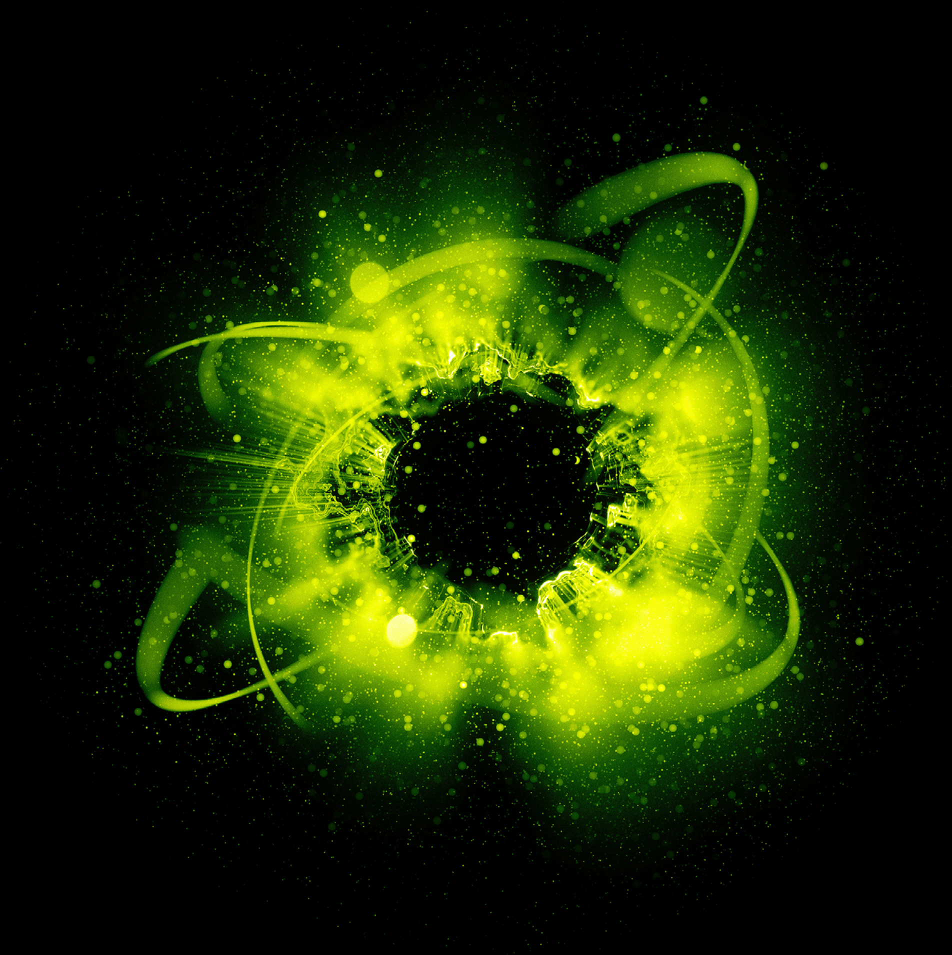


Deloitte's Energy Transition Monitor

Energy transition at a crossroads

A Deloitte Netherlands publication

September 2023

Executive Summary

The energy transition is arguably the most challenging undertaking of this generation. The Netherlands has made good progress, so far, but the country has come to a crossroads. Most of its progress has come from picking the low-hanging fruit, and reducing industrial output, but to achieve the emission goals for 2030 and beyond, fundamental choices need to be made around the structure of the Dutch economy and the energy system that enables it. The Netherlands has excellent offshore wind potential, a long-established industrial sector, and a leading educational system, so the country is well-placed to create a global blueprint for a successful energy transition.

A successful energy transition depends on the right decisions being made, which require the right information. This Energy Transition Monitor therefore provides a common fact-base, with which to assess the transition's progress. However, true progress requires more than just reducing emissions (because have we really been successful if we relocate emissions to other countries?). This report therefore provides a holistic perspective, and brings together statistical data, stakeholder perspectives (NGOs, journalists, industry professionals, academics and government officials) and an analysis of public sentiment.

Using these sources, this report examines the transition's progress from 1990 to 2022, toward the country's statutory (Klimaatakkoord) targets for 2030 and overall goal of net-zero emissions by 2050. Some key highlights:

01. The industry sector has reduced its emissions the most, but through lower production output and by reducing non-CO_2 greenhouse gases, so the real transition still needs to start.

02. National energy-related emissions have reduced by 32% in 2022 (relative to 1990). However, this ignores emissions from international aviation and shipping, and imported products, which together exceed the reported national emissions.

03. 15% of energy consumed in the Netherlands comes from renewables – mainly biomass, but with strong growth in wind and solar sources for generating clean electricity.

04. Electrification offers the greatest potential for increasing the use of renewables, but progress has been limited. For instance, electric vehicles represented only 1.5% of the mobility sector's energy consumption.

05. One in three households on average now uses at least one clean energy technology (solar panels, EVs or heat pumps), and the adoption rate is growing fast.

06. Although public sentiment is mixed, the Dutch energy transition has achieved some notable successes, such as the EU's highest adoption of solar panels and per capita provision of EV charging stations, and 40% of the country's electricity now being generated from renewables.

The current rate of progress is too slow to meet the Dutch 2030 targets, so the energy transition must accelerate, and tough decisions lay ahead. To help make a successful transition, the following approaches to the transition are proposed.

01. Develop the path together
Combine private and public interests, to benefit Dutch society and economy, as well as the global climate. In particular, industrial emissions should be considered alongside domestic production, possibly including a target for manufacturing output.

02. Take full responsibility
The effect on greenhouse gas emissions from international aviation and shipping and imported goods should be taken into account when designing and evaluating emission-reduction policies and incentives.

03. Take the public along
Public support can be harnessed by celebrating the transition's successes, and by using public policy to set new behavioral norms, rather than focusing purely on financial incentives.

04. Decarbonize molecular energy demand
Although electrification should remain the main focus, the remaining demand for molecular sources should be decarbonized more actively, by promoting the use of clean hydrogen and making optimal use of the limited biomass resources.

05. Prioritize impact in scaling
Incentives have proved an effective way to promote the household take-up of some clean energy technologies, and should now focus on initiatives where the Dutch government is leading and where the greatest impact on emissions can be achieved. For instance changing domestic heating from gas to new renewable technologies, which will create the demand, momentum and confidence for the private sector to scale up production.

The Energy Transition Monitor provides an overview of the status of the energy transition and proposes bold ideas to accelerate it further and creates a starting point for discussion, allowing professionals in the field to work together and make the right decisions for future progress.

Contents

1. Introduction

The energy transition is arguably the most challenging undertaking of this generation. With the excellent offshore wind potential, the long-established industrial sector, and a leading education system, the Netherlands is well-placed to face this challenge and create a global blueprint for a successful energy transition.

The country has made substantial progress so far, but the Netherlands has come to a crossroads. Most of its progress has come from picking the low-hanging fruit, such as efficiency measures, reducing industrial output and making more use of existing technologies, including solar and wind power. The next decade, however, will require the country to make fundamental choices, around whether to meet its net zero target by curbing demand, replacing grey domestic production with imports, or transforming the economy to become green. These choices will have profound implications for the future of the Dutch country, society and economy. It will determine how the Dutch live, create economic wealth, and interact with their environment. Moreover, a balance needs to be found between reducing emissions, ensuring security of energy supply and maintaining economic affordability, which is also referred to as the energy trilemma.

To make the right choices, industry professionals, academics, policy-makers and society as a whole need a clear view and common fact-base on the status of the energy transition in the Netherlands. But this view must encompass more than simply measuring national emissions, because has the transition been successful if emissions have just relocated? The Energy Transition Monitor provides a comprehensive view of the current state of the energy transition in the Netherlands and shows what lies ahead, by combining statistical analysis (e.g., data from Centraal Bureau voor de Statistiek (CBS), Eurostat, Nederlandse Emissieautoriteit (NEa) – with stakeholder sentiment – based on 37 industry interviews and social media analysis. As this report focuses on the Dutch energy transition, its scope is limited to the energy-related greenhouse gas (GHG) emissions that are emitted in the Netherlands (see Figure 1).[a]

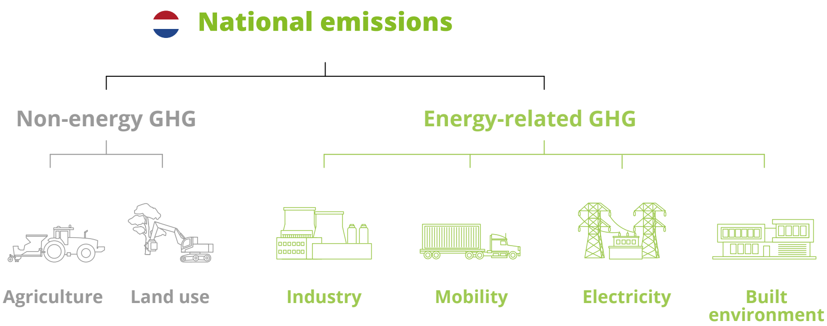


Figure 1: Scope of the Energy Transition Monitor (energy-related GHG emissions in green)

The Energy Transition Monitor is published in 2023, roughly half-way along the transition timescale: from 1990, the common reference year, to 2050, when net zero emissions need to be achieved.[b] As the implications of climate change become more widespread globally, and countries look ahead to 2050, this is a very relevant time to take stock of progress to date and develop a clear view on what needs to happen next.

The next chapter summarizes the Dutch energy transition in terms of three metrics: energy-related emissions,[c] energy mix and investment in clean energy technology, which are examined in more depth in the following chapters. The conclusion of this report presents Deloitte's perspective on the Dutch energy transition and the way forward.

If we can't make it happen in the Netherlands, where will we? Person

NGO Representative

We have picked the low-hanging fruit and are now at a crossroads

Industry professional

The energy transition is more than just a quest to reduce megatonnes

Government Official

[a] Emissions from agriculture and land use are outside the scope of the report, because they are not energy-related; it is acknowledged that these emissions play a large role outside of the energy transition.

[b] European Climate Law and EU Green Deal state the goal of net-zero emissions by 2050, while the Dutch Climate Law (Klimaatwet) requires a 95% reduction in GHG emissions by 2050 compared to 1990 levels.

[c] Non-energy emissions are emissions from agriculture and land-use change (e.g., emissions from crops, livestock and conversion of land into agricultural land); these will be shown but not analyzed in depth – see more details in the chapter "Monitoring Dutch Emissions".

2. The state of progress, shown in three charts

The state of progress of the energy transition in the Netherlands can be summarized in three metrics: GHG emissions reduction, share of renewable energy, and investment in clean tech, which the following three chapters will analyze in more depth.

Energy-related GHG emissions reduction measures progress toward the overall goal of

net zero by 2050. Energy-related GHG emissions have decreased by 32% (1990 to 2022). This relates to the Netherlands' legally-binding target to achieve a reduction of 55% by 2030 (as part of the EU's 55% overall target).[a, 1]

Share of renewable energy measures progress in the energy system transition. In 2022, renewable energy made up 15% of total final energy consumption in the energy mix, compared with only 1% in 1990.[2] This relates to the 2023 target of 16.7% (Energieakkoord), and the European 2030 target of 27% for the Netherlands (32% for the EU overall).[b, 3, 4, 5]

Investments in clean technology reflect the adoption of clean energy technologies by Dutch households. Dutch households are investing at a fast growth rate in three clean energy technologies: rooftop solar panels, electric vehicles and heat pumps.

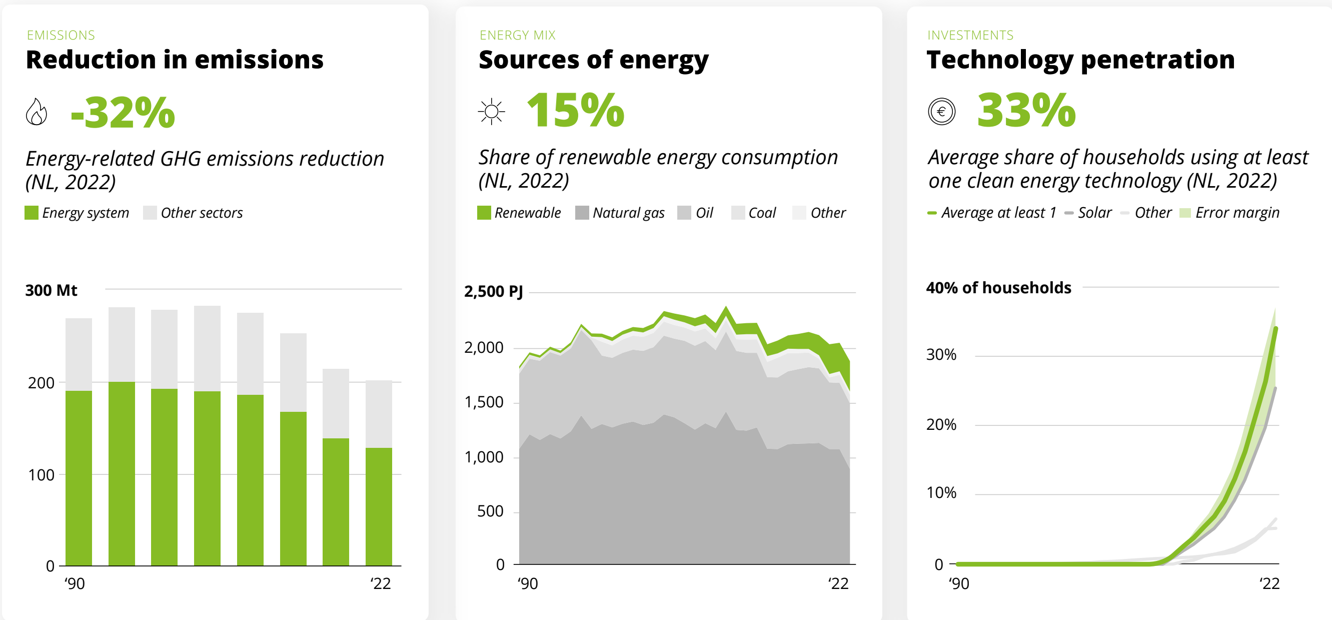


Figure 2. Three graphs showing the status of the Dutch energy transition: energy-related GHG emissions, share of renewable energy in total final energy consumption and investments in clean technology by households in NL.[c, 2, 9, 10, 11, 20, 22]

[a] (1) The target for the national emission reduction of the Netherlands until 2030 includes land use and agriculture. (2) The 55% emission reduction goal is laid down in the Klimaatwet. According to the EU climate law, the Netherlands has to achieve and emission reduction of 49%.

