Report

How the Dutch achieve climate-neutrality by 2050: summary of the guiding principles and key outcomes of the four scenarios.

Berenschot

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Berenschot and Kalavasta have developed four integrated climate-neutral scenarios for the Dutch energy system in 2050. This study was commissioned by Gasunie, TenneT and the regional energy network operators in the Netherlands and produced in close cooperation with the Dutch ministry of Economic Affairs and Climate. Key findings of this study have been presented by the energy and climate policy minister to Parliament.

1. Introduction

The network operators in the Netherlands want to prepare for the climate-neutral vision set out in the Dutch Climate Agreement. After all, the investments that network operators make in the energy infrastructure are for the long term. It takes time to install power lines, sustainable gas distribution networks and other energy supply infrastructure, which itself has a long-life cycle.

In order to provide a proper response to these challenges, the network operators and other parties to the Dutch Climate Agreement decided to conduct a phased exploratory study on the options for an integrated energy infrastructure (known in Dutch as the integrale infrastructuurverkenning 2030-2050, or II3050). Berenschot and Kalavasta conducted in cooperation with the network operators phase 1 of II3050. For phase 1 four scenarios for 'climate neutrality in the Netherlands' in 2050 were developed. These scenarios have been established not as four separate options to choose from, but to flag the four corners of the future energy mix on which these developments could play out in practice.

2. Concise summary of the applied methods

To create future energy demand projections Berenschot and Kalavasta gathered information about the main sectors in the Netherlands, which are the build environment, mobility, industry, agriculture and the electricity sector. Particular emphasis was placed on the current energy supply and feedstock of the 5 biggest chemical clusters in the Netherlands. This information was gathered by desk research and sending out a questionnaire to industry leaders, and followed up with several interviews with industry clusters. In-depth intelligence about the current energy balances (energy and feedstock) of these clusters was gathered and processed in order to fit the modelling of the energy transition of the industry sectors.

To create future energy supply projections interviews with associations for renewable power took place to gather the newest insights in the field of solar and on/offshore wind power. With the information obtained from these interviews and modelling steps that followed, four energy scenarios were constructed, which primarily focus on the future demand and supply of (renewable) energy carriers. In the scenario's that endeavour an autonomous energy system, modelling took place to create a balanced energy system. The main objective was to establish a seasonal balance and avoid loss of load and black-out hours. This balanced energy system did not solely focus on renewable electricity, but also on (green) hydrogen production, heat production and biomethane production. Therefore the required future storage capacities for hydrogen and (bio) methane were calculated. Finally, the impact of extreme weather conditions were explored to create more robust scenarios, as extreme weather conditions have major impact on the supply and demand of energy carriers.

The transition towards renewable energy carriers affects the current energy system, the outcome of the four scenarios were used to assess this effect on the energy infrastructure. The outcomes of the study are currently used by TSO's and DSO's for long-term grid investment planning, phase 2 and 3 of II3050. Although, these scenarios are in principal developed for Dutch TSO's and DSO's, other parties/stakeholders within the energy transition are able to use these scenario's and base their future (investment) plans on this research' outcomes.

The following paragraphs provide detailed insight in the general principles and outcomes of each scenario.

3. Four climate neutral scenario's (KNES2050) for the Netherlands

3.1. Regional governance scenario

General principles

- The Netherlands achieves its CO_2 targets through regional development
- 100% CO_2 reduction
- Self-sufficient and no imports
- Contraction of energy-intensive industry
- Regional projects and large share of local ownership
- Highly committed citizenry
- Circularity key in manufacturing and food production

Key outcomes

- High share of renewables in the energy mix
- Maximum use of solar-PV
- Housing: Heat (various sources) + all-electric
- Mainly green hydrogen production; hydrogen imported to support long-distance transportation (aviation and shipping)
- High demand for storage options

In this scenario the Netherlands' government largely delegates the management of the energy transition to local and regional government bodies.

The objective is to make the Netherlands completely sustainable and self-sufficient. Regional authorities are provided with the necessary resources and competence to lead their energy transition. Regional authorities launch many initiatives to make optimal use of the region's potential, but their energy supply will not necessarily be autonomous. For specific sectors that have a more national scope, such as industry clusters and airports, the regional authorities will work closely with national government.

