Recommendations from II3050

Second edition

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Netbeheer Nederland

These are the recommendations from the most recent 2030–2050 Integrated Infrastructure Outlook (II3050 – second edition). The objective of this outlook is to gain insight into the energy infrastructure, flexibility resources and system integration needed to ensure a reliable, effective, robust climate-neutral energy system by 2050. The main conclusion is that while achieving a climate-neutral Netherlands by 2050 will be a major challenge, it is possible. The new findings, as described in these recommendations, show what is needed for this.

II3050 – second edition is an update of the first edition of II3050, published in 2021, and contains both content updates, a partly broader scope and methodological improvements compared to the initial edition. The update of the underlying scenarios was published separately in June 2023.

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Topic: Fundamentals for creating the future energy system

RECOMMENDATION 1.1 Create targeted, feasible climate policies that take physical boundaries into account, and ensure regular refinements of national programmes using infrastructure analyses.
With climate ambitions and the laws and regulations that arise from these, take into account the physical limitations of the infrastructure, the effect on other parts of the energy system, and feasibility at every level and scale. A comprehensive analysis of the energy infrastructure, flexibility and implementation capacity will reveal bottlenecks and help in drawing up effective, implementable legislation and making effective policy and system choices.

If it is decided to bring forward a zero-CO_2 electricity system, ensure that the facilitating conditions are in place. To give an example: faster growth in hydrogen production, import and storage also requires faster growth in renewable energy generation and more storage, conversion capacity and demand management. Furthermore, the infrastructure has to be expanded faster too.

Also ensure that ETS emission allowances are removed from the market so as to prevent CO_2 leakage to other sectors.

Provide for regular refinements of the National Energy System Plan (policy direction) and *Programma Energie Hoofdstructuur* (spatial development) to ensure the right facilitating conditions at all times for timely development of the energy system. This is essential given the uncertainties concerning the industry now and in the future, the national production of renewable energy, the pace of the transition and the pathways for neighbouring countries, and other factors.

RECOMMENDATION 1.2 For each energy carrier, and possibly for specific sectors, draw up a standard for the security of supply and/or revise the existing standards.
At the moment there are different standards for electricity and gas, and none yet for hydrogen or heat. With the transition to a sustainable energy system, these standards will also become more interconnected. Agree on what is expected of the future sustainable energy system, for all energy carriers and for all customers. This clarification is needed to ensure that the right investments in infrastructure and flexibility resources are made at the right time. In a sustainable energy system, the permanent security of supply as we have known this in the past would be very expensive. There needs to be a discussion about the degree of security of supply desired, the costs that would be deemed acceptable, and who is to be supplied with what type of energy at times of scarcity.

RECOMMENDATION 1.3 Ensure that each administrative tier reserves, in good time, sufficient space for renewable energy generation, infrastructure (on land and offshore), flexibility and storage to keep up with the required pace of the transition.
In addition to reserving large tracts of land and space offshore for the sustainable generation of electricity and heat, space is also needed for the requisite infrastructure and flexibility resources. To meet the sharp increase in demand for transmission capacity for the various modalities (electricity, hydrogen, heat, CO_2), the infrastructure needs to be expanded significantly. At the national level, this includes space for offshore cables and pipelines and for EHV transmission lines on land, as well as space for above-ground stations and underground gas storage facilities. At the provincial level, there needs to be space for new HV transmission lines, substations and flexibility resources, for example. And at the municipal level, this concerns space for MV and LV cables and MV transformer stations, both in the built environment and beyond.

RECOMMENDATION 1.4 Draw up a national energy transition implementation plan that considers the transition of the four value chains (electricity, hydrogen, heat and CO_2) at both the regional level and the national level (including offshore and abroad).
For the energy transition to be feasible, there needs to be more certainty about the pathway and pace of the transition for the various sectors as well as about the scaling up and innovation of many new technologies. A successful transition demands a lot from society too: over the next two decades roads will be torn up in virtually every community in the country, the costs for the energy system will increase in the short term, and the behaviour of people and companies will need to change.

A national implementation plan would need to:

- provide individuals and companies with clarity on what will change where and when;
- guide local, regional and national authorities in their preparations (drafting planning procedure orders, reserving land, engaging local communities, granting permits, etc.);
- help network operators and, by extension, their contractors, with personnel and material planning.

RECOMMENDATION 1.5 Work on a carbon transition ('feedstock transition') and facilitate synergy with the energy transition.