[b] Lower limit of the National Energy and Climate Plan (NECP) of the Netherlands. The upper limit is 35%. In March 2023 the European Parliament and Council reached a provisional agreement to raise the target of renewable energy to at least 42.5% by 2030.

[c] (1) 2022 data on emissions from land use and international aviation and international shipping emissions based on 2021 data. (2) The average of Dutch households that have invested in clean energy technology was calculated using the statistical average which calculates the average of households that have at least one of the three technologies. Average = 1 – [(1 – share of households with solar panels)*(1 – share of households with EVs)*(1 – share of households with heat pump)] (3) Error margin indicates the range of statistical possibilities of households having at least one technologies, given the uptake of the technologies individually.

Call-out A. The energy transition – mixed feelings amongst the Dutch

The energy transition not only affects everyone, but its progress depends on societal support. It is therefore important to understand the attitude of the Dutch population toward the energy transition. As a proxy, a sentiment analysis was conducted, of 10,000 selected posts that were published between 2012 and 2022 on the social media platform formerly known as Twitter.[a]

Compared with ten years ago, six times as many tweets expressed negative feelings toward the energy transition. Almost half of the recent tweets analyzed expressed doubts or concerns, for example, on current (insufficient) pace, the feasibility, costs and drawbacks of the energy transition. Only a tenth of the tweets analyzed expressed positive attitudes on topics such as current progress, the current direction of the Netherlands, and the effectiveness of the energy transition.

This contrasts with tweets from government officials and other policy-makers, whose negative sentiments about the energy transition have decreased by two-thirds over the past ten years.

However, the energy transition cannot happen without societal support, so public sentiment must be recognized. Throughout the transition, affordability and energy security for today's society needs to be balanced with the sustainability needs of future populations.

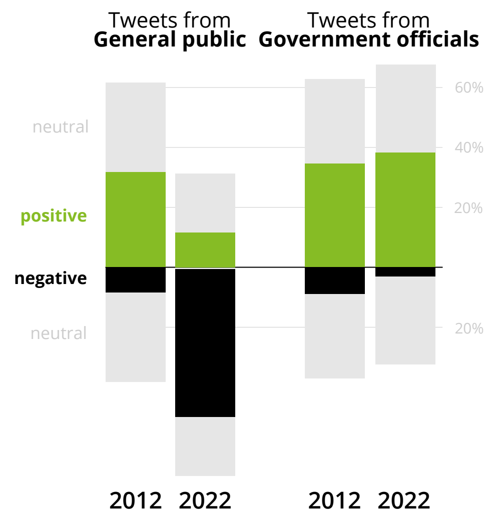


Figure 3. Changing sentiment in tweets mentioning the energy transition, originating from the general public and government bodies or agencies (2012 vs. 2022) [b, 7]

The behavior change required from our society represents a key barrier to decarbonize the economy

Academic

It's the biggest transition of our time, so we can't leave any people out

NGO Representative

[a] For detailed methodology of the sentiment analysis, see Appendix.

[b] The neutral sentiments are divided equally over positive and negative sentiments.

3. Monitoring Dutch GHG emissions

By 2022, the Netherlands has reduced 32% of its energy-related national emissions compared to 1990. Looking at emissions in the energy system, the mobility sector has made the least progress, especially when international aviation and shipping are included, while industry has made greatest progress, and almost halved its total GHG emissions. However, the progress achieved by industry does not show signs of a real transition yet, and most reduction has been achieved by reducing non-CO_2 greenhouse gasses and production output. Therefore, Dutch industry faces important choices that must balance greener domestic production with suitable import policies, to achieve the right outcomes for the economy, society, and the planet. Finally, Dutch citizens and businesses are indirectly responsible for the significant emissions caused by imported products, raw materials and semi-finished goods, which are roughly as large as total national emissions.

3.1 Reduction of NL GHG emissions: clear progress, which varies by sector

Energy-related emissions account for the majority of Dutch GHG emissions, and have decreased by 32% since 1990, to a total of 128 Mt CO_2-eq (0.4% of global energy-related emissions). However, national emissions exclude emissions from imported products (which are hard to assess), and emissions from international aviation and shipping, which have grown since 1990 to an additional 45 Mt CO_2-eq in 2022 (see Call-out B). This means that the overall reduction in emissions, including international aviation and shipping, is only 24%. This reduction relates to the binding target for Dutch national emissions, set by the Dutch national climate law (Klimaatwet),[a] which means the country is legally obliged to achieve a 55% reduction in national GHG emissions (i.e., excluding international aviation and shipping, including agriculture and land use) by 2030, compared to 1990 levels.[b] Based on 2022 emission levels, the Netherlands must therefore make a further reduction of 54 Mt CO_2-eq in the next seven years. However, emissions have reduced by an average of only 21 Mt per decade since 1990, so a major acceleration of emissions reduction is needed if the Netherlands is to achieve its 2030 goals.

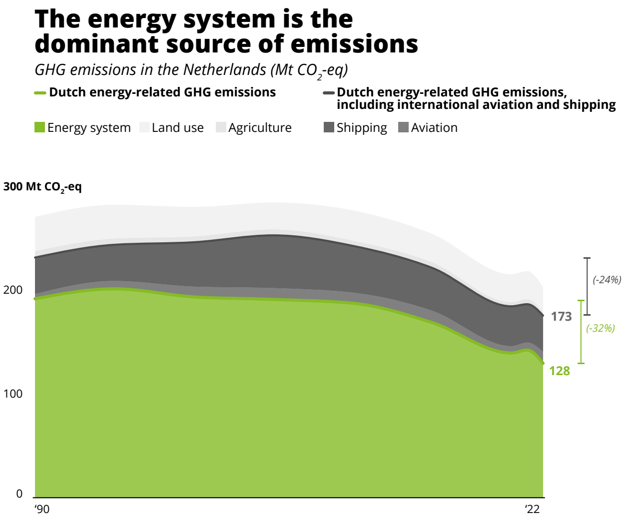


Figure 4: NL GHG emissions, covering national emissions and emissions from international aviation and shipping (Mt CO_2-eq, 1990–2022) [c, 8, 9, 10, 11]

[a] The Klimaatwet is the translation of the EU Climate Law into Dutch national law and had previously a target of 49%. Based on the effort-sharing policy of the EU, the Netherlands does not have to achieve a reduction of 55%, However, the Dutch Cabinet under Rutte IV has agreed to a target of 55% for 2030, with the ambition to reach 60%. The 55% target has been entered into Dutch Law before the coalition was dissolved and is now legally binding as of beginning 2023.

[b] In 2022 the Dutch Cabinet increased this target in the Coalition Agreement under Rutte IV a reduction of 55% of GHG emission, with the ambition to reach 60% by 2030, which also raised the emission targets per sector. However, these targets are not changed in the Klimaatakkoord, and are not definitive by sector.

[c] 2022 data on emissions from land use and international aviation and international shipping emissions are based on 2021 data.

Call-out B. National versus non-national energy-related GHG emissions of the Netherlands

Dutch GHG emissions include national emissions – emitted in the Netherlands, as accounted for by the CBS – and non-national emissions, which relate to Dutch activities, but are emitted outside the Netherlands.

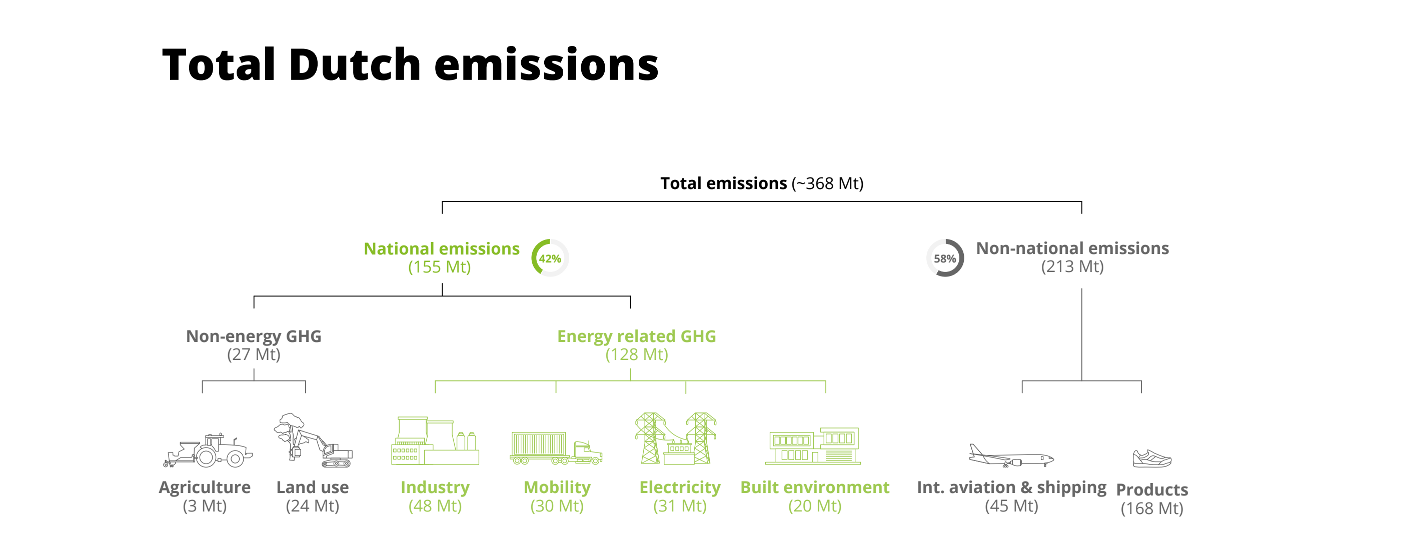


Figure 5. Scope of the Energy Transition Monitor [a, 8, 12]

- National GHG emissions include energy-related and non-energy emissions (e.g., agriculture and land use).
- National energy-related GHG emissions are split into four main sectors, as defined by the intergovernmental panel on climate change (IPCC).
- Non-national emissions include emissions from international aviation and shipping, and imported products.
- International aviation and shipping emissions do not count toward official national emissions figures. However, they are noted herebecause they do relate to Dutch economic and social activity. In 2022, the emissions from international aviation and shipping were 45 Mt CO_2-eq, which would make it the sector with the second-highest emissions. International aviation bunkering emissions can reasonably be attributed to Dutch activities, as planes typically take on fuel at stops on their route, so emissions from fueling in the Netherlands have a logical connection to the country. International shipping bunkering emissions are more difficult to assign: while some bunkering is a consequence of Dutch trade activity, the Netherlands' location and the Port of Rotterdam's infrastructure allow many cargo vessels to bunker off-route, so not all bunkering emissions arising in the Netherlands can be attributed to Dutch activities.
- Emissions related to imported goods and services (including electricity) are excluded from official national accounts of emissions because they are not released within national borders. However, there is a case to be made that Dutch businesses and citizens are directly responsible for these emissions through consumption of goods produced abroad and import of raw materials and semi-finished goods: these emissions contribute to the welfare of Dutch society, while impacting the global climate. To give an indication of the size, CO_2 emissions (excluding non-CO_2 gases) from imported goods are roughly as large (168 Mt CO_2) as all emissions made on Dutch soil (national emissions). For the purposes of consistency with standard accounting practice, emissions from imports are beyond the scope of this report.[b] Additionally, including imported goods into national emissions would lead to double accounting of emissions amongst countries.

[a] Note (1) that due to rounding energy-related emissions add up to 129 and (2) emissions of imported products is extrapolated from 2018 data by taking the average of the previous five years.

[b] Standard accounting practice here refers to the reporting requirements of the IPCC, which measures CO_2-eq emissions that are emitted during activities that happen within the national boards, including emissions related to export products. The emission figures are broken down into six climate sectors (Industry, Electricity, Mobility, Built environment, Agriculture & Land use).

