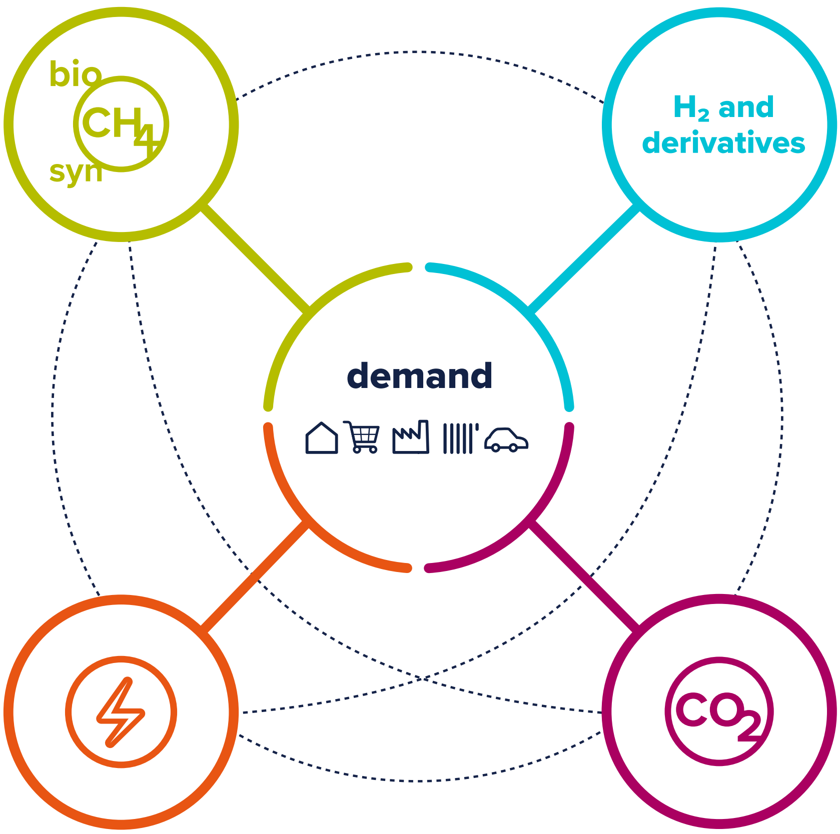
Towards an optimal energy system for Belgium and neighbouring countries

Key insights from the North Sea Integration Model



November 2024

fluxys

shaping together a bright energy future

As a key infrastructure partner, we help building a sustainable and cleaner energy future. That is our purpose. With our terminalling, transmission and storage infrastructure for different molecules, we bring energy where it is needed – today and tomorrow.

Making all solutions work together towards net-zero

Oil, natural gas and electricity currently account for a large proportion of the energy mix. Greater energy efficiency is expected to considerably reduce consumption. At the same time, the energy mix must evolve towards a low-carbon combination of electricity, molecules and biofuels to achieve net-zero.

A flurry of questions

These changes in the production and use of energy raise important questions: How can we design an affordable energy system with net-zero emissions? How can we ensure that the right amount of energy goes to the right place at any given time? What transmission and storage infrastructure is needed to connect supply and demand? In short: how do we make all solutions work together to achieve net-zero?

How to provide answers?

We can only obtain answers to these questions if we take an integrated view of the energy system as a whole. This is why, together with partners, we have developed the North Sea Integration Model: a simulation tool capturing all interactions between electricity, hydrogen, methane and CO_2 infrastructure for Belgium and all other countries bordering the North Sea.

Better understand the drivers

The model is not a forecasting tool pretending to reveal absolute truths and it does not serve to promote the scenarios we have run with it. It is, however, a state-of-the-art machine that helps better understand the drivers in developing an integrated energy system. And it brings to the table a series of key insights that we are happy to share with the community of stakeholders in building the future energy system.

Agility is of the essence

Above all, the North Sea Integration Model is a simulation model that continues to evolve. Various further developments are ongoing and we take into account on a rolling basis new developments in technology and energy & climate policy. Similarly, we keep the data used for e.g. costs and technical parameters up to scratch with any evolutions in the public sources we rely on.