The energy transition means changing from a fossil energy system to a renewable energy system. As a result, fossil carbon will gradually disappear from the feedstock flow – no more oil, no more scope 2 and 3 emissions. Accordingly, we will need renewable carbon instead to produce plastics, steel, synthetic fuels and other products and materials. This will require completely new production processes, however, and the development of the infrastructure will be heavily dependent on the extent of these new production processes in the Netherlands. Having a clear understanding of companies' aims and having a roadmap from the government are of great importance for ensuring the timely availability of the infrastructure. Certification of renewable carbon is also important: this will make it possible to distinguish non-fossil carbon from fossil carbon so that the former can be given a financial value or be standardised. The carbon transition is part and parcel of the energy transition.

Topic: Flexibility

RECOMMENDATION 2.1 Draw up a policy framework that will ensure the realisation of sufficient flexible capacity. Keep the rules simple and the business case appealing.

The future scenarios described in the second edition of II3050 show that the gap between supply and demand will increase sharply for all energy carriers. It is not a given that, with the current market regime, it will be profitable to create sufficient flexible capacity. If the development of local flexible capacity at consumer level lags behind, central dispatchable power needs to take on a bigger role to continue to guarantee security of supply. Local flexible capacity (supplied from electric boilers or battery storage systems, for example) and central flexible capacity (supplied by zero-CO_2 power stations, for example) would work as 'communicating vessels', each balancing the other. As part of this policy framework, define development pathways for flexibility resources and, for example, set a minimum threshold for the target flexibility capacity. This minimum threshold could apply to the total flexible capacity or per technology. The findings of II3050 – second edition can provide guidance in this regard.

RECOMMENDATION 2.2 Encourage more flexibility in energy demand behaviour in all sectors through financial incentives. Agree firm targets and monitor progress towards these.

The more demand adapts to the available supply, the better: this way, less investment will be required in flexibility options and energy infrastructure, the business case for renewable energy producers will be better, and the social costs will be lower. Flexible behaviour regarding energy demand can be stimulated through financial incentives. Together with the relevant actors, explore the desired adjustments and implement these in a timely manner.

Though the estimated potential of demand response is immense, it is difficult to determine at this point how much of that potential will be realised. Given the major influence demand response has on grid balancing and on security of supply, agreements regarding demand response should always be made in conjunction with other flexibility options. In view of the estimated potential of this factor, it is essential to make concrete agreements with industry players, both in the clusters and outside, and to monitor these agreements.

RECOMMENDATION 2.3 Focus on the location and method of utilisation of flexibility options.

Flexibility options to balance the system should not lead to an increase in transmission demand. This can be prevented, for example, through the differentiation in network tariffs, fast tracking connection requests if a certain amount of flexibility is guaranteed, alteration of the current bidding zones, or by other means. By choosing the how, when (times of the year) and where prudently, smarter use can be made of the flexibility options and energy infrastructure.

RECOMMENDATION 2.4 Draw up an integration framework for connecting flexibility sources in a 'scarcity-neutral' manner, one which can be quickly put into practice after adoption.

By connecting flexibility options in a scarcity-neutral manner – meaning in such a way that flexibility resources do not worsen congestion – bottlenecks can be prevented and the available transmission infrastructure can be used more efficiently. For example, having batteries connected in a scarcity-neutral manner means that the network operator can restrict the charge or discharge capacity when congestion occurs. It should be investigated whether the 'scarcity-neutral' connection of flexibility resources should be included in the connection conditions or reflected in connection prioritisation or in a new tariff. The framework for the integration of large-scale battery storage systems drawn up on behalf of Netbeheer Nederland can serve as a source of inspiration (link).

Topic: National energy system

RECOMMENDATION 3.1 Intensify cooperation with neighbouring countries and develop a European plan (where not yet in place) for harmonising national energy mixes, market forces and the main energy infrastructure in the EU, encompassing interconnectors, hydrogen and gas transport and the offshore grid.

The high-voltage grid is connected to surrounding countries, as will be the future hydrogen system, and they are thus part of the energy transition in neighbouring countries too; this makes mutual coordination even more essential.

RECOMMENDATION 3.2 Have all parties involved start the preparations for the expansion of the high-voltage grid in their region (routing, permits, reserving land, etc.) in good time so as to prevent delays (or further delays) in realising the required transmission capacity.

Expanding high-voltage transmission capacity is a lengthy process. Investment decisions taken now will only deliver new high-voltage capacity in the second half of the energy transition. For the 110/150kV network, further implementation of a pocket (sub-grid) structure is an important first step. In addition, it is important for larger initiatives (load, generation or flexibility) to be connected directly to the 220/380kV grid to ensure that they do not place additional burdens on the 110/150kV grid.