The Klimaatakkoord is part of Dutch climate policy. It is an agreement between many organizations and companies in the Netherlands to combat greenhouse gas emissions. It categorizes national emissions into six sectors, each with its own emissions reduction targets: built environment, mobility, industry, electricity, agriculture, and land use. The first four sectors represent the national energy system. In 2022 these represented 128 Mt CO_2-eq emissions (-32% since 1990), meaning the Netherlands needs to reduce 36 Mt (-28%) from the 2022 emission level to reach the 2030 target.

Of these four sectors, industry has progressed most since 1990, in both absolute and relative terms, with a 39 Mt CO_2-eq reduction (-44% relative to 1990). This means a gap of 16% relative to 2022 emissions needs to be closed by 2030. It should be noted that some industrial reductions arose from the special circumstances that the Netherlands experienced last year. For instance, the war in Ukraine caused gas supply shocks and subsequent high gas prices, which led some companies to halt production, and therefore reduce their emissions.

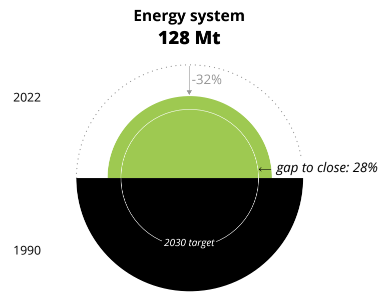
The built environment has achieved a 10 Mt CO_2-eq reduction (-35% relative to 1990). This means a gap of 28% relative to 2022 emissions still needs to be closed by 2030. The reduction has been driven mainly by efficiency measures, extension of heat networks and the initial adoption of heat pumps, which reduced dependency on natural gas. The relatively high price of gas in recent years also has (involuntarily) reduced consumption substantially (-15%), and thus emissions.[13]

Electricity has made similar progress, and reduced 9 Mt CO_2-eq (-22% relative to 1990). This means a gap of 26% relative to 2022 emissions still needs to be closed until 2030. The built environment and electricity therefore still have to make roughly half their targeted reductions in the next seven years.

Surprisingly, the mobility sector has reduced just 3 Mt CO_2-eq (-11% relative to 1990). This means a gap of 13% relative to 2022 emissions still needs to be closed until 2030. This is 37% of its total targeted reduction. Given the increased adoption and high public visibility of electric vehicles (in 2022 24% of car sales were zero-emission cars), and lower average CO_2 emissions for new passengers cars (since 2000 CO_2 emissions decreased from 172 g CO_2/km to 108 g CO_2/km in 2020) this slow progress seems unexpected. It is clear that the energy transition in the mobility sector must involve much more than simply electric cars on the road.

Energy system emissions decreased by 32%

GHG emissions (Mt CO_2-eq)



Industry has reduced emissions almost by half

GHG emissions by sector (Mt CO_2-eq)

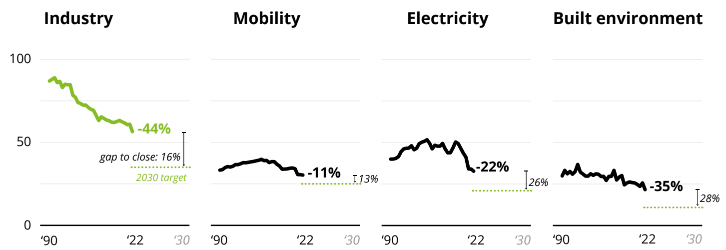


Figure 6. Dutch energy related GHG emissions by sector and sub-sector, showing current and target emissions (Mt CO_2-eq, 1990–2022)[a, 15]

[a] Targets are based on the Klimaatakkoord goal that sets a reduction of 49% in emissions compared to the 1990 emission level. The total emission goal for the energy system in 2030 is thus 92 Mt CO_2-eq. It is noted that the recent increase of the targets by the coalition under Rutte IV sets a reduction target of 1 Mt CO_2-eq more in built environment, industry and mobility sector emissions and 14 Mt more for electricity. However, this report focuses on the Klimaatakkoord goals per sector as these were agreed upon and developed by businesses and other stakeholders

3.2 Industry: a closer look at progress and choices ahead

Industry was the largest emitter in absolute terms (see Figure 6), but has also made the greatest reductions.[a] This section looks more closely at where these reductions have been achieved, and how the Dutch industrial sector can make further progress toward its target.

Types of GHG

Although the sector almost halved its total GHG emissions, the reduction came mostly from reducing non-CO_2 GHG emissions, such as methane (CH4), nitrous oxide (N2O) and F-gases such as tetrafluoromethane (CF4) These non- CO_2 emissions have reduced by almost 80%, from 33 Mt CO_2-eq in 1990 to 7 Mt in 2022, partly through efficiency measures, such as tackling flaring and leakage. However, relatively little progress has been made on reducing CO_2, with only a 25% reduction since 1990, from 54 Mt to 42 Mt.

Industrial activities

Within industry, the vast majority (85%) of GHG emissions arose from manufacturing – particularly four sub-sectors in which energy is fundamental for production processes: chemicals, coke and petroleum refining, base metals processing, and non-metallic minerals processing. Chemicals produced the highest emissions, representing almost half of the manufacturing total.

The real transition still needs to start

NGO Representative

Reduction came from non-CO_2 GHG emissions

GHG emissions from industry and other sectors (Mt CO_2-eq)

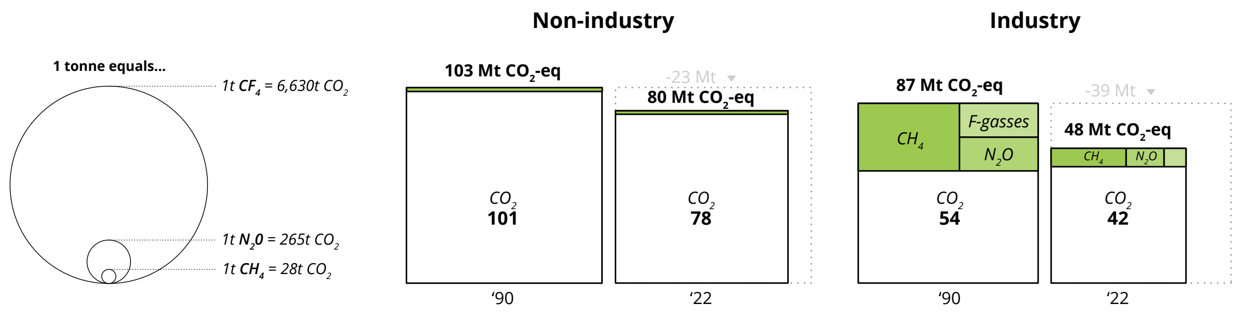


Figure 7: NL GHG emissions from industry and other sectors by type of gas (Mt CO_2-eq, 1990–2022) [8, 9, 16]

[a] Industry contains Manufacturing, Coke and Petroleum, Base Metals, Chemicals and Non-metallic Minerals, a see Figure 9.

Although industry has made good progress in reducing its emissions, this has been mainly a consequence of a decline in production output, probably caused by changes in local and global economies since 2000, such as declining demand volumes and production shifts to lower-cost locations outside the Netherlands.

Figure 9 shows that total manufacturing emissions in the Netherlands have decreased by 30% since 2000,[b] while production output decreased by only 25% over the same period.[c] This implies a trend of reducing carbon intensity, with a 7% improvement by 2022.[d] Carbon intensity measures emissions per unit of activity, and thus links environmental and economic performance. A reduction in carbon intensity therefore means that emissions are reducing more than production levels – typically by adopting technologies that deliver the same output with lower emissions. Of the four most-polluting manufacturing segments, only non-metallic minerals has reduced its carbon intensity in the last couple of years.

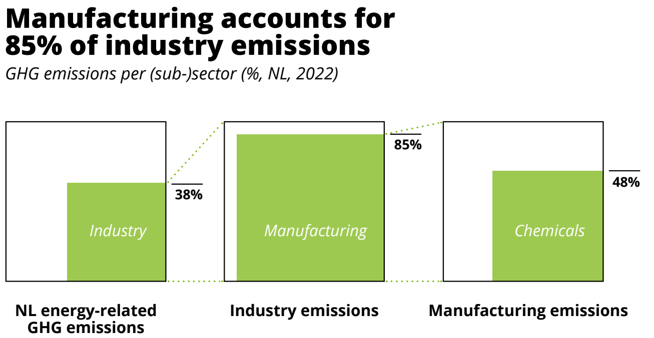


Figure 8. Breakdown of NL GHG emissions in manufacturing segments (Mt CO_2-eq, 2022) [a, 8, 9, 10, 11, 17]

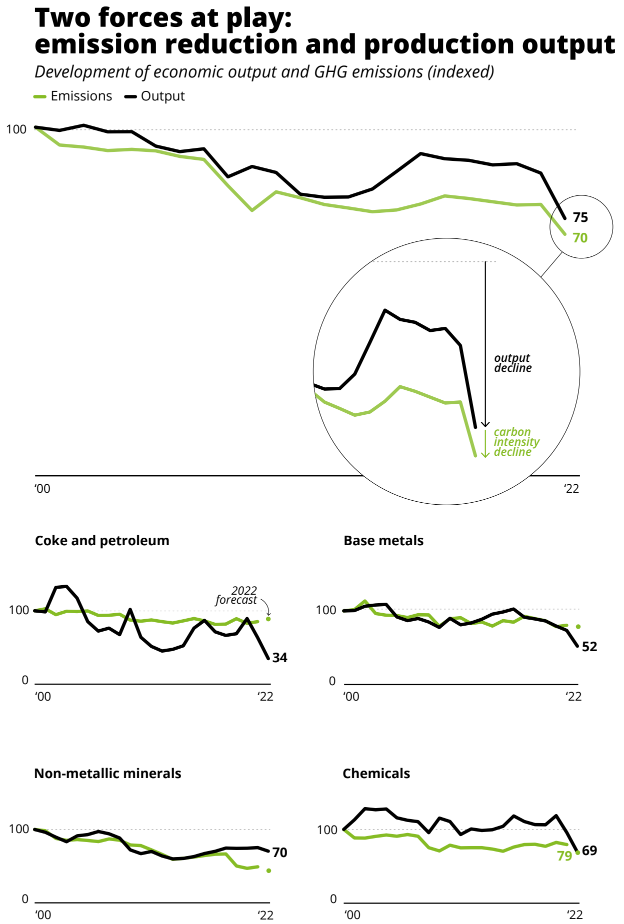


Figure 9. Development of economic output (volume) and NL GHG emissions (%, index year 2000, 2000–2022) [e, 17, 18, 19, 23]

[a] Small discrepancy in emissions data due to difference in methodologies – IPCC versus NACE Rev. 2; NACE is a statistical classification of economic activities that is commonly used across the EU. Its different segments account for emissions by NL citizens whereas IPCC accounts for emissions in NL. Relevant NACE segments here reported are defined with the following activities:

Manufacture of coke and refined petroleum products: Manufacture of coke oven products – Manufacture of refined petroleum products and fossil fuel products.

Manufacture of chemicals and chemical products: Manufacture of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms – Manufacture of pesticides, disinfectants and other agrochemical products – Manufacture of paints, varnishes and similar coatings, printing ink and mastics – Manufacture of soap and detergents, cleaning and polishing preparations – Manufacture of other chemical products – Manufacture of liquid biofuels – Manufacture of man-made fibers.

Manufacture of other non-metallic mineral products: Manufacture of glass and glass products – Manufacture of refractory products – Manufacture of clay building materials – Manufacture of cement, lime and plaster- Cutting, shaping and finishing of stone – Manufacture of abrasive products and non-metallic mineral products N.E.C.

Manufacture of basic metals: Manufacture of basic iron and steel and of ferro-alloys – Manufacture of tubes, pipes, hollow profiles and related fittings, of steel – Manufacture of other products of first processing of steel – Manufacture of basic precious and other non-ferrous metals – Casting of metals.

[b] 2000 is used as the baseline reference year, rather than 1990, as this is the earliest year for which this data breakdown is available.

[c] Production output is measured as the share of GDP and adjusted for price.

[d] Carbon intensity improved by 5% while output decreased by 25%, implying a net improvement in carbon efficiency of 5%*(75/100)=6.7%.

[e] 2022 emissions data extrapolated due to availability: Manufacturing emissions from industry emissions 2021–2022 (Manufacturing emissions were 85% of total industry emissions) – sub-sector emission data extrapolated from emissions of top-20 emitters (non-electricity and heat) in 2022. No 2022 emissions data for Non-metallic minerals as no top-20 emitter belongs to the sub-sector.

Types of company
To understand how different company types have contributed to the reduction in emissions, industrial emitters can be divided into two broad categories, according to whether or not they participate in the EU's Emission Trading System (ETS), which is mandatory for the largest emitters in the Netherlands (in the industry and electricity sector). Within the ETS participants, the 20 highest-emitting companies are typically assessed in the Netherlands as a separate group.