Because a lot of this will take place in a local context, the general public will be in close contact with the regional authorities' initiatives. This works in two ways. Firstly, businesses and the public will be actively involved in projects initiated by local government bodies. Energy cooperatives are formed in which the authorities, businesses and private citizens work together and set up sustainable initiatives. Examples of such initiatives could include solar-PV solutions, collective district heating networks, geothermal energy projects and onshore wind parks. Secondly, businesses and private citizens will receive support from government to realize their sustainable initiatives. Private citizens can for instance receive grants for home insulation and a voluntary transition to electrically powered transport will be facilitated, e.g. through a vehicle charging infrastructure.

People alter their lifestyle in such a way that there will be more demand for sustainable products. Reduced consumption will become part of that lifestyle. This means that the demand for sustainable products will rise while the demand for products made using traditional fossil-fuel based methods will decline. In this way private citizens will exert pressure on industry to become more sustainable (buyer power). National government will be subject to increased pressure from society and the regions to strictly regulate industry in the areas of sustainability and circularity. In the same way, circular agriculture will also become the norm. As a result, the demand for artificial fertilizer in the Netherlands will largely disappear, although it will still be produced to some extent for export. In addition, fossil-based industries will be forced to switch to circular bio-oils (e.g. pyrolysis), to close or to move abroad. There will also some degree of 'flight shame'. All of these factors will lead to a contraction of the energy-intensive industry in the Netherlands.

Due to the fact that regional governments are expected to lead the energy transition in this scenario, it is less likely that energy projects involving large investment will be developed. Regional authorities do have a significant influence on the public

transport sector though. As such a relative greater (time) effort will be invested to reduce public transport emissions, which will therefore become fully electrified in the short term.

The regional authorities' strong commitment towards self-sufficiency will lead to large-scale energy storage under this scenario. Should the electricity supply be reduced for a longer period, this shortfall would be met through hydrogen production (and green gas) from reserves built up for this purpose.

3.2. National governance scenario

General principles

- The Netherlands is the first in Europe to meet its national CO_2 targets
- 100% CO_2 reduction
- Very high level of self-sufficiency and minimal imports
- Energy-intensive industry stays at current scale
- Large national projects
- Circularity key in manufacturing and food production

Key outcomes

- High share of renewable energy in energy mix
- Maximum use of wind (predominantly at sea)
- Housing: Mostly all-electric
- Mainly green hydrogen production; hydrogen imported to support long-distance transportation (aviation, freight and shipping)
- Medium demand for storage, as some imports possible

In this scenario the central government takes the lead. The energy transition becomes a central government task, with the aim to make the Netherlands largely self-sufficient, sustainable and circular. As a result, fewer small-scale initiatives will be implemented by businesses and the general public.

Purposeful steering by central government will bring about a clear transition to an autonomous energy supply. Based on a clear climate-neutral roadmap towards 2050, large-scale projects will be implemented with the risks largely borne by central government. This will favour projects with high start-up costs.

Under this scenario large-scale offshore wind parks in the North Sea region are one of the keys to becoming self-sufficient. Furthermore, the government will focus on projects that are indirectly linked to the energy transition: switching to electric passenger transport and developing a national hydrogen infrastructure with refuelling points for hydrogen-powered freight transport, for instance.The ambition to become autonomous in renewables will have a major impact on the spatial planning policies of the regional authorities. Because central government is in the lead it can make decisions which could have a considerable local impact on people and industry. The construction of large-scale offshore and onshore wind parks and solar farms are examples of measures that will have a major impact on spatial planning.

By requiring industry to electrify, make increased use of renewable raw materials and introduce the concept of circularity the government will not only propel industry towards the energy transition, it will also partially cover it's risks. The size of the energy-intensive industry sector itself will be largely unchanged.

Like the regional governance scenario, here too any imbalance in the energy supply will be met through an increase in storage capacity, for instance through the use of hydrogen, etc.