Close cooperation makes the clock tick

Here in Belgium, we are fortunate to have plenty of top-level experts who have also developed useful multi-energy models, each with their own merits and specificities. We firmly believe that the complementarity of these models together with a close collaboration among players will be very helpful for policy and enable authorities to develop an energy vision aligned with Belgium's societal and economical objectives.

Pascal De Buck

Managing Director and CEO
Fluxys Belgium

Towards an optimal energy system for Belgium and neighbouring countries

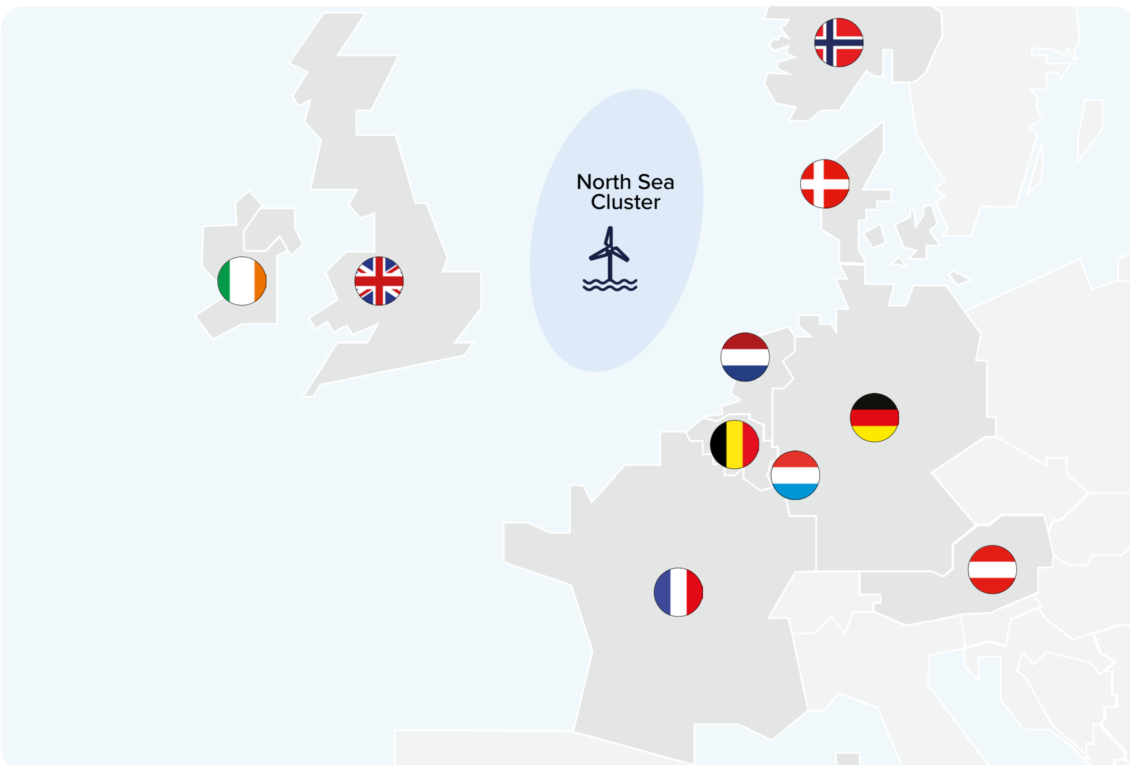
The North Sea Integration Model in a nutshell

The North Sea Integration Model results from the multi-year collaboration between Fluxys Belgium and the University of Liège (Belgium) on the INTEGRATION project. Aimed at developing methodologies to design an optimal energy system for Belgium, the project was supported by the Belgian Energy Transition Fund.

Once the project completed, with Fluxys Belgium we extended the approach to create a model covering all countries bordering the North Sea. Through this development we also take into account the commitment of the North Sea countries to make the North Sea the largest green energy plant in Europe.