Figure shows a significant difference in GHG emissions reductions between these three groups. Since the ETS came into effect in 2013, the top 20 emitters have made a 10% (3 Mt CO_2-eq) reduction, and other ETS participants 15% (7 Mt CO_2-eq), while non-ETS companies have reduced emissions by 21% (35 Mt CO_2-eq). The electricity producers that are part of the ETS decreased their emissions by 28% (12 Mt CO_2-eq) since 2013.

The lower reduction by the top 20 group is most likely because production processes in heavy industry are harder (or impossible) to decarbonize and/or electrify without large investments. To reduce these barriers, the government has started bilateral talks with companies in the top 20 emitters, to understand how progress on reducing their emissions can be improved. On an EU level, the tightening of the ETS means that companies within the ETS trading scheme must be emission-free by 2040. Secondly, the next iteration of the Renewables Energy Directive (RED III) will also have a significant impact on industry emissions. When the directive comes into force, industry will have to increase the renewables share of its total energy consumption mix by 1.6% annually until 2030.[4] This will put further pressure on the industry sector to find ways of reducing its emissions.

The largest industrial players are still waiting for the right set of regulations and support mechanisms to start the real transition

Industry professional

Companies that are not covered by ETS have made greater emissions reduction

Emissions reduction ETS vs. non-ETS (Mt CO_2-eq)

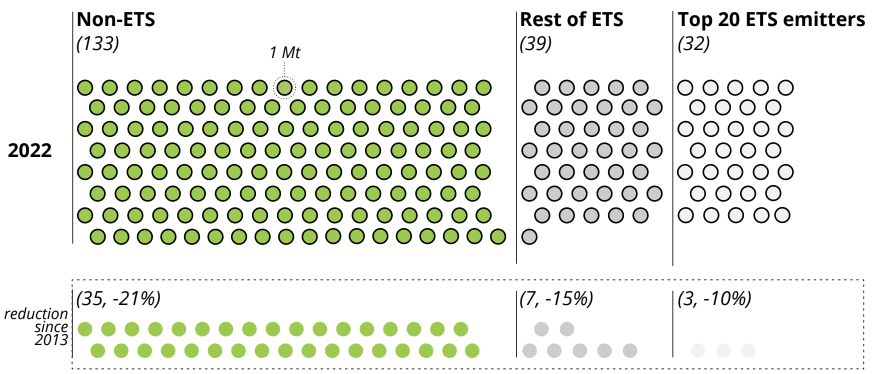


Figure 10: Emission reduction, ETS versus non-ETS, excl. electricity sector (Mt CO_2-eq, 2013–2022) [a, 8, 9, 10, 11, 20, 21]

[a] Top 20 emitters based on government shortlist of 'maatwerkbedrijven'; for additional bilateral agreements on reduction, excluding waste processing organizations, see Kamerbrief over voortgang maatwerkafspraken; four of top 20 emitters are installations from the Chemelot Industrial Site, however all emissions from the site are included due to lack of granular data; power companies (electricity generation) are excluded as these fall under the electricity sector instead of industry

Call-out C. Choices for Dutch industry to reduce emissions

The challenges for the industry sector are significant, and two main choices underpin how it could meet its targets, which will influence how the sector looks in the future, and its role in the Dutch economy. These choices are shaped by two main directions open to the Netherlands: to create a green industrial base, and produce a similar range of goods domestically at the same scale; or to reduce industrial production, import the products that are needed and replace industrial economic activity with less carbon-intensive goods or services. Of course these choices are guided by Dutch and European legislation, such as the European Green Deal, ETS, Energy Tax Directive, and Carbon Border Adjustment Mechanism (CBAM).

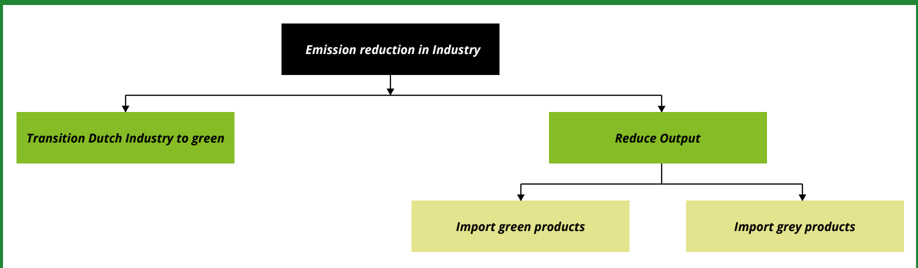


Figure 11. Emissions reduction choices for NL industry

Next to emission reduction targets, we need ambitions of green industrial production in the Netherlands

Academic

Reports are not just studies any more, but the basis of real fundamental choices that require large capital investments

Journalist

Choice 1: What is the right balance between investing in the energy transition in industry, while maintaining competitiveness at home and abroad?
A green domestic industrial base could benefit the Netherlands, through self-sufficiency, longer-term competitive advantage, (blue-collar) job security, and control over industrial emissions. In addition, the country's offshore wind resources would be a positive contributor in this transition. Such an industry could also produce the clean energy technologies for export. However, this choice is not without implications: although goods manufactured and used within this country could have similar prices to today, Dutch export trade might be hampered if the global market still offers cheaper (and more polluting) alternatives.

Choice 2: What is the right balance between the affordability and emissions impact of imported products?
The option to reduce emissions by reducing domestic industrial output and meeting domestic needs through imports could be an alternative to transitioning the Dutch industrial base.
To make such an approach effective, controls would be needed that require imported goods to meet a carbon intensity standard, which would eventually reduce to zero (aligned to the EU's CBAM initiative). Such standards could be complemented by bilateral agreements with the exporting countries, to help them create green products that would abide these standards. With such an approach, imports would help the Netherlands take a big step toward its national emissions targets, while also making a positive impact on global emissions. Without such controls, the climate benefit would be minimal, as production would take place outside of the Netherlands with no guarantee of lower global emissions.

This choice also has implications for the country's competitiveness and economic security: industry's contribution to the Dutch economy would reduce significantly, declining industrial activity could lead to fewer jobs, while business and individual customers could face higher costs for (compliant) imported goods. New economic activity would also be needed, to replace industrial production, prevent a loss of GDP and avoid a poorer standard of living in the Netherlands.

Taken together, the greatest potential for emissions reduction both at home and abroad will be realized if Dutch industry makes a full energy transition to a green base, and any imported products are held to increasingly strict carbon intensity standards. The carbon intensity of domestic industry could be reduced by making production processes more energy-efficient, or replacing fossil fuels with renewable electricity or clean hydrogen. However, transforming some heavy industrial processes to use cleaner energy will require technology and infrastructure (e.g., for renewable electricity) at a scale that is not yet feasible with current developments.

Charting this course will require much deeper collaboration between society, industry and government, to balance economic support (to keep exports economically competitive) and non-economic factors such as security of supply, jobs, control and resilience. One way to achieve this balance would be to formalize green industrial production ambitions as policy, alongside emissions reduction targets, to incentivize support for reducing industrial emissions.

3.3 Key take-aways and Deloitte perspective

Develop the path together

Although a part of the route to net zero has been achieved, reducing the last 68% of Dutch national emissions and reaching the target of net zero by 2050 will be more challenging. Fundamental changes in the coming years, especially in industry, will be crucial and require close monitoring and conversations to steer decision-making in the right direction. The decisions that must be made by the Dutch industry sector – whether to stay in the Netherlands or move abroad – will also depend on what action the Netherlands takes to keep and greenify domestic industry. If the aim is to create a green industry in the Netherlands, the public and private sectors need to support its development through bilateral trade agreements, import standards and the necessary infrastructure investments.

Take full responsibility

Taking responsibility means, firstly, looking beyond reducing megatonnes of GHGs. Since the Netherlands is responsible for only 0.4% of global emissions, the greatest potential impact of a successful transition will be to show the world how it can be done: transition the industry, develop the technology, design the optimal policy, and equip talent with the right set of capabilities. The fact that most of the emissions that the Netherlands have a responsibility for actually take place outside of the Netherlands, only emphasizes this point. Secondly, if the Dutch energy transition is to be effective in reducing global emissions, it should have a clear picture of all the emissions that can be attributed to the Netherlands, and take responsibility for them. Therefore, the effect on global greenhouse gas emissions from international aviation and shipping and imported goods should be taken into account when designing and evaluating national emissionreduction policies and incentives.

Take the public along

Given that negative public sentiments about the energy transition have increased over the past ten years, and the energy transition cannot happen without broad societal support, it is important to take the public along on this journey. Therefore, societal support for the energy transition needs to be stimulated by celebrating its successes. This could be achieved through, for example, grassroots campaigns to build excitement for clean energy, and policy initiatives that promote new behavioral norms (rather than financial incentives), while supporting the most vulnerable households through their transition.

4. Monitoring the Dutch energy mix

The Dutch energy system is undergoing fundamental changes. As of 2022, renewables represented a 15% share of total energy consumption. Biomass remained the main source of renewable energy, but wind and solar are growing rapidly. Historically, energy consumption relied on molecular sources (coal, oil and gas), but this share is decreasing. The Dutch electricity system is the greatest success in the energy transition, so far, with a 40% share of electricity now coming from renewables. However, integrating renewables must go hand in hand with electrifying more of the energy system, which has started, but only in niches. In the midst of these developments, the Netherlands is also changing structurally, from a gasexporting country to an net importer.

In 2022, about 15% of energy consumed in the Netherlands came from renewable sources. Since 83% of national GHG emissions originate from the Dutch energy system,[a] shifting its composition will have a major impact on the country's overall ability to reduce its emissions and meet its net-zero targets.

Historically, the availability of natural gas in the Netherlands made it the dominant energy source, and it still represented 36% of total primary energy use in 2022 (see Figure 13). The country's deep-sea harbors have also made Dutch ports an ideal place for landing crude oil for Europe from across the world. With six large refineries, the Netherlands is also a large consumer/ refiner of oil, used mainly by the mobility sector in the form of transport fuels such as kerosene and gasoline.

The Dutch energy system is increasingly including new sources, such as biomass, solar, wind, geothermal and ambient energy.[b] Most of these renewable sources are used in the electricity generation sector, but some – such as geothermal and some biomass energy – are also used directly by other sectors. Historically, biomass has been the dominant renewable source in the Netherlands, which made different choices or lacks the alternative energy sources available in other countries, such as hydro (Norway) or nuclear (France). However, other renewable sources – such as North Sea wind power – are gaining traction, and it is expected that the Netherlands will come to rely on a broader mix of primary energy sources and carriers in the future.

Three main decarbonization trends can be observed in the Dutch energy system. Firstly, electricity is becoming cleaner, through the adoption of renewable sources. Secondly, more energy consumption is becoming electrified although currently only in niches (e.g., electric personal road mobility, electric home heating), and therefore reducing the dependence on oil products and natural gas for uses such as home heating and mobility. Thirdly, it is expected that sectors unable to run on electricity (e.g., steelmaking) will be powered by renewable molecules, such as biofuels, biogas or hydrogen. Even the renewable fuels currently made from biomass will increasingly be produced synthetically using (renewable) electricity.

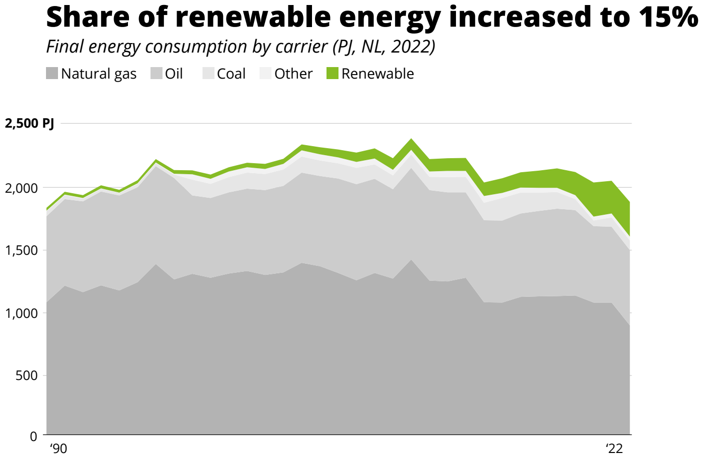


Figure 12. Final energy consumption by carrier (PJ, NL 1990-2022) [c, 2, 7, 20, 22]

[a] Excluding non-national activities of international aviation and shipping, which are not shown in this chapter.

[b] Energy retrieved from ambient air through heat pumps installed in residential houses.

[c] (1) To calculate the share of renewable energy, in line with European agreements, the gross final energy consumption is used. This is consumption of energy by end-use sectors (industry, households, services, agriculture and transport) for energetic applications. This therefore excludes use for non-energy applications.