RECOMMENDATION 3.3 When further scaling up offshore wind energy, consider the added value that hybrid connection points (i.e. offshore energy hubs) can offer.

With a hybrid connection point, energy generated offshore is brought to the landfall point partly as electricity and partly as hydrogen. Hybrid connection points provide more options for supplying electricity or hydrogen, making it easier to balance the energy system and respond proactively to developments in the market. These developments depend on factors like the available technology, political choices, legislation and regulations and price trends. The extent to which the hybrid use of offshore electrolysis would impact transmission and flexibility on land (e.g. with regard to the use, in operating hours, of future hydrogen power stations) and on the total system costs is not yet sufficiently clear and requires further research.

RECOMMENDATION 3.4 Support and accelerate the development of the hydrogen value chain, and specifically the construction of the offshore hydrogen network, importing hydrogen and hydrogen carriers, and increasing the number of hydrogen caverns.

Hydrogen plays a key role in every scenario examined in II3050 – second edition. All scenarios foresee a need for a robust hydrogen infrastructure. However, much of the requisite hydrogen system is yet to be developed. Investments in hydrogen production, import, demand, balancing and infrastructure (including storage) lag behind the hydrogen ambitions for 2030. Current uncertainty about the applicable laws and regulations, the total costs and the cost differences between countries (e.g. exemption from network charges in Germany) means that few investment decisions are being taken as yet.

RECOMMENDATION 3.5 Encourage the further development of hydrogen storage in salt caverns and investigate the suitability of hydrogen storage in empty gas fields.

Over the coming decades, the need to store hydrogen will increase due to the anticipated domestic production and growing dependence on hydrogen as a feedstock and energy source. A maximum of 60 caverns can be realised in the Netherlands (TNO, 2021). HyStock is currently working on the creation of four caverns, which should be operational early in the next decade. It is assumed in II3050 – second edition that empty gas fields are suitable for hydrogen storage and will become available in good time. If this assumption is correct, then the required storage capacity would be equal to about 70 caverns (possibly also partly in Germany). The realisation of sufficient storage capacity can be facilitated through coordination and incentivisation. Also, further research is needed into whether empty gas fields actually do have the potential to be used for hydrogen storage.

RECOMMENDATION 3.6 Make choices on strategic storage for the broad energy system of the future and do not close current gas storage facilities until it has been investigated whether, and to what extent, they can play a role in terms of strategic storage in the long term.

Strategic storage can ensure sufficient energy in the Netherlands in exceptional circumstances, for example in the event of a 'green energy drought' – several years of little wind and solar generation combined with particularly cold winters – and/or reduced imports due to geopolitical developments. This involves vast volumes, sufficient to meet the energy needs even in these exceptional circumstances. The existing natural gas storage facilities, in combination with the production of blue hydrogen, can, in the long run, play a key (and efficient) role as strategic storage for the broad energy system of the future.

RECOMMENDATION 3.7 There need to be clear, long-term agreements between the government and companies that focus on CO_2 capture and storage (CCS).

The pace of CCS deployment is important for the grid operators given the impact CO_2 storage in a particular region will have on the required transmission capacity and the type of grid in that region. The eventual shift in the carbon value chain, from capturing CO_2 from industry to transporting CO_2 to industry (CCU as carbon becomes more scarce), must also be taken into account. The CO_2 pipelines can eventually be used to transport CO_2 to locations where there is a shortage. Introduce certification for CO_2 in good time so that renewable carbon can, in due course, be distinguished from fossil carbon.

Topic: Regional energy system

RECOMMENDATION 4.1 Make systematic area-specific choices for the overhaul of the energy system (what goes where?). In those choices, focus on implementation and then arrange all facilitating conditions (land, permits).
From residential areas to industrial clusters, choices regarding energy planning urgently need to be made: what will the energy solutions look like, where and when will those solutions be installed physically, and how and when will they be integrated into the energy system? The energy infrastructure has become one of the guiding and structuring principles in spatial development. Make these choices through programme-based collaboration between network operators and government bodies, with input from companies and grid users. Make the choices binding, carry them forward into implementation, and then make arrangements to speed up implementation. This concerns reserving land for infrastructure, integrating the routes and stations in the physical space, working together more efficiently on permits, and doing what is necessary to ensure timely implementation. It is essential that, rather than working ad hoc, from project to project, the infrastructure for each particular region be reinforced and made future-proof in one go. This way, businesses and households can prepare for what they need to do and the network operator can take targeted action to get the infrastructure in order.