Geographical scope

The model includes **Belgium** and **Luxemburg**, **the Netherlands**, **Germany** and **Austria**, **Denmark**, **Norway**, the **UK** and **Ireland**, **France**, and the **North Sea Cluster**. The latter includes all offshore wind developments more than 40 km from shore. Some countries have been combined in order to reduce the complexity of the model.



Geographical scope of the North Sea Integration Model.

What goes in the model: the inputs

Final energy demand – We use the demand scenarios jointly established by the Transmission System Operators (TSOs) in Europe working together through the European gas and electricity system organisations ENTSOG and ENTSO-E. They have developed the Global Ambition and Distributed Energy scenarios, each with a possible mix of final electricity, methane and hydrogen demand by 2050 (see box below for more information about the energy vectors). These scenarios, consolidated at the European level, translate the National Energy and Climate Plans established by each Member State according to Regulation (EU) 2018/1999. The scenarios used are those published in May 2024.

Assumptions – On the supply side, renewable energy sources (e.g. wind, sun, hydro, bio-energy) and low-carbon energy sources (e.g. conventional fuels with carbon capture) are expected to provide most of the energy needed to meet final demand in a net-zero emissions energy system. The capacities in the model that could be installed in each country are limited to the potential capacities defined in the scenarios of the European Transmission System Operators.

Assumptions are also made on technology costs, CO_2 storage potential and key technology parameters, e.g. efficiency and flexibility. For these, public reference date are used from a.o. the Danish Energy Agency and the *ASSET Study on Technology pathways in decarbonisation scenarios* by the European Commission.

Net-zero constraint – The model is fed with the constraint to achieve net-zero CO_2 emissions for the 10 North Sea countries together, but not for each individual country, similar to the way in which the EU Emission Trading System works today.

Methane, hydrogen, bio-energy: what's in a name?

Methane (CH_4) includes fossil methane (natural gas), biomethane (methane produced from biological sources), synthetic methane (methane produced from hydrogen combined with captured CO_2), and all other forms of methane that are interchangeable with natural gas in existing gas infrastructure.

Hydrogen (H_2) includes hydrogen produced from electricity (through electrolysis) and hydrogen produced from methane with carbon capture (low-carbon hydrogen) or without carbon capture (grey hydrogen). It also includes hydrogen derivatives such as ammonia (NH_3) and methanol (CH_3OH).

Bio-energy includes all forms of energy of biological origin. It includes biomass, bioliquids and biogas. Biogas can be upgraded to biomethane and injected into gas networks.

How the model works: calculating the optimum

Starting from the final energy demand mix, the model considers the cost and characteristics of each technology for the production, use, transmission, conversion and storage of electricity, methane and hydrogen. The model also takes into account some constraints such as typical utilisation rates for wind and solar generation technology.

Running all these factors simultaneously, the model calculates and designs an energy system that matches the requirements put forward: a net-zero system serving demand at any given time at the lowest cost. This translates into capacities that should be built for each technology.

The model also shows the hourly usage of each element of the installed infrastructure, giving as such an insight in the optimal interaction between the different technologies in the entire energy system.

Key insights from the North Sea Integration Model

How can we work towards a carbon-neutral energy system that supplies households, businesses and industries the energy they need at the lowest possible cost at any given time? Our multi-energy North Sea Integration Model helps provide direction.

Running the Global Ambition and Distributed Energy scenarios through the model gives insight into how the optimal interaction between electricity and molecule works to the advantage of society as a whole. In terms of emissions, cost, security of supply and increasing local energy production.