Figure 13 illustrates the current Dutch energy system, by three elements: total primary energy, total final energy consumption by carrier, and total final energy consumption by end-sector. The system still relies heavily on fossil fuels (oil, natural gas and coal), for 84% of primary energy. Looking at where this energy ends up, most of the final energy consumption is within Industry (around 40%). The figure also shows where losses arise in the energy system when the energy output of a carrier is less than its input. These losses occur because energy is used to refine fuels, and produce and distribute electricity, so total final energy consumption is less than the total primary energy fed into the system. The largest losses are incurred in fossil-based electricity production.[a] Note that the energy-related discussion in this report excludes non-energy uses of oil, gas and coal, such as plastic production since those products are not emitting GHG during their end-use.[b]

The energy system is still reliant of fossil fuels

Dutch energy system (PJ, 2022)

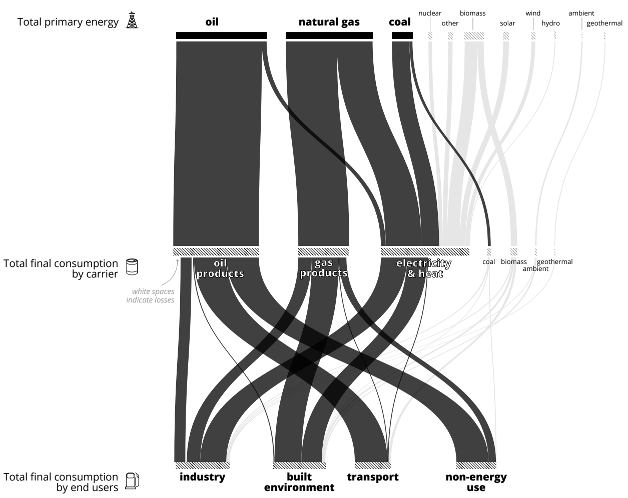


Figure 13. Flow of energy sources in the NL energy system (2022), from Total Primary Energy (TPE) to Total Final Consumption (TFC) by carrier and by end-user [c, 7, 11]

4.1 Energy consumption by carrier: molecules, not electrons, are the dominant energy carrier

Public discussion of the Dutch energy system has focused heavily on electricity, including photo-voltaic (PV) solar, wind energy, electric vehicles (EVs) and heat pumps. Such technologies are (or are likely to become) scalable and commercially-available, so electrification provides one of the most important levers for reducing emissions, and its share of total final energy consumption has already grown to from 14% in 1990 to 23% today (~65% increase) as shown in Figure 14.

However, electricity represented only 23% of Dutch final energy consumption in 2022, and heat 9%.[d] 68% of the final energy consumption in the Netherlands in 2022 was consumed in other forms (e.g., gasoline, diesel). This share has shown a limited decline over recent decades (from 79% in 1990), which was driven by advances in electrification such as EVs or heat pumps. Primarily, the decline has been slow because industrial processes – such as chemical cracking, industrial heat, or secondary steelmaking – still need to be electrified and require large investments.

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[a] This is partly due to difference in the statistical guidelines of renewable electricity production and fossil electricity production. See Kraan et al. The influence of the energy transition on the significance of key energy metrics.

[b] Energy used for manufacturing plastics and fertilizers is accounted in the industry sector, while the use of fuel as feedstock is excluded as it does not result in any energy use nor emissions (except in the case of waste incineration, which is accounted for in the previous chapter on emissions).

[c] Import of electricity is not shown; "Other" in TPE consist mostly of waste of non-biogenic origin (e.g., plastics); for a list of definitions, see https://www.cbs.nl/en-gb/our-services/methods/definitions.

[d] Heat in the Netherlands is partly distributed via district heating network.

Also notable is the decline in total energy consumption, which has decreased by 9% since 1990, despite 18% population growth and 90% increase in GDP in the same period.[a, 23, 24, 25] This is due to several factors: advances in energy efficiency, such as home insulation, electrification in light industrial sectors, combined heat and power, high energy prices and inflation, and declining industrial production in recent years, which indicates a structural shift from a production to a service-based economy. The direct consumption of biomass (e.g., wood stoves, biofuels, biogas) and other renewable energy in non-electricity form, e.g., geothermal, ambient energy, solar heat has increased four-fold in the past 32 years, from 1% to 4%. This direct consumption excludes the use of biomass for the production of electricity and heat (see next paragraph).

Biomass: A closer look at the dominant carrier and its future outlook

Figure 15 shows that biomass accounts for the largest share (40%) of renewable energy consumption, followed by wind (28%) and solar (22%).[b] Within biomass, the dominant form is solid biomass, used in household fireplaces, decentralized electricity and heat production, (part of) waste incineration, and for co-firing power stations. The other two biomass sources are biofuels (bio gasoline and biodiesel blended into traditional fuels); and biogas (mostly created from fermenting manure, sewage, landfills and other vegetable waste), which is blended into the gas supply grid or co-fired in gas turbines to generate electricity.[c]

Energy efficiency should be considered as the 'first fuel' as it is the cleanest and, in most cases, the cheapest way to meet our energy needs

Academic

Today we are on a quest for the most energy efficient way of producing, while in reality we should first start questioning some of our consumption by asking: do we need this demand?

Industry Professional

Share of electricity consumption increased to 23%

Energy consumption by carrier (PJ, NL, 2022)

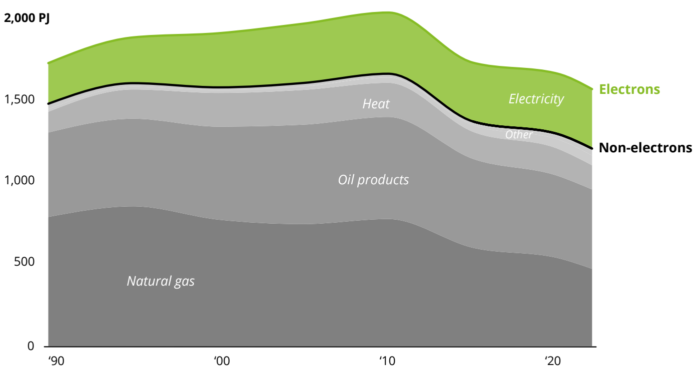

Figure 14. Total Final Consumption by carrier, excl. non-energy use and losses such as generation and distribution losses (PJ, 1990–2022)[d, 11]

Biomass is the dominant source of renewable energy

Consumption of renewable energy by source (PJ, NL)

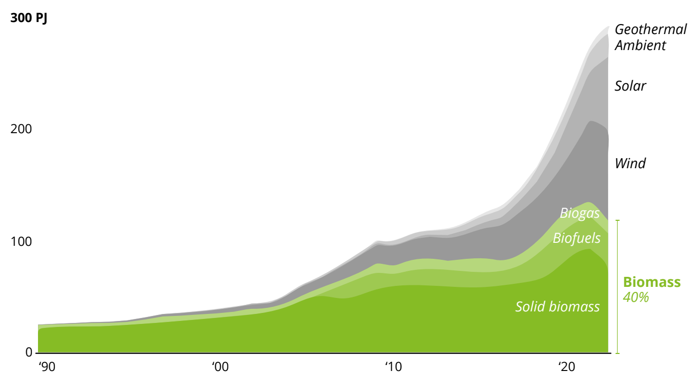

Figure 15. Consumption of renewable energy by energy source[e, 7, 11]

[a] Figure for GDP growth between 1990–2022, net of inflation.

[b] Biomass qualifies as a renewable energy source, because it has a short carbon cycle, which means that the carbon that is emitted by burning wood from trees or vegetable waste was removed from the atmosphere during its growth via photosynthesis. Therefore, GHG emissions from biomass are not affecting emissions in the long-run.

[c] Biofuels include hydrotreated vegetable oil (HVO), hydro processed esters and fatty acids (HEFA) and fatty acid methyl esters (FAME).

[d] When including energy consumption by the energy sector (194 PJ) and distribution losses (26 PJ), the total energy consumption in 2022 amounts to ~1,850 PJ. Heat is consumed in the form of hot water or steam

[e] Only renewable biomass showed – as per latest sustainability criteria entered into force for certain installations of solid and gaseous biomass (e.g., those for smaller boilers announced in the Dutch Climate Agreement as of 2022).

Four main reasons account for the dominance of biomass amongst renewable sources. Firstly, solid biomass (wood and charcoal) has traditionally been used in household fireplaces and stoves. Secondly, biogas from animal manure abounds because of the large Dutch agricultural sector. Thirdly, biomass can easily be blended into existing energy generation (e.g., co-firing wood pellets in coal power stations), and EU incentives have increased demand for this practice further. Finally, European blending mandates have increased the demand for biofuels.[a]

Nonetheless, the dominance of biomass is likely to be short-lived because its sustainable supply is limited. The supply of vegetable waste is limited, and cannot be increased by growing additional crops without compromising the food crops for human consumption.[23] Therefore, regulations around biomass are likely to tighten even further in Europe, and deter the use of biomass where wind and solar energy offer economic alternatives (e.g., electricity generation). Nonetheless, biomass will remain crucial for the production of clean molecules (e.g., biosustainable aviation fuel (SAF) and bioplastics), because synthetic production using wind- and solar-based electrolysis remains more costly.

4.2 Energy consumption by endsector: electrification has started, but only in niches

Roughly half of all renewable energy was consumed in the form of green electricity, which is blended within the electricity grid. A key challenge is therefore to integrate more of these renewable (intermittent) sources and increase the overall share of electricity, which is currently the minority energy carrier for all sectors: 3% in mobility, 24% in industry and 35% in built environment (see Figure 17). In the short term, an increase in the electricity share will be achieved by electrifying trucks and small industrial plants, and household heating.

Looking at mobility in 2022 specifically, the final electricity consumption in this sector was split equally between cars and trains, where EVs contributed only 1.5% of the sector's energy use (see Figure 18). One could argue that electrification of cars is quick to grab public attention, but it has little real impact on reducing emissions. Additionally, it has been ineffective so far in terms of emissions reduced per Eurosubsidy and offers little strategic value for a country with limited car production. However, government subsidies have contributed to the creation of the country's EV infrastructure (and corresponding EV charger-industry), which can be potentially used partly for future electrification of road freight.

Apart from renewable energy being used in the form of green electricity, other forms were used in several sectors, predominantly in the form of biomass. In the mobility sector, renewables represented 6% of total final energy use, due to the blending mandates of biofuels. Renewables represented 7% of built environment energy use, comprising mostly biomass (e.g., wood), biogas fed into the gas grid, and renewable heat (e.g., ambient energy and solar heat). In industry, renewable energy sources (3%) were used mostly in form of solid biomass and geothermal energy.

Call-out D. Case-study: biomass – low popularity among the Dutch

Public sentiment toward biomass has become increasingly negative over the past ten years.[b] In 2023, half of the tweets analyzed expressed negative sentiments toward biomass – more than five times higher than in 2013. Most concerns are about high CO_2 emissions, the negative effect on air quality if biomass use continues to rise, and the risk of losing biodiversity if biomass enters large-scale production. This lack of public acceptance might further limit the role that biomass can play in the energy transition.

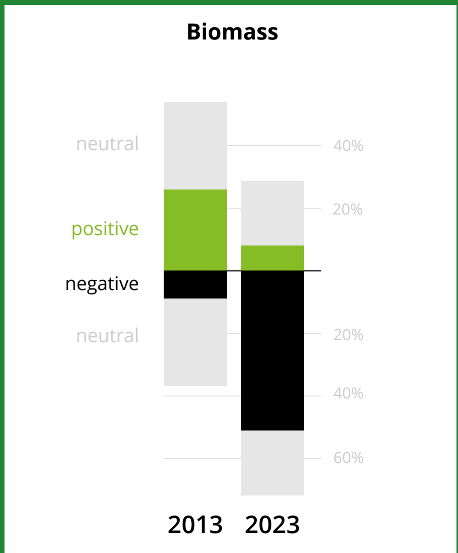

Figure 16: Changing share of sentiment for tweets mentioning biomass (2013 vs. 2023) [c, 7]

[a] See Renewable Energy Directive and Hernieuwbare Brandstofeenheden directive.

[b] For detailed methodology of the sentiment analysis, see Appendix.

[c] The neutral sentiments are divided equally over positive and negative sentiments.

4.3 Transition of the electricity system: the Dutch energy success story

Renewables will play an important role in decarbonizing the built environment, industry and mobility sector, and the electricity sector is already transforming rapidly. From less than 1% in 1990, 2022 saw an impressive 40% of electricity being produced from renewable sources.[c] Clean electricity is generated largely from solar (38%) and wind (46%) sources, with limited use of biomass (16%) in coal-fired power stations. More impressive still is that this progress has been achieved without increasing electricity imports, while consumption has increased by 72% (since 1990). This increased share of clean electricity means that the sector's carbon intensity has halved since 1990.

For the vision of a GHG-free electricity system in coming years to become a reality (by 2050 according to the Klimaatakkoord, by 2035 according to Rutte IV),[d] more investment is needed in battery or hydrogen storage, demand response, extra transmission capacity (incl. internationally) and flexible/baseload supply (e.g., investments in new nuclear capacity), to complement the increased capacity for generating clean power in the Netherlands. This is especially relevant for the Netherlands since its electricity generation is very a dependent on emissions-intensive sources, such as gas and oil, compared to other countries that generate electricity from sources such as hydropower, biomass and nuclear. However, the unique salt caverns in the Netherlands are able to store hydrogen, and therefore have the potential to make the Dutch electricity system more flexible. During periods in which renewables generate a surplus of electricity, the excess can be transformed into hydrogen, stored, (at the expense of conversion losses) then used to generate electricity during periods when renewables provide insufficient power to meet electricity demand.

