

46 'Interim Ruling by Council of State Delays Porthos Project', Porthos, 2 November 2022, https://www.porthosco2.nl/en/interim-ruling-by-council-of-state-delays-porthos-project/; 'Project', Porthos, accessed 30 September 2024, https://www.porthosco2.nl/en/project/.

47 'What We Do', Northern Lights, accessed 30 September 2024, https://norlights.com/what-we-do/.

48 'Value Carbon Partners with Evos to Build Future Proof Carbon Storage Tanks', Value Maritime, 12 December 2023, https://valuemaritime.com/news/value-carbon-partners-with-evos-to-build-future-proof-carbon-storage-tanks/.

Electricity

The expansion of batteries for electricity storage is one of the most pressing needs of the renewable energy system. Initiatives to develop large-scale battery storage are proliferating across the Netherlands and Europe. Transmission system operator TenneT needs around 10 GW of flexible storage by 2030 for a stable electricity grid.[49]

Electricity can be stored in liquid form in flow or saltwater batteries, which could be promising for tank storage companies specialized in liquid storage. Flow batteries consist of two tanks storing liquid electrolytes, while saltwater batteries make use of sodium to conduct and store electricity.[50] Storage company Vopak is experimenting with vanadium redox flow batteries in Singapore and Australia, and is looking at developing hydrogen bromine flow batteries as well.[51]

The entry of tank storage companies into the electricity market would imply a change in their business model, as they would own the electricity and be involved in its trade. This is different from the service provision model, whereby storage companies offer their infrastructure for rent to traders and customers.

49 TenneT, 'TenneT's Position on Battery Energy Storage Systems (BESS)', 15 June 2023, https://tennet-drupal.s3.eu-central-1.amazonaws.com/default/2023-06/TenneT_s_position_large_BESS_-_Public_Info_-_update.pdf.

50 Nancy Stauffer, 'Flow Batteries for Grid-Scale Energy Storage', MIT News | Massachusetts Institute of Technology, 7 April 2023, https://news.mit.edu/2023/flow-batteries-grid-scale-energy-storage-0407.

51 'Energy Transition', Royal Vopak, accessed 30 September 2024, https://www.vopak.com/new-energies-and-sustainable-feedstocks?language_content_entity=en.

5. Industrial competitiveness

Energy intensive industries (EII) like chemical manufacturing, oil refining or recycling in the Netherlands have been under pressure due to economic and political reasons. The competitiveness of EIIs has decreased over time, with negative impacts on domestic manufacturing capacity and an increase in reliance on imports. As EIIs rely on large amounts of energy for their processes, high energy prices, high carbon prices and the difficulty to decarbonize have been key root causes for decreased competitiveness.[52]

Economically, energy intensive industries are struggling with the high electricity costs in the Netherlands and the uneven playing field compared to other regions.[53] The Netherlands has much higher costs than the United States or China, making it difficult for Dutch companies to offer competitive prices on global markets. Even though other European countries have relatively high costs as well, the effective costs paid by industry after indirect cost compensation in the Netherlands (€95/MWh) is much higher than in Germany (€46/MWh), France (€32/MWh) and even Flanders (€56/MWh). Unlike these countries, the Netherlands has no indirect cost compensation and high network charges with no exemptions. Congestion issues and investment needs in the electricity grid make it even more difficult for companies to maintain operations.

From a political perspective, the relatively weak industrial policy of the Netherlands compared to the strict corporate social responsibility regulations, long lead times for permitting as well as negative public opinion, are hampering industrial competitiveness as well.

52 Mario Draghi, 'The Future of European Competitiveness: Part B In-Depth Analysis and Recommendations', September 2024, https://commission.europa.eu/document/download/ec1409c1-d4b4-4882-8bdd-3519f86bbb92_en?filename=The%20future%20of%20European%20competitiveness_%20In-depth%20analysis%20and%20recommendations_0.pdf.

53 'Electricity Costs for Large Industrial Consumers: An In-Depth Comparative Analysis of the Netherlands, Germany, France and Belgium', E-Bridge, 2024, https://e-bridge.com/portfolio-items/electricity-costs-for-large-industrial-consumers-an-in-depth-comparative-analysis-of-the-netherlands-germany-france-and-belgium/.