- The **North Sea** shows its vast potential: it is a giant source of local renewable electricity and hydrogen. At the same time the North Sea is a solution for safely storing half of the CO_2 emissions in the energy system, the other half being compensated by carbon credits resulting from the use of biomethane, biomass and biogas.
- When there is not enough renewable electricity generation (e.g. during so-called periods of 'dunkelflaute' in winter) dispatchable generation capacity that can be ramped up on command (hydro generation or gas-fired power plants) will provide **back-up** electricity where it is needed. When hydrogen production by electrolysis is insufficient, dispatchable low-carbon hydrogen production capacity provides **back-up** hydrogen supply together with hydrogen storage.
- When too much renewable electricity is produced in one country and not enough in another, **interconnections** take electricity to the right place. However, transporting electricity is more expensive per energy unit than transporting hydrogen, which in turn is more expensive per energy unit than transporting methane, leading to an optimal mix of electricity, hydrogen and methane interconnections, depending on the distance between energy production and consumption and on conversion efficiency between energy carriers.
- When there is too much renewable electricity (mostly wind) compared with demand, **conversion to hydrogen** by electrolysers optimises the energy system, fulfilling the role of 'demand-side management' and reducing the volatility of electricity prices while at the same time producing renewable hydrogen.
- Solar PV production that exceeds local demand can be **stored** locally in **batteries** to balance the electricity system over the day; while cheaper **hydrogen storage** balances wind over the week(s) and cheaper **methane storage** balances the methane system over seasons.

How to read our key insights?

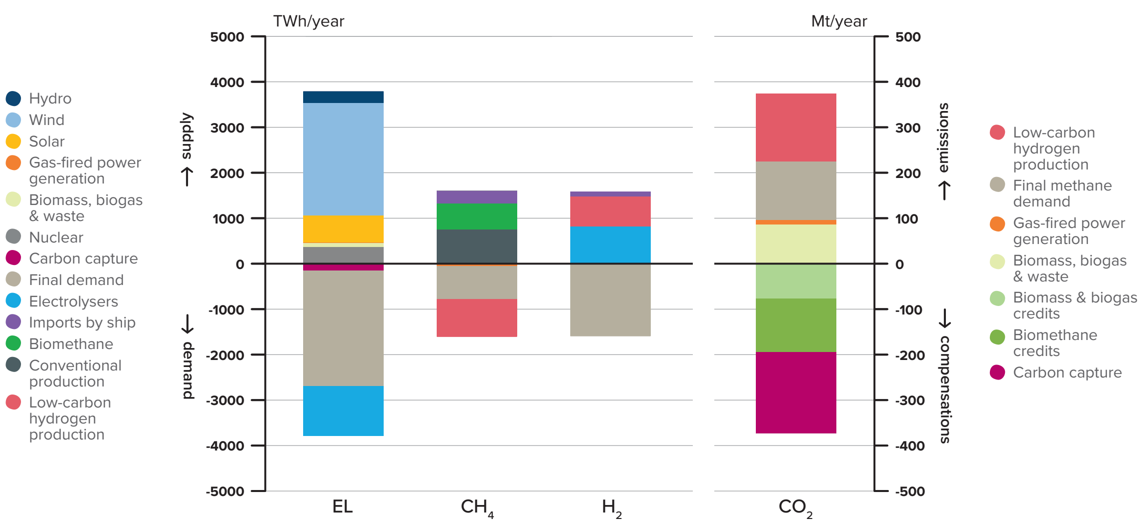
The final energy demand mix is a key input for the model (see p. 5 'What goes in the model: the inputs') and different final energy demand mixes may lead to different outputs. This publication presents the key insights from the North Sea Integration Model using the final energy demand defined in the Global Ambition scenario. When the conclusions reached differ in the Distributed Energy scenario, or when some key parameter is modified, this is highlighted.

1 A net-zero energy system in the North Sea countries in 2050 is realistic and will need both electrons and molecules

An energy system that supplies electricity, methane and hydrogen to North Sea countries in 2050 according to the Global Ambition and Distributed Energy scenarios of the Transmission System Operators in Europe is possible. It achieves net-zero emissions and security of supply at the cheapest cost.

North Sea countries

In the North Sea countries electricity is mostly produced by wind and solar PV. Most of electricity is used immediately and excess production is converted to hydrogen by electrolysis. Hydrogen is also produced from methane with carbon capture and storage, and small quantities are imported from abroad by ship – possibly in the form of hydrogen derivatives such as ammonia and methanol. Biomethane is produced locally and complemented by conventional natural gas production in the North Sea countries and by approximately 20% of LNG imports. Storing limited quantities of electricity, methane and hydrogen helps balance the energy system. About half of CO_2 emissions are compensated by credits for bio-energy[1] and the remaining CO_2 emissions are captured and stored permanently to achieve net-zero emissions.