Figure 17 also shows that coal use was declining by 2020, but the energy crisis (due to e.g., high gas prices and issues with availability of nuclear capacity) hitting Europe has led to consumption growing again, to provide security of supply. Although this growth has increased Dutch CO_2-eq emissions, it has not impacted overall European emission levels because power generation is part of the ETS.[e, 28]

Policy focus on electric mobility in the Netherlands does not contribute to our competitive advantage as a country as we don't have a large car industry

Academic

Share of electricity in mobility is still marginal

Energy consumption by sector

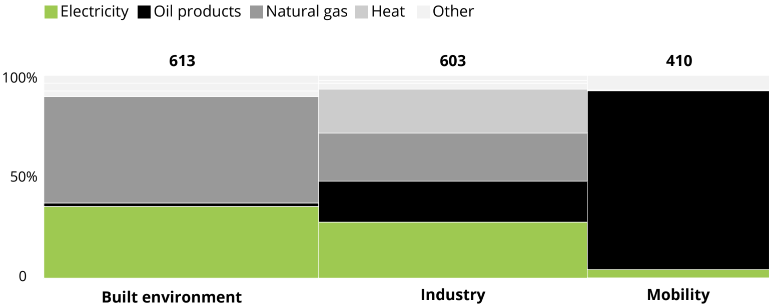

Figure 17: Energy consumption by sector and carrier (PJ, 2022) [a, 7, 11, 27]

Only 3% of mobility is electrified

Split of energy consumption in selected mobility sectors (PJ, NL, 2022)

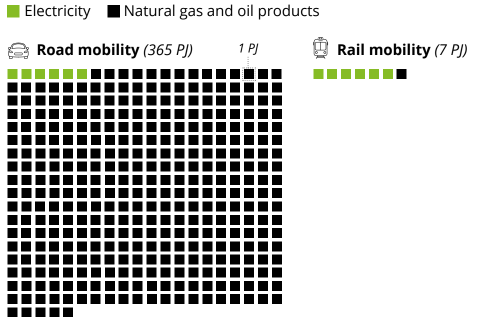

Figure 18: Split of energy consumption in mob ility between electricity, oil products and natural gas [b, 11]

[a] 2022 data is preliminary; consumption shares by sector are based on 2021 and biomass totals are based on 2021 data; energy consumption from Agriculture and Fishery (7%) is allocated to industry (for natural gas) and mobility (for all other carriers); energy consumption from other/unknown sectors (13%) is allocated proportionally to industry, mobility and built environment; biogas consumption is allocated proportionally to industry, mobility and built environment.

[b] 2022 data is preliminary.

[c] Relative share of renewables in the electricity production is based on renewable normalized gross production. Renewable normalized gross electricity production adjusted for weather conditions and including indirect production from green gas. From 2021, electricity production from solid biomass and biogas in installations above a certain power limit will only be included if the biomass used meets the sustainability rules from the EU Renewable Energy Directive (RED II).

[d] Goal set by the Klimaatakkoord the ambition has been raised in the Coalition Agreement under Rutte IV (non-binding) to net-zero in 2035.

[e] The ETS allows a fixed number of emission allowances for the sectors it regulates (cap-and-trade), which is decreased yearly by 2.2%. Higher emissions from electricity generation (due to employment of coal in power stations) was compensated by lower emissions in other sectors to maintain the total number of emission allowance within the cap (for instance, halting of fertilizer production).

4.4 From exporter to importer: structural changes to Dutch energy dependency

Historically, the Netherlands has depended on imports for coal and oil, while producing its own natural gas and renewable energy, but the picture has changed and Figure 20 shows its transition from exporter to importer.

A major change occurred in 2013, when the government decided to reduce gas production from the Groningen gas field.[29] By 2018, natural gas exports from the Netherlands had halted, and the country became an importer of gas. The implications of this development are enormous: the Dutch energy system and industrial production still depend heavily on natural gas (and removing that dependence will not be easy), but relying on other nations for natural gas affects the Dutch energy security. This was evident during the recent turbulence in the global energy markets, which were destabilized by the post-COVID economic recovery and Russia-Ukraine conflict. To ensure energy security in the Netherlands, the national infrastructure had to be adjusted: and projects such as the Energiebuffer ZuidWending and EemsEnergyTerminal helped to secure and integrate the imports of liquefied natural gas (see Call-out E, case study on how to accelerate timelines for permitting).

Beyond its disadvantages for energy security and affordability, imported natural gas can have a more negative impact on the climate than domestic production. In addition to higher emissions from shipping the liquified fuel, natural gas produced abroad is often more polluting because drilling produces higher emissions (from leakage and flaring), which are substantially lower in the Netherlands compared to international standards. Therefore, extending the gas production from Dutch offshore gas fields could in some way contribute to reducing emissions.[29]

Strategic autonomy means reaching an acceptable level of dependency on other countries

Goverment Official

Share of renewable electricity production has increased to 40%

Electricity production by source (PJ, NL)

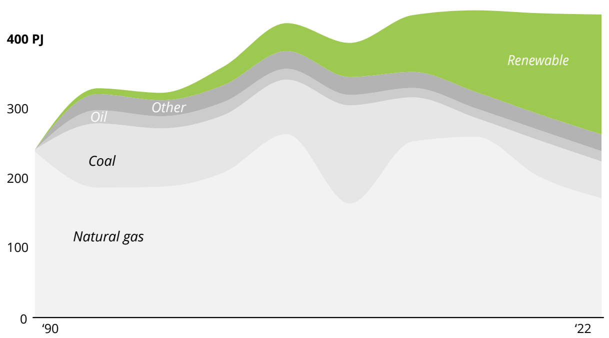

Figure 19: Electricity production by source (PJ, 1990–2022) [a, 7, 11]

The Netherlands transformed into a net importer of natural gas

Import-export balance of energy (PJ, NL)

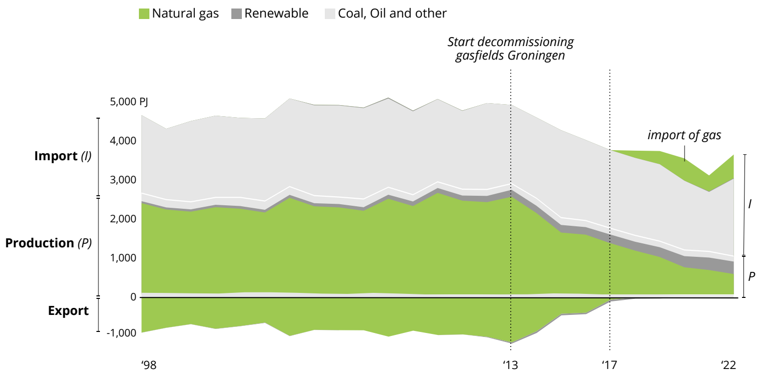

Figure 20: Import and export of energy carriers in the Netherlands (PJ) [b, 11]

[a] 1) Normalized electricity production based on net figures, i.e., excluding the energy used by the electricity installations (~5%), and including use of biogas in electricity production; 2) For years prior to 1998, only aggregated data available; 3) Oil products includes coke oven gas, blast furnace gas, chemical residual gases; 4) 2022 figures are preliminary.

[b] Net imports/exports considered e.g., excluding energy sources imported and re-exported subsequently; 2022 data is preliminary, volumes for renewable energy and other carriers assumed equal to year prior.

Call-out E. How to accelerate timelines

The energy transition will require large infrastructure investments to transform the energy system. In addition to developments such as wind turbines and electrolyzers, the Netherlands will need a stronger electricity grid, underground CO_2 storage and pipelines, such as the hydrogen pipelines part of the European Hydrogen Backbone.

Achieving the energy transition by 2050 will require coordinated actors and supply chains, but a key barrier will also be permits, which involve long timelines and can stop businesses from making decisions quickly.[a] Accelerating these timelines would accelerate many energy transition related projects.

A good example of where this acceleration was successful in the energy space is the EemsEnergyTerminal – an LNG terminal built in Eemshaven where fuel imported by ship is landed, for use within the national gas grid. Normally, such a project would take three years to complete, but the entire terminal was fast-tracked and operational in a record 200 days (~80% faster), allowing the Netherlands to tackle the urgent gas shortage caused by the Russia-Ukraine conflict. By comparison, the WarmtelinQ project took eight years to reach a final investment decision (FID) and another four years to be realized.

The EemsEnergyTerminal experience suggests that the critical factors for rapid delivery were an emergency approach to granting permits, and a higher tolerance for uncertainty by all parties, specifically:

- all parties committed to the key project objective, of delivery by the agreed date, which created a shared sense of urgency;
- government accelerated its normal timescale for permits, and bypassed the standard tendering process for issuing conditional permits; and
- businesses accepted a higher tolerance for risk: unusually, no commercial contracts were signed before FID took place, so parties had no guarantee that the LNG would be bought once the terminal was built.

These learnings show how the energy transition can be accelerated by simplifying permitting processes, increase the willingness to take risk or create a safe-fail mechanisms for investors. The EU Industrial Plan and the latest provisional agreement of the EU's Renewable Energy Directive will include dedicated acceleration areas for renewables, with particularly short and simple permitting processes.

We need bold, emergency measures instead of the business-as-usual roadmaps, which are vague and slow

Academic

[a] When the court overturned the construction exemption for nitrogen emissions (bouwvrijstelling) in 2021 many renewable projects a were stopped.

4.5 Key take-aways and Deloitte perspective

Decarbonize molecular energy demand

Roughly half-way through the energy transition, at least in time, the Dutch energy system is still reliant on 85% nonrenewable resources, and only 23% of energy is consumed in the form of electricity. Despite the acceleration of wind and solar-based electricity, biomass still plays a crucial role in today's renewable energy share (40%). The fact that biomass remains the dominant source of renewable energy shows that, historically, biomass has been the easiest way to increase the renewable energy share in a country such as the Netherlands. However, its future use will be restricted by the availability of sustainable supply, regulations, and competition with the food system. Therefore, although electrification should remain the main focus, the remaining demand for molecular sources should be decarbonized more actively, by promoting the use of clean hydrogen and making optimal use of the limited biomass resources, and shifting its main uses. This would mean a shift from using biomass for generating electricity and low-temperature heat, to producing sustainable fuels for shipping and aviation (while taking into account how different sources of biomass can be used most efficiently across sector).

Position the Netherlands as the powerhouse

To increase the share of renewable energy in the Netherlands, given its great potential in offshore wind energy, the country can position itself as the powerhouse for producing offshore wind energy and green hydrogen. This can be achieved by strengthening the existing North Sea Consortium, to drive its vision and execute plans for the physical infrastructure and market design, which will position the North Sea as the powerhouse of North-West Europe's offshore wind electricity and hydrogen production.

Fix permit delays

To prevent delays and keep momentum in the energy transition, government bodies should create a regulatory ringfence and challenge prevailing assumptions, to accelerate permitting times and simplify qualification processes for new projects, while improving the use of technology and data to make faster, better decisions and speed up their development. This is in line with the EU Industrial Plan that includes mechanisms for faster permitting timelines.

Support security and near-term shifts with gas

The energy system transition needs to be achieved while also balancing affordability, security and sustainability. As the Dutch production of natural gas comes to an end, the Netherlands must learn to rely on a broader spectrum of energy sources, and recognize the advantages of domestic natural gas production ovser imports (i.e., relatively low carbon intensity, increased security of supply). Fortunately, the Netherlands is well-positioned to regain energy independence as further development of renewables will not only decrease the reliance on natural gas for electricity production, but also has the potential to satisfy some of the other fuel requirements. Hydrogen, produced with wind and solar power, represents a strategic opportunity in the production of synthetic fuels. In turn, these could help decarbonize the mobility, industry and built environment sectors, and reinforce national energy security.

5. Where the energy transition in the Netherlands is heading: household, private sector and public investment

Investments by households, companies and government give a good sense of where the energy transition is heading. Household investments in clean energy technologies are growing rapidly. Private sector announcements also look promising, with a shift from inland to offshore projects. Government investment has, to date, been mainly in electricity generation, but a growing focus on molecular energy can be observed, along with increasing investment in the infrastructure for energy distribution.

Monitoring GHG emissions and the energy mix gives useful insights into where the Netherlands is now but, to understand where it is heading, there is also a need to look at indicators that signal future changes. This chapter therefore explores investment in clean energy technologies, within three groups: households, private sector, and public sector.[a]

5.1 Household investment: technology penetration is growing rapidly

The eight million households in the Netherlands do not, together, invest the most money of the three groups, but their willingness to adopt clean energy technology is crucial for reducing Dutch emissions, because passenger cars are responsible for 15 Mt CO_2-eq emissions (50% of mobility emissions) and residential housing is responsible for 14 Mt CO_2-eq (74% of built environment emissions).[17, 30] Investment by households can also reflect their wider underlying lifestyle choices, as an indicator of societal trends.

Figure 21 shows the adoption curve of three household technologies: rooftop solar panels (PV), electric vehicles (EVs), and heat pumps. The chart shows that adoption of all three technologies by Dutch households is growing fast. It is estimated that, by 2022, an average of one in three households had adopted at least one of these clean energy technologies.