3.3. European CO_2 governance scenario

General principles

Europe leads the world in achieving its CO_2 targets

- 100% CO_2 reduction
- General CO_2 levy, import duties and compensation on Europe's borders
- Energy-intensive industry grows
- Global market for hydrogen and biomass
- Plenty of space for CCS

Key outcomes

- Moderate share of renewable energy in energy mix
- Moderate development of wind, solar and bio-gas
- Housing: Combination of hybrid electrification and biogas
- Hydrogen from natural gas combined with CCS ('blue') and from renewables ('green'); hydrogen import for long-distance transport, including freight and some private
- Low demand for storage capacity

In this scenario European member states are all ambitiously working towards carbon neutrality. As such, national governments have a high degree of freedom to determine how their energy mix will look like in 2050. This scenario assumes that a general Europe-wide CO_2 levy is introduced. This levy will affect all sectors and therefore go beyond the present EU ETS (Emissions Trading System) which only applies to energy-intensive industry and electricity producers.As the rate of this CO_2 levy gradually rises towards 2050, CO_2-emitting products and processes will become less attractive and will ultimately disappear. The speed of the energy transition will therefore be directly linked to increases in the CO_2 levy and the availability and price of renewable alternatives.

Measures will be introduced in Europe where they will be most cost-effective and where the business case is most favourable. Europe supports its own industries (so-called 'champions') and the mutual solidarity between member states is high. This will strengthen the Pentalateral Energy Forum, which coordinates roll-out of energy options across the continent. The Netherlands will import energy from abroad, preferably sustainable energy from a European source.

Projects and initiatives will only be launched when supported by a strong business case. In other words, a sustainable alternative will only be selected if it is cheaper than the cost-price of the fossil fuel alternative. Even though climate costs are factored into investment decisions, CO_2-neutral technology will not necessarily be the automatic choice. All energy solutions with the potential for an unprofitable top margin (notwithstanding carbon pricing) will therefore be rejected. In the near future this will lead to the use of hybrid technologies and CCS (Carbon Capture and Storage) in situations where this technology is relatively cheap with opportunities to switch between different energy sources. Hybrid technologies are therefore less sensitive to price fluctuations for both fossil and renewables.

This means that the cheapest options will also be used for transport. During the first few years when the CO_2 levy is still low, fossil fuels will continue to be widely used for transport. But as this tax starts to rise, electric and hydrogen-powered transport will become more attractive and take over the market.

To prevent the CO_2 levy from damaging the competitive position of European industry relative to the rest of the world, revenues from the CO_2 levy will be used to provide compensation on the EU's borders. Revenue from the CO_2 levy will also be ploughed back into the sectors concerned. In industry this will take the form of subsidies for sustainable processes, feedstock and circularity. Under this scenario the industry will grow gradually.In this scenario gas with CCS will be used until 2050, as it is expected that this is cheaper than many alternative technologies. Some gas-powered installations will ultimately switch to green gas (possibly imported). This will also be used as a back-up if there are energy supply problems in the short or longer term.

3.4. International governance scenario

General principles

- Whole world strives to meet CO2 targets, fossil greatly reduced
- 100% CO2 reduction
- Free trade promoted
- Trade infrastructures supported
- Energy-intensive industry expands
- Global market for hydrogen and biomass
- Space for CCS

Key outcomes

- Moderate share of renewable energy in energy mix
- Development of offshore wind
- Housing: Combination of hybrid electrification and hydrogen
- Hydrogen sourced from (sustainable) import ('yellow-green')
- High use of hydrogen in process industry
- Use of hydrogen in all forms of transportation
- Medium storage capacity required (strategic reserves)

This scenario assumes open international global market in which a robust climate policy is also pursued worldwide. This means no import tariffs, quotas or other measures which could hinder trade either inside or outside Europe. The Netherlands is not self-sufficient, making it dependent on imports. Under this scenario there will also be close international cooperation. As a result, within Europe there will be an advanced international infrastructure in place for the exchange of energy sources (hydrogen, biomass and bio-fuels). To safeguard the supply of these energy sources the government will focus on maintaining international trade relations. In addition, the Netherlands will have state-of-the-art infrastructures with strategic reserves in place to facilitate the transport and storage of very large volumes of various renewable energy sources.