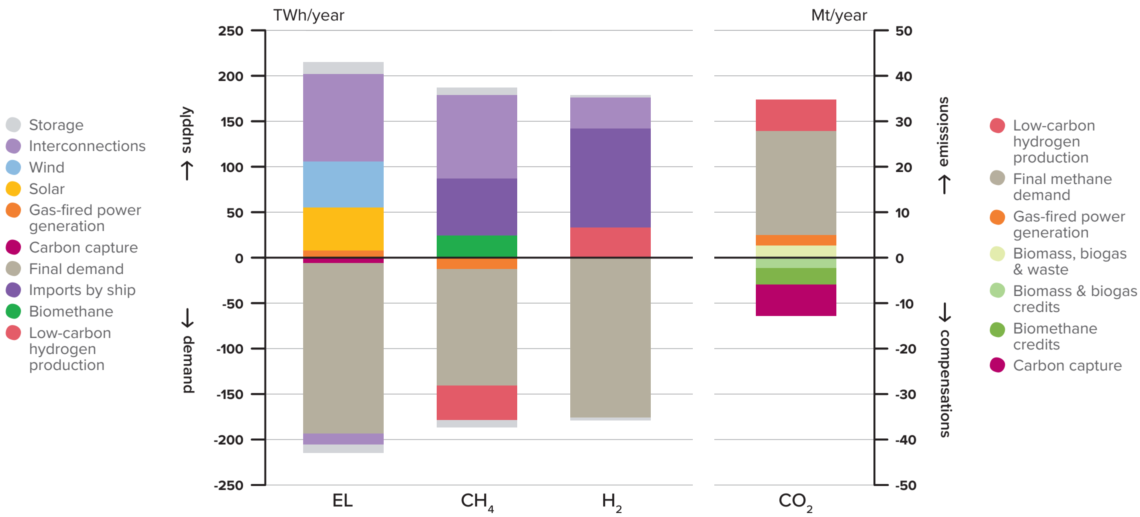


2050: energy and carbon balance in the net-zero energy system of the North Sea countries.

1. Bio-energy releases CO_2 when it is used, but it has absorbed CO_2 from the atmosphere in its biological origination process. The CO_2 credits represent these avoided emissions, adjusted for direct and indirect CO_2 emissions along the value chain, in accordance with the RED III directive.