Solar panel (PV) take-up has been growing most rapidly, and was at 25% in 2022, or one in four households having at least one PV panel on their roof. In Europe, the Netherlands has the largest installed PV capacity per capita.

Heat pumps are being adopted more slowly, and 5% of households are now heated by electric heat pumps. However , this take-up lags behind other European countries and the Netherlands ranks 12th, with Norway, Finland and Sweden as the top three countries, with the highest adoption of heat pumps per capita.[31]

EVs are also gaining traction, with 7% of Dutch households now driving an electri car, while 35% of new cars sold in 2022 were EVs. Dutch households have also invested in private charging points, and installed almost 400,000 in their homes, supplementing those provided in public spaces (see Call-out H).[32, 33] Dutch citizens have the fourth-largest EV car fleet in Europe.[b, 34] Looking at the share of EVs in passenger cars, the Netherlands is even in second place – just behind Norway.[c]

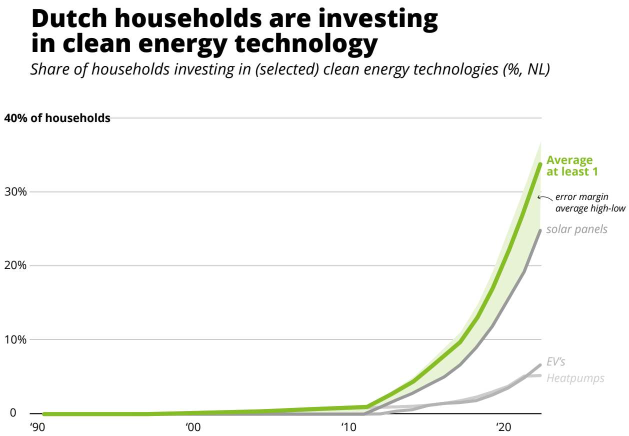

Figure 21. Share of (selected) sustainable energy technologies in NL households, 1990–2022 [d, 6, 7, 31, 34, 40]

[a] A word of caution: metrics for technology investment are used here to indicate the general direction of the Netherlands (e.g., future emission reduction potential), and should not be taken as precise quantitative predictions.

[b] This is based on the amount of registered electric passenger cars in the Netherlands, so it includes electric passenger cars used for business purposes.

[c] Based on 2021 data.

[d] (1) The average of Dutch households that have invested in clean energy technology was calculated using the statistical average which calculates the average of households that have at least one of the three technologies. Average = 1 – [(1 – share of households with solar panels)*(1– share of households with EVs)*(1– share of households with heat pump)] (2) Error margin indicates the range of statistical possibilities of households having at least one technologies, given the uptake of the technologies individually.

5.2 Supply-side private sector investments: moving from onshore to offshore

Project announcements[a] indicate the general direction of structural changes in the Dutch energy system, and in emerging technologies. As Figure 22 shows, project announcements suggest large future increases in offshore wind capacity, clean molecules production (e.g., green and blue hydrogen, and SAF), carbon capture and storage (CCS), and battery storage.[b] However, there is still a large gap between the announced capacity of projects and the government targets in the Nationaal Plan Energiesystem (NPE), which aims for 70 GW of offshore wind, 15–20 GW of hydrogen and 3.5 to 7 GW nuclear by 2050.[35]

These expansions in the capacity for renewable energy supply are built on the premise that structural changes will also occur on the demand-side, such as electrifying industrial processes or scaling up green hydrogen demand, which will also require large scale investments.

The production capacity currently being planned for the electricity system suggests that its rapid expansion will continue, but will change in nature. While onshore solar and wind has so far dominated, offshore wind is expected to play a much greater role, as indicated by government plans to tender offshore wind sites.

Solar (PV) has been a big success in the Netherlands, due to attractive policy incentives.[c] However, solar projects are often smaller in scale, and have shorter development timescales, so they are under-represented in announced projects.

Based on project announcements, a shift in the nature of molecular energy is also expected, and it will become dominated by hydrogen and hydrogen derivates. The role of biomass might change in the years ahead, and it will decline as the primary molecular energy carrier. Instead, it will increasingly become a source of biogenic carbon, combining with hydrogen to create more valuable energy carriers, and reduce demand for the limited supply of biomass. The Netherlands can play a leading role in electrolysis-based hydrogen production, given its abundance of offshore wind. Indeed, integrated hydrogen production is expected to become sizeable in the Netherlands.

Financing the transition is a challenge: institutional investors might have the capital, but their risk appetite is not aligned

Investor

[a] Announcements include all projects that are being announced, including projects with FID and projects without and across different time horizons.

[b] Based on Deloitte Data Cube.[34]

[c] See the Salderingregeling.

The Netherlands has a great opportunity with CCS, and is well-positioned to adopt the technology, with many decommissioned (offshore) gas fields and a high concentration of CO_2 source streams (e.g., Port of Rotterdam) to be captured. Although project announcements (including subsidy requests) have been delayed,[a] they suggest a huge increase in CCS capacity over the coming years. CCS technology is expected mainly to reduce emissions from industry and electricity production, as the only sources of concentrated CO_2 streams.

Energy storage projects in the Netherlands play an important part in a CO_2-free energy system, because they can complement intermittent generation sources, such as wind or solar, to ensure a more predictable energy supply.

Although announcements indicate the range of technologies that can be expected in future projects, the capex that is committed to these projects gives an indication of the scale and location of the investments. As Figure 22 shows, most capital will be allocated to offshore wind projects (~€80 billion), followed by CCS (~€29 billion) and green hydrogen (~€20 billion).

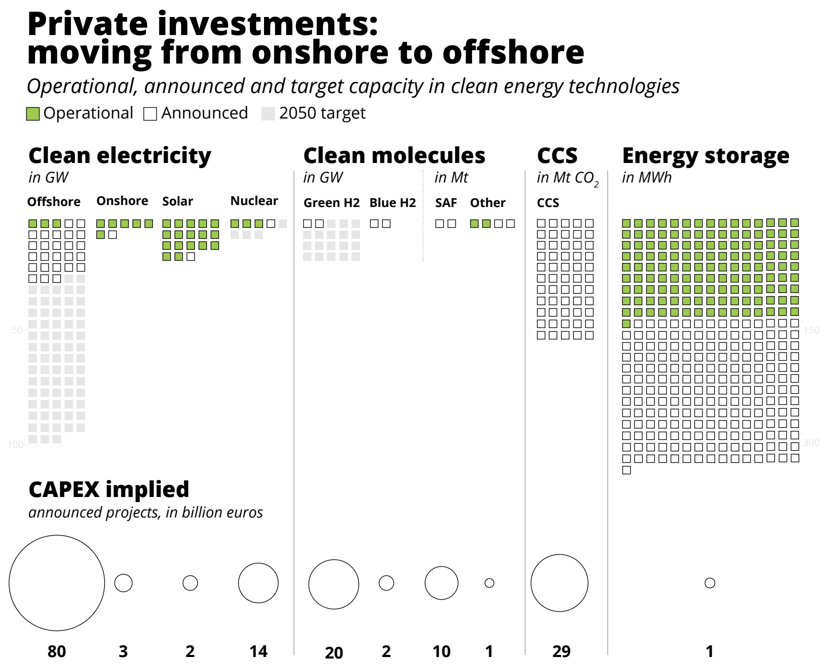

Figure 22. Operational v. Announced[b] capacity in clean energy technologies in the Netherlands (March 2023) [c, 7, 35, 36, 37]

[a] Many large CCS projects are on hold due to the nitrogen ruling, potentially delaying the development of CCS capacity.

[b] Announced: all publicly announced projects not yet operational with defined production capacity and timeline (pre and post-FID); online date varies per project.

[c] Announced capacity only for utility-scale (solar above 20MW and wind above 10MW); 3) Low Carbon Fuels include (clean) ammonia, methanol, bio-/e-gas and other biofuels; 4) CAPEX implied by announced projects is based on CAPEX proxies from known projects: Offshore wind: €3B / GW; Onshore wind: €1b / GW; Solar: €1B / GW; Green H2: €11B / Mt; Blue H2: €11B /Mt; CCS: €1B / Mt CO_2; SAF: €5B / Mt; LCF: €0.3B / Mt; Geothermal: €7b / GW; Nuclear: €4b / GW). Note that the implied CAPX gives an indication of the total investments in euro but not the levelized costs of energy (LCOE) because the load factor differs between the different production methods for clean energy.

Call-out F. Case study: Wind energy less popular than solar

Of the two main renewable energy sources, the analysis of social media posts (formerly known as tweets) showed that positive sentiments toward solar energy have declined, but are still greater than positive feelings about wind power.[a]

Negative sentiments toward wind energy more than doubled (to 35%) between 2013 and 2023, probably because citizens dislike having wind facilities near their homes, or in sight. However, most of the analyzed sentiments continued to express neutral or positive feelings about wind.

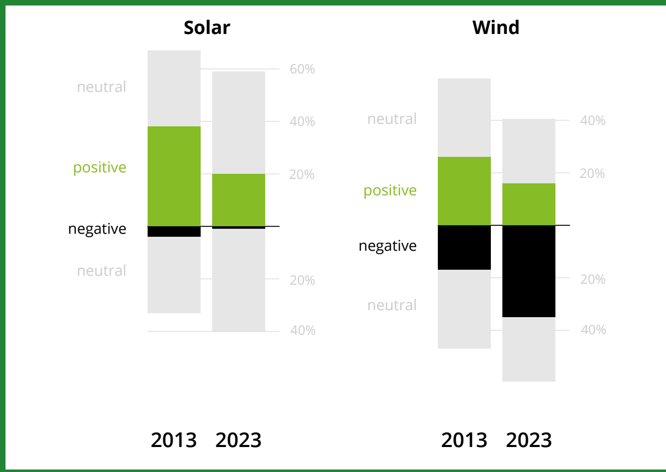

Figure 23: Comparison of changing share of sentiment for tweets mentioning wind versus tweets mentioning solar (2013 vs. 2023)[b, 7]

Call-out G. What needs to be true if the Netherlands wants to reach its emissions targets?

Energy transition targets can sound abstract. So what do these numbers mean for the effort that is required in the years up to 2030 and 2050? This section explores some examples in different sectors.

An example in the electricity sector

The government has a target of 70 GW in offshore wind energy by 2050. To reach this goal, from an installed base of 4.7 GW capacity at the end of 2023, and assuming a capacity of 15 MW per wind turbine, one wind turbine will need to be built every other day until 2050. This is more than two times more than the current build rate and, allowing for construction breaks in winter, this rate is even higher in reality.

Examples in the mobility sector

Following the Klimaatakkoord, public transport has a goal to make all Dutch OV buses emission-free by 2030. The current fleet is approximately 5500 buses. This means that, until 2030, 10 buses each week need to become powered by electricity or hydrogen. And how many EV chargers need to be built each year? The government aims to have 1.8 million EV charging stations (including home chargers) by 2030. Even though there are already over 500.000 charging stations, 570 charging stations need to be installed per day, which is more than 17 times the current installation speed.

An example in built environment

The government aims to take 7 million Dutch houses off the gas grid by 2050, and connect them to sustainable heating systems. To reach this goal over 600 houses need to become gas free every single day (based on 700.000 gas free houses in 2022).

These examples show how large a challenge the Netherlands is facing. Fortunately, the knowledge to build this infrastructure is already there and no revolutionary technology is required. However, the speed required is exceptional and will present many challenges, such as directing sufficient investment, or overcoming shortages of labor and materials.

- Build **1 Windmill every 2 days** till **2050**
- Put **10 emission-free buses per week** into operation until **2030**
- Install **570 charging stations per day** until **2030**
- Electrify the heating system for **600 houses per day** until **2050**

Figure 24: Examples of speed of build-out required to meet a selection of NL emission targets[c, 7, 25, 32, 38, 39, 40]

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[a] For detailed methodology of the sentiment analysis, see Appendix.

[b] The neutral sentiments are divided equally over positive and negative sentiments.

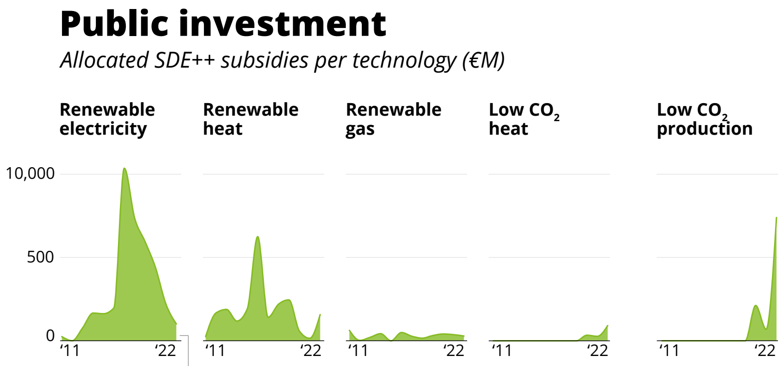
[c] Speed of changes based on 2022 data.

5.3 Public investment: shifting incentives from electrons to molecules

Governments have many policy instruments available, such as taxes, obligations or quotas, and market mechanisms such as the ETS. However, subsidies are a leading way in which governments can drive change, by reducing private costs and hence improving the business case for private investment.