Companies have been raising their concerns about the potential implications of this weak business climate. Industrial production in the Netherlands has been systematically decreasing.[54] Aluminium producer Aldel and zinc producer Nyrstar put their operations on hold in early 2024 due to the high energy prices.[55]

Uncertainty regarding the energy transition and the implications for infrastructure sectors have the potential of further deteriorating the business climate.[56] The delay in flagship infrastructure projects like Porthos for carbon storage, the Delta Rhine Corridor connecting the Netherlands with Germany, the Shell biofuel plant in Rotterdam, and the slow moves to address net congestion, is decreasing investors' confidence in the Dutch and European business climate and hampering long-term competitiveness. This uncertainty is negatively impacting the investment decisions of private infrastructure companies as well, creating a negative feedback loop that can ultimately hurt the speed and cost of the energy transition in the Netherlands, Northwestern Europe and the entire EU.

Uncertainty regarding the energy transition and the implications for infrastructure sectors have the potential of further deteriorating the business climate.

54 'Productie Industrie Blijft Dalen, Wel Kleine Lichtpuntjes', NOS, 10 June 2024, https://nos.nl/artikel/2523869-productie-industrie-blijft-dalen-wel-kleine-lichtpuntjes.

55 Rob Koster, 'Na Aluminium Stopt Nu Voorlopig Ook de Productie van Zink in Nederland: "We Moeten Echt Opletten"', NOS, 4 February 2024, https://nos.nl/artikel/2507559-na-aluminium-stopt-nu-voorlopig-ook-de-productie-van-zink-in-nederland-we-moeten-echt-opletten.

56 Bert Van Dijk, Mathijs Schiffers, and Albert Wagenaar, 'De Vijf Plagen van de Europese Industrie', Financieele Dagblad, February 2024, https://fd.nl/politiek/1504696/de-vijf-plagen-van-de-europese-industrie; Lisa Van der Velde, 'Bezorgdheid over flinke vertraging aanleg waterstofleiding', BNR, 28 June 2024, https://www.bnr.nl/nieuws/duurzaamheid/10551423/bezorgdheid-over-flinke-vertraging-aanleg-waterstofleiding.

6. Concluding remarks and policy recommendations

The tank storage sector is stuck between a rock and a hard place. The current energy landscape requires both energy security – mainly of oil and oil products – and an accelerated move to net zero. The business case for low-carbon energy remains an issue as technologies tend to not be cost-competitive and markets remain undeveloped. Contrastingly, oil consumption is high, and so is the demand for their oil services. This is causing issues with the social license to operate of tank storage but also with long-term investment decisions.

Moreover, uncertainty regarding the speed and character of the energy transition has the potential of worsening industrial competitiveness in the Netherlands as a whole. The delay in flagship infrastructure projects and the slow move to address net congestion, is decreasing investors' confidence in the Dutch and European business climate. It is also impacting the investment decisions of private infrastructure companies, creating a negative feedback loop that can ultimately hurt the speed and cost of the energy transition in the Netherlands, Northwestern Europe and the entire EU.

To help the tank storage sector navigate an uncertain energy landscape, this paper makes the following recommendations to Dutch policymakers:

1. **Dutch climate policies should support an incremental approach to the transition for tank storage and other energy infrastructures**, in order to maintain energy security and affordability. This can be operationalised through optionality and flexibility in new market developments. There is no singular energy transition taking place in the Netherlands and in Europe, so 'one-size-fits-all' solutions that fit narrowly defined pathways are not fit for purpose. For now, storage of oil and oil products remains as important as ever, especially strategic reserves. As new markets with niche products are emerging, their needs should be integrated into infrastructure projects as well.

2. **The Dutch government should take a more active role in stimulating and coordinating supply chain-wide actions** to accelerate the energy transition. A pragmatic yet flexible approach from the government helps tank storage companies as one of the links in the complex low-carbon supply chain. Different approaches are required for different markets. On the one hand, without clear commitments from suppliers and consumers as well as regulations from the government, making large private investments in infrastructure remains difficult for some carriers. For others, there are already opportunities to kick-start the market at a small scale by involving the entire supply chain, which should be pursued.

3. **Dutch policymakers and state-owned companies with commercial tasks should invest in creating the enabling conditions for a sustainable and competitive business climate**. This can start with infrastructure for low-carbon energy (hydrogen pipelines, electricity grid, etc.). The way in which governments choose to govern the energy transition also brings up the dilemma of how the public and private sectors are splitting roles in this difficult task and how to synergize efforts most efficiently.


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