Belgium

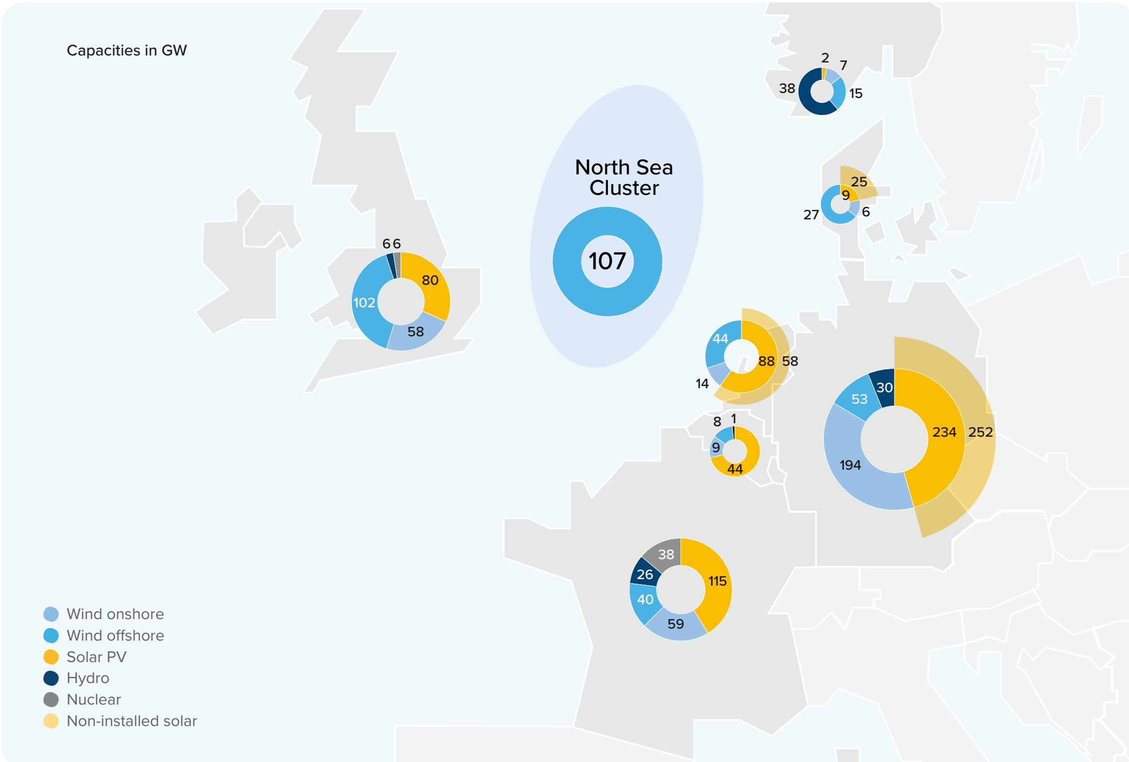
In Belgium wind and solar PV is fully deployed to produce electricity but it covers only half of electricity demand. The other half has to be imported from neighbouring countries with excess electricity.[2] Hydrogen is mainly imported from neighbouring countries and from abroad by ship – potentially in the form of hydrogen derivatives. Methane is produced locally thanks to biomethane and the balance is provided by natural gas from Norway or by LNG imported from abroad in Zeebrugge. CO_2 emissions are compensated partly by biomethane, biomass and biogas credits, and partly by capture and storage in the North Sea. Belgium has net-positive emissions – showing that it is cheaper to reduce emissions in other North Sea countries through a compensation system similar to the EU Emission Trading System.



2050: energy and carbon balance in the Belgian energy system. Belgium has net-positive emissions – showing that it is cheaper to reduce emissions in other North Sea countries through a compensation system similar to the EU Emission Trading System.

2. According to the Global Ambition and Distributed Energy scenarios for 2050 of the Transmission System Operators in Europe, no nuclear production is considered in Belgium in 2050.

2 Renewable electricity generation gets massively built



2050: The potential for onshore wind, offshore wind, hydro and biomethane is fully installed in all North Sea countries, while the potential for solar PV is not fully deployed because of a lower production profile and the distribution grid upgrade needs.

In all countries, the **potential for onshore and offshore wind is fully deployed**. This shows that the high production factor[3] of wind is a key parameter of the optimal energy system. Overall, **offshore and onshore wind supply 64% of electricity**.

Solar PV – is not fully deployed where it would have to be shut off too much. This is the case in Germany because of excessive potential and in Denmark because of limited local demand. However, it is fully deployed in France, where there is more sunshine. Overall, **solar PV supplies 15% of electricity**.

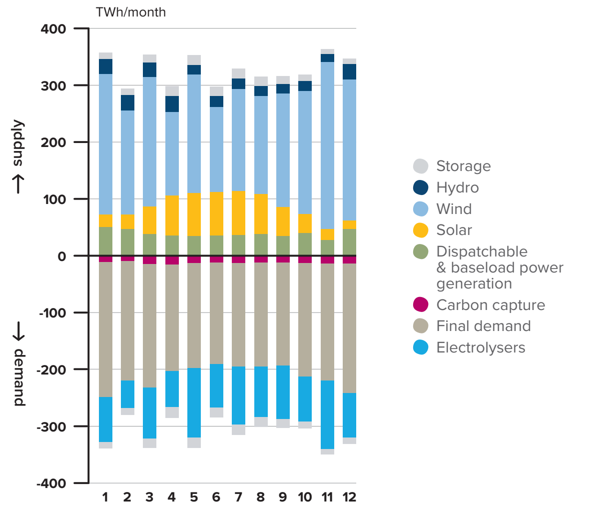
The combined variable production of onshore wind, offshore wind and solar PV across the North Sea countries, complemented with biomass & waste together with some nuclear, is almost sufficient to cover electricity demand[4] in the whole region. The opportunity to combine wind and solar production over a larger region improves the balancing of the electricity system thanks to interconnection capacities. However, the higher cost per energy unit of transporting electricity over long distances triggers the conversion of excess electricity into hydrogen closer to renewable production.