Energy supply

In the Netherlands, the main subsidy instrument for stimulating renewable energy investment has been the SDE++ subsidy.[a] The allocation of SDE++ subsidies to different technologies +(+) gives an indication of how the energy system will change in the coming years. Between 2015 and 2021, it focused heavily on renewable electricity, leading to a high percentage of renewable power in the electricity mix (discussed previously). Since 2021, though, the focus on renewable electricity has decreased significantly, with only 9% of funds being allocated to renewable electricity projects. Now, much more funding is being directed toward CO_2- related projects, such as low-CO_2 production and low-CO_2 heat.



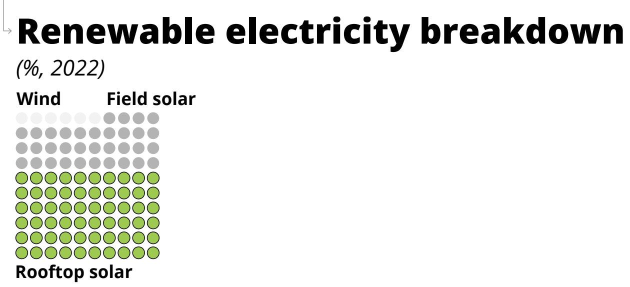


Figure 25: Allocated SDE+(+) subsidies per technology, 2011–2022 (€M) [7, 41]

The capital required for the energy transition is colossal – institutional investors need to play a role in this, but first increase their risk appetite

Investor

It's crazy to use price incentives for energy use which is a necessity of life such as space heating

Academic

[a] This is next to other instruments such as the Versnelde klimaatinvesteringen in de industrie (VEKI), Demonstratie Energie-en Klimaatinnovatie (DEI+), hernieuwbare energietransitie (HER+), amongst others.

Infrastructure

In addition to clean energy incentives, the government is also responsible for planning and coordinating infrastructure. The Dutch electricity transmission system operator (TSO) TenneT requires more than €44 billion over the next decade to expand and modernize its infrastructure in the Netherlands.[42] The three largest gas and electricity distribution network companies (DSOs) will need to invest between €23 and €30 billion until 2050; and the Dutch heating network will require a further investment of €48 billion.[7, 43, 44, 45] Gasunie estimates €1.5 billion is needed for the development of the hydrogen network in the Netherlands.[46] One example of a successful infrastructure investment is the building of an EV charging infrastructure in the Netherlands (although this was heavily driven by demand side).

> We can't build all infrastructure at the same time (electricity, heat, hydrogen, CCS), so choices need to be made in collaboration with industry
>
> **Industry Professional**

5.4 Key take-aways and Deloitte perspective

Prioritize impact for scaling – Reduction levels across sectors indicate that the European carbon price (via the ETS system) is working relatively well for industry and electricity. However, stronger measures are needed to accelerate progress in built environment and mobility if their sector goals are to be achieved. So far, incentives in these sectors have encouraged households to start adopting clean energy technologies, such as solar panels, heat pumps and EVs. Now, they should promote the massive scale-up that is required: instead of focusing on measures in ETS sectors, national incentives should support initiatives where the Dutch government is in control, and which make the largest impact on decarbonization.

Unlock new money – Investment figures show positive signs for the take-up of clean energy technologies. Households have been adopting clean technology at a fast growth rate, while the private sector is planning major capacity increases across key energy sources and technologies. Project developers and investors (in all categories) should align their views on risk and incentives more closely, to unlock new sources of market capital, drive project realization and taper reliance on public funding, to help accelerate the energy transition. Lessons can be learned from the LNG terminal Eemshaven, where investors were willing to accept higher risks to enable the project. Additionally, (national) public parties should make the best use of available (European) funds, which could not only stimulate the transition but also fund the build-out of the required infrastructure.

Find the skills and materials – To realize the ambitious projects development plans and reach the targets for renewable energy many materials and (new) people with the right skills are required. Therefore, new market levers and trading partnerships should be explored, to secure the skills and materials needed to expand the development of a renewable energy system.

Call-out H. Successfully driving electrification – EV infrastructure

One example of successful infrastructure build-out is the development of the national EV charging infrastructure. This has been a great success, and represents a quarter of all 500,000 slow charging points in Europe, giving Dutch car drivers access to the continent's largest charging network, in both absolute and per capita terms.

The main drivers of this infrastructure development were government subsidies for EVs in private ownership and in company lease schemes. Although the effectiveness of this incentive design has been questioned, it did enable the increasing share of EVs in the Dutch car fleet to 7% by 2022.

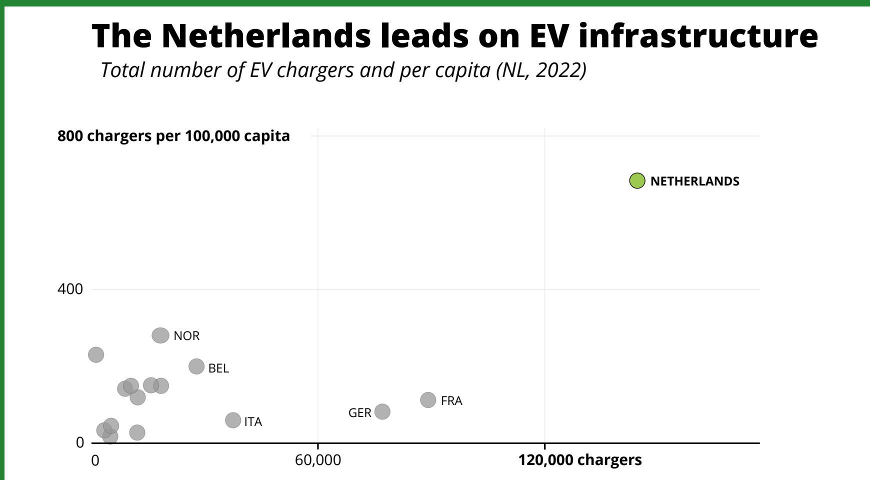


Figure 26: Total and per 100.000 capita slow EV charging points in Europe [a, 7, 25, 47]

[a] Slow chargers have power ratings less than or equal to 22 kW.

6. 10 bold ideas to speed up the energy transition – Deloitte's perspective

The Dutch energy transition has made good progress in many parts of the energy system. However, the decisions we make in the years ahead will fundamentally change the way of life and economy in the Netherlands, and determine whether we will reach the goal of net zero by 2050.

We have much work to do in a short time, but the Netherlands has the right elements to do it well, with a mature economy and regulatory environment, a well-educated workforce, a culture of innovation and the willingness to invest in our future. The challenge now is how to orchestrate these capabilities in new ways, to accelerate the transition, protect our energy security, and benefit our society and economy.

We therefore propose ten bold ideas, to help deliver a successful energy transition:

01. Develop the path together
Harmonize public and private interests by developing deeper and more extensive bilateral agreements between governmental bodies and the largest emitters to enable the industrial energy transition along with settings output targets for domestic manufacturing and building the infrastructure for a green industrial base.

02. Take full responsibility
The effect on greenhouse gas emissions from international aviation and shipping and imported goods should be taken into account when designing and evaluating emissionreduction policies and incentives.

03. Take the public along
Public support for the energy transition should be increased by celebrating its successes, through grassroots campaigns and policy initiatives that promote new behavioral norms (rather than financial incentives), while supporting the most vulnerable households through their transition.

04. Decarbonize molecular energy demand
The decarbonization of energy consumption which cannot be electrified should be stimulated by driving the hydrogen market and by making optimal use of biomass – shifting its role from generating electricity, low-temperature heat and road mobility, to producing fuels for the hard-to-decarbonize decarbonize shipping and aviation sectors.

05. Position the Netherlands as the powerhouse
North Sea Consortium should be strengthened to create a vision and execution plan for the market design that positions the North Sea as the powerhouse of North-West Europe's offshore wind electricity and hydrogen production.

06. Fix permit delays
A regulatory ring-fence should be created, and prevailing assumptions should be challenged by government officials to accelerate permitting times and simplify qualification processes for new projects, while improving the use of technology and data to make faster, better decisions.

07. Support security and near-term shifts with gas
Security of supply of natural gas should be strengthened by choosing sources that are the least carbonintensive (i.e., national), least pricevolatile (i.e., supported with longterm contracts) for as long as natural gas plays a role in the Dutch energy system (at least the next ten years).

08. Prioritize impact in scaling

Incentives that have been effective in encouraging households to adopt clean energy technologies should now promote the expansion of measures that have greatest impact, and reduce costs of these technologies, such as transitioning domestic heating from gas to new renewable technologies which will create the demand, momentum and confidence for the private sector to scale up production. Focus of policy makers should be on those sectors where their influence is largest (ETS vs Non-ETS) and over-incentivization should be evaluated (e.g., "salderingsregeling").

09. Unlock new money

Views on risk and incentives should be aligned more closely amongst developers and investors (in all categories) to unlock new sources of market capital, drive project realization and taper reliance on public funding, to help accelerate the energy transition. Where required this should go hand in hand with unlocking existing European funds to support the Dutch energy transition.

10. Find the skills and materials

New labor market levers and trading partnerships should be explored to secure the skills and materials that are needed to expand the development of a renewable energy system.

These ideas, in combination with the facts presented in the Energy Transition Monitor, aim to provide a starting point for the discussion, collaboration and decision-making that will take us toward a successful energy transition.

[a] Slow chargers have power ratings less than or equal to 22 kW.

7. Glossary and abbreviations

CBAM	Carbon Border Adjustment Mechanism (an EU tariff on carbon-intensive products)
CBS	Centraal Bureau voor de Statistiek (statistical bureau of the Netherlands)
CCS	Carbon capture and storage (used to mitigate carbon emissions that can't be eliminated at source)
CCUS	Carbon capture, usage and storage (used to mitigate carbon emissions that can't be eliminated at source)
CH_4	Methane (a GHG)
CO_2	Carbon dioxide (the dominant GHG)
CO_2-eq	Carbon dioxide equivalent (a standardized measure of GHG emissions)
ETS	Emissions Trading Scheme (an EU emissions reduction initiative)
EU	European Union
Eurostat	Statistics agency of the European Union
EV	Electric vehicle
F-gases	Fluorinated gases, which combine hydrogen, fluorine and carbon, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)
FID	Final investment decision (the point in project planning when funds have been secured)
GHG	Greenhouse gas
H_2	Hydrogen (a fuel source)
HFC	Hydrofluorocarbon (a type of GHG)
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquefied natural gas (a compressed form of natural gas, typically used for transportation)
Mt	Megatonnes, or 10^6 tons (a measurement of mass); in this report, GHG emissions measured in Mt refer to the CO_2 equivalent
N_2O	Nitrous oxide (a GHG)
NEa	Nederlandse Emissieautoriteit (the Dutch emissions authority)
NGO	Non-governmental organization (e.g., public or policy body, independent of elected government)
NL	Nederland (The Netherlands)
O_3	Ozone (a GHG)
PFC	Perfluorocarbon (a type of GHG)
PJ	Petajoule, or 10^{15} joules (a measurement of energy)
PV	Photovoltaic (a technology used in the solar generation of electricity)
SAF	Sustainable aviation fuel, including biomass-based bio-SAF
SDE	Stimulering Duurzame Energietransitie (Dutch government sustainability energy transition subsidy scheme)

8. Table of Figures

9. Appendix

Sentiment Analysis Methodology

	Gather	Translate	Score
Actions	• Access Twitter API to collect raw data. • Apply search query for "energie transitie" in Dutch tweets. • Limit collection to the 1000 most popular tweets per year. • Filter tweets for the Dutch language (proxy for location filter). • Save tweets and metadata to a CSV file.	• Utilize the Google Translate API for translation. • Translate Dutch tweets to English for compatibility. • Translate each tweet individually for accuracy. • Save translated tweets to a CSV file.	• Use a pre-trained, open-source sentiment analysis model from Hugging Face called Twitter-roBERTabase for Sentiment Analysis. • Feed translated tweets into the sentiment analysis model. • The model assigns sentiment labels (positive, negative, neutral) based on tweet content. • Save final output to a CSV file. • Aggregate and perform analyses. • Expand with other data sources (population density, provincial geospatial data).

Sentiment Analysis Definitions

Term	Definition
Social media sentiment analysis	The process of analyzing and determining the emotions and attitudes expressed by individuals on social media platforms regarding specific topics, such as the Dutch energy transition, using advanced algorithms and techniques to assess overall sentiment.
Positive sentiment	Favorable or optimistic emotions, opinions, and attitudes expressed by individuals toward a particular subject. In the context of the energy transition, positive sentiment may include expressions of support, enthusiasm, or belief in the benefits and effectiveness of transitioning to renewable energy sources.
Negative sentiment	Unfavorable or pessimistic emotions, opinions, and attitudes expressed by individuals toward a specific topic. In the case of the energy transition, negative sentiment may involve criticisms, concerns, or doubts about the feasibility, costs, or potential drawbacks associated with adopting renewable energy solutions.

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Our insights can help you take advantage of change. If you're looking for fresh ideas to address your challenges, we should talk.

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