The Netherlands' focus will be to build an energy knowledge economy. The technologies developed here can be sold as an export product. This will enable the Netherlands to maintain its strong competitive position: as a market leader it exports know-how and imports renewables on a large scale. Renewable energy will be generated on a large scale worldwide at strategic locations (strategic in terms of technology and economics).

For the Netherlands this means primarily the construction of offshore wind parks as the favourable weather conditions on the North Sea will enable it to be price-competitive on the world market. Outside the Netherlands this will lead to large-scale solar farms and/or biomass production in sparsely populated areas, for example.

The international nature of this approach means that private citizens and businesses will mainly focus on the development of new technologies, because the fossil supply will be greatly reduced. The large volumes involved mean that the pricing of renewables will also start to become more interesting towards 2050. Supply will grow only slowly in the near future, but as more countries invest to reach their carbon reduction targets and large-scale projects are implemented, the volume will grow exponentially. Imports will ensure a wide range of energy sources that will be used for both passenger and freight transport. Although electric transport will predominate, hydrogen, biogas and bio-fuels will also be used.

As the energy-intensive industry grows it will focus initially on natural gas and CCS for pricing reasons (lowest capital and operational expenditure). Hydrogen will also be added later when it becomes available in large volumes. The present fossil feedstock will continue to be used in many industries.

4. More information

Download the complete scenario study (in Dutch only).

To supplement this exploratory study, at the request of the Dutch Ministry of Economic Affairs Berenschot and Kalavasta developed a fifth 2050 Climate Neutral scenario. This separate variant study focused on the impact and options for including nuclear energy in the climate-neutral future (in Dutch only).

5. Energy Expertise & Energy Services Berenschot

The energy transition brings radical changes, creating opportunities as well as challenges for enterprises, businesses and governments involved. The development towards a more sustainable energy system is a dynamic process, with different development paths. These paths are surrounded with a wide range of uncertainties, risks, policy questions and technological challenges. Think of increased generation of sustainable energy, more local production, more urgency for system flexibility and a growing complexity of the energy system.

In order to accelerate the energy transition, Berenschot supports EU institutions, national governments, European regions, enterprises and organizations by performing scenario studies (Development of four Climate Neutral scenario's for 2050, NBNL), development of strategic sector roadmaps (Roadmap for the Dutch chemical industry, VNCI; Roadmap of supply, demand and infrastructure for hydrogen towards 2050, EBN), qualitative and quantitative policy analysis (comparing options of solar energy production, Enpuls) and participative governance in the field of energy (facilitating focus groups with the socially disadvantaged, KBF, on-going).

In our work we make use of the best-practices among our (Dutch) experiences and expertise, our approach integrates extensive and in depth expertise of energy markets, knowledge on sustainability with deep technical insight (electricity, gas, heat power, hydrogen and CO2).

Would you like to learn more about our expertise in the energy sector? Please contact:

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6. Other EU consultancy Services Berenschot

In addition to our energy services, the Berenschot EU team offers a range of consultancy services towards the European Union and Dutch clients who wish to spread their wings in Europe. Our aim is to live up to our excellent reputation in the Netherlands, for example in the field of participative governance and energy transition, at the European level as well, and to help clients tackle major social challenges, we particularly focus on the following fields:

- Communication;
- Cross-border cooperation and governance;
- Mobility; and
- Participative governance.

Berenschot

Berenschot is an independent management consultancy firm with 350 employees worldwide. For 80 years, we have impressed our clients in the public and business sectors with smart, new insights. We acquire these new insights and turn them into something practicable. We do this by combining innovation and creativity. Again and again. Clients prefer Berenschot because our advice gives them a head start.

Our firm is staffed by inspiring and determined individuals who all share the same passion: organising, i.e. transforming complex issues into practicable solutions. Because of our broad sphere of activity and extensive expertise, clients can call on us for a wide variety of assignments and projects. And we can put together multidisciplinary teams to tackle all aspects of an issue.

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