3. The production factor expresses how much energy is produced by a particular technology, e.g. 1 GW of offshore wind with a production factor of 48.2% produces 1 GW x 8 760 h x 48.2% = 4.2 TWh of electricity annually. The average production factor of offshore wind, onshore wind and solar PV across the North Sea countries is 48.2%, 26.5% and 11.7%, respectively.
4. Total electricity demand includes final electricity demand, demand for hydrogen production by electrolysers and demand for carbon capture.

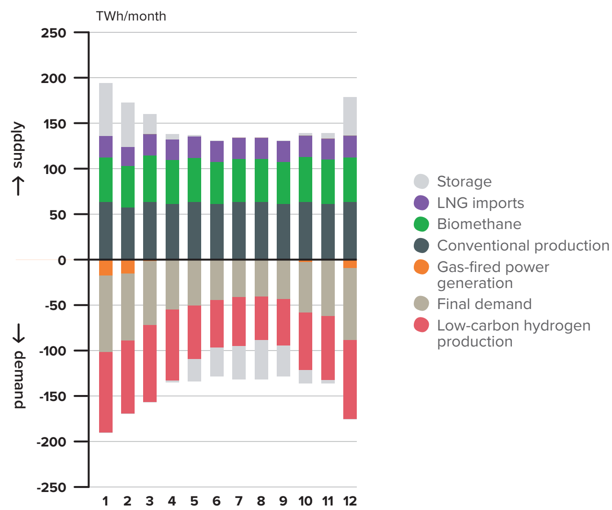
Hydro – mostly existing capacity – is also fully used in the optimal energy system. Indeed, hydro power with dams provides renewable electricity production that can be ramped up on command, while pumped hydro uses or generates electricity to balance the electricity system. As geography limits potential installations, **hydro provides a modest 7% of electricity supplies**.

Nuclear – nuclear is installed with the capacities included in the scenarios for 2050 established by the Transmission System operators in Europe: 38 GW in France, 6 GW in the UK and 0.5 GW in The Netherlands.

Biomethane – biomethane is fully installed and used in the optimal energy system. With very low net CO_2 emissions along the supply chain and the availability of cheap methane storage, biomethane is a key source of green energy covering **36% of total methane demand** (including methane for power generation and low-carbon hydrogen production) and **79% of final methane demand**. To meet the full methane demand, biomethane production is supplemented by fossil methane production in Norway and fossil Liquefied Natural Gas imports in several North Sea countries. The use of fossil methane is combined with carbon capture and storage to achieve net-zero.

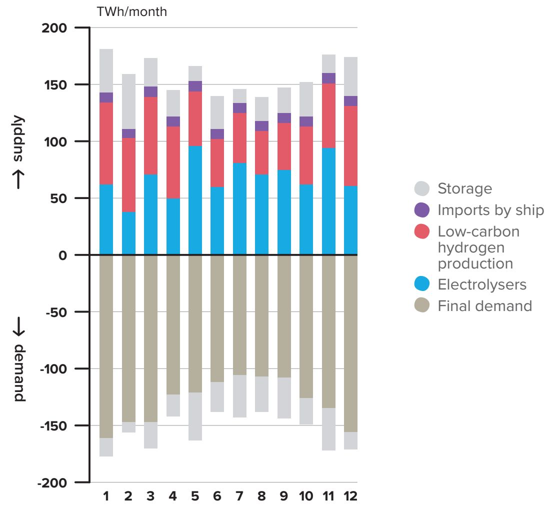


2050: supply/demand balance for the electricity system across the North Sea countries. Renewables and nuclear produce more than 95% of electricity and electrolysers maximise wind power generation.

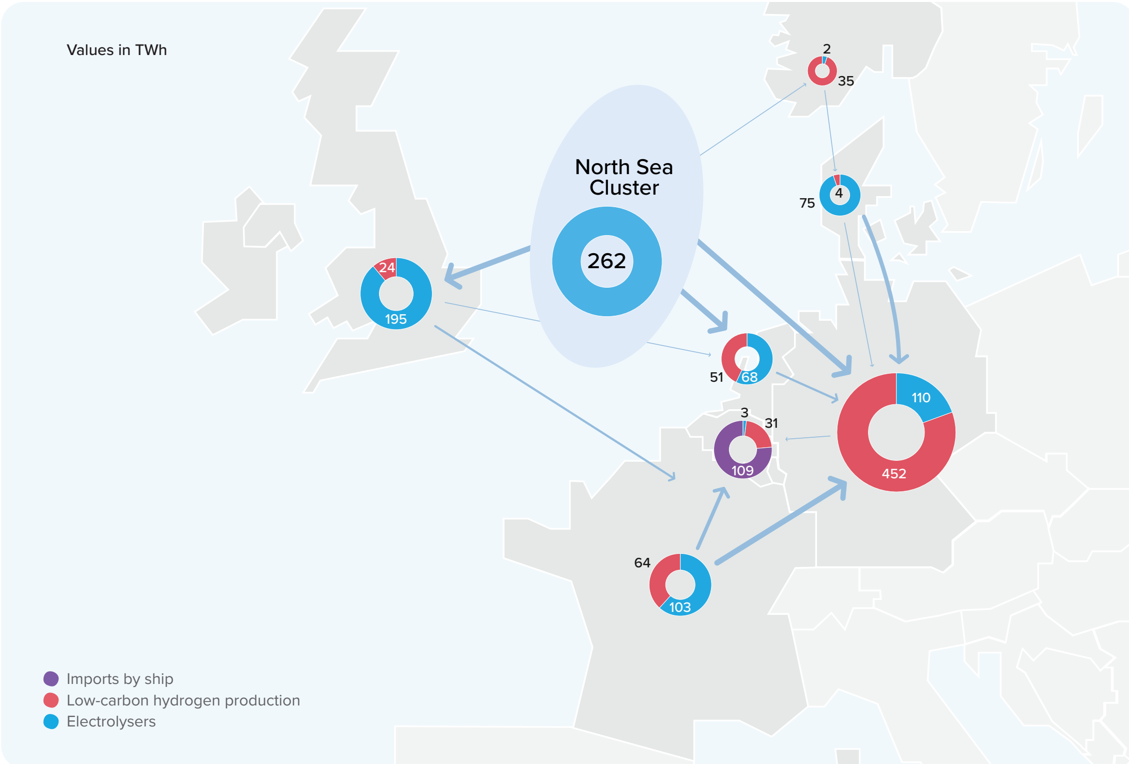


2050: supply/demand balance for the methane system across the North Sea countries. Biomethane gets fully deployed and serves **36% of total methane demand**.

Hydrogen – hydrogen is produced by electrolysis of electricity or from methane with carbon capture and storage. In the Global Ambition scenario, limited imports from overseas by ship are needed to supplement hydrogen production in the North Sea countries. In all optimal energy system scenarios, the reconversion of hydrogen to electricity or methane is not needed. Hydrogen storage helps balance supply and demand across the seasons – using repurposed salt caverns currently in operation for methane storage. It also helps balance supply and demand for periods from days to weeks & smooth hydrogen production of electrolysers using excess wind – employing fast salt caverns and hydrogen storage tanks.



2050: supply/demand balance for the hydrogen system across the North Sea countries. Hydrogen from excess wind serves 51% of demand while **low-carbon hydrogen production from methane with carbon capture serves 42% of demand.** This local production is supplemented by overseas imports by ship.



2050: the detailed hydrogen mix by country shows wide discrepancies. In some countries with more excess renewable electricity, hydrogen production by electrolysers exceeds production from methane, while in other countries production from methane comes out ahead.