RECOMMENDATION 4.2 For the requisite changes to the grid, give priority to communities where the plans and facilitating conditions are already in order and which can transition to a final sustainable solution (such as full electrification) as a cluster and in one go. This requires a change in current rules regarding regional network operators and their working methods.
It is essential that all municipal Transition Visions for Heating (TVHs) and the district implementation plans be fully elaborated and finalised, with clear choices regarding numbers, locations, technology and timeframe per district, in conjunction with plans for EV charging points and other energy users. Based on this, network operators and municipal authorities can jointly determine the prioritisation for the area-by-area overhaul of the electricity grids and/or conversion of heat grids, possibly eventually with hydrogen too. To ensure efficient implementation, a district-by-district approach – with the district essentially reaching the required final capacity all at once – is key. District-by-district means that network operators do not carry out the work in all districts at the same time. That means some grid users will have to wait longer, possibly up to several years.

RECOMMENDATION 4.3 Apply significant capping to all solar categories (solar farms and small- and large-scale rooftop solar systems).
Connecting solar installations at 50% of the capacity ensures efficient use of the grid while limiting the loss in energy yield (+/- 10%). Significant capping through built-in curtailment prevents unnecessary investments and improves realisability. This certainly applies to new connections. However, given its societal importance the approach could also be extended to existing connections, though that would of course be challenging from a legal point of view and would require the cooperation of the sector.

RECOMMENDATION 4.4 Allow for flexibility in the approach to removing decommissioned regional gas pipelines so that this can be approached in an efficient manner.
Requiring that decommissioned gas pipelines be removed immediately has a direct impact on the speed of the energy transition because the people qualified to carry out this work then cannot be deployed elsewhere. If the removal of decommissioned gas pipelines can be spread over a longer period and can be combined as much as possible with other scheduled ground work, this will allow other, more urgent work to be carried out sooner.

RECOMMENDATION 4.5 Make it clear when hydrogen will play a role, for whom and in which areas, who is responsible for the realisation of the necessary regional infrastructure and what requirements this hydrogen network must meet.
Concrete guidelines can be taken into account when planning regional hydrogen networks, either new or through retrofitting the gas network. This will also provide clarity for companies that are currently making strategic choices about their pathway to sustainability.

Topic: Other recommendations and follow-up actions requiring addition investigation

RECOMMENDATION 5.1 See that the Netherlands acts in a European context to minimise dependency on a limited number of countries that export hydrogen and scarce and rare-earth metals.
This also applies to import (and other) dependencies as regards renewable carbon. In II3050 – second edition, as well as in the draft NESP, availability and affordability have been assumed for hydrogen, scarce and rare-earth metals and renewable carbon.

RECOMMENDATION 5.2 Encourage the application of circular strategies in all sectors to reduce dependency on imports of scarce minerals and metals.
To decrease dependency on imports of scarce minerals and metals while scaling up sustainable production value chains, the circular strategies of rethink, reduce, repair and re-use must be promoted.

RECOMMENDATION 5.3 Further investigate the role of hydrogen derivatives (particularly ammonia).
Ammonia can play an important role in balancing the system, for example in cracking plants in the ports. It is anticipated that the availability of an ammonia cracker can make a major contribution to balancing the hydrogen system and reduce the number of caverns required. The possibility of running certain power stations on ammonia fuel should also be investigated.

RECOMMENDATION 5.4 Carry out additional research into how an increase in the feed-in of green gas will impact the gas network.
The increase in green gas feed-in combined with a decrease in total gas demand presents challenges in the areas of feed-in, transmission and storage. For parties wanting to feed in green gas, the preferred option is to connect them on a large scale and at high pressure where possible. Where green gas is to be stored (regionally or nationally?) also needs to be investigated. Costs and land use are relevant aspects, and gas quality is also an important consideration in this regard. These choices influence the production locations, required infrastructure and use of the available land.

RECOMMENDATION 5.5 Investigate the role that high voltage direct current (HVDC) can play in the expansion of the power grid.
HVDC is used offshore to transmit large amounts of electricity over long distances. Onshore, it has the added advantage that HVDC can be deployed underground, limiting the impact on land use above ground. For this reason, an investigation is recommended into what role HVDC can play in the onshore HV grid in terms of taking pressure off the AC grid and freeing up land above ground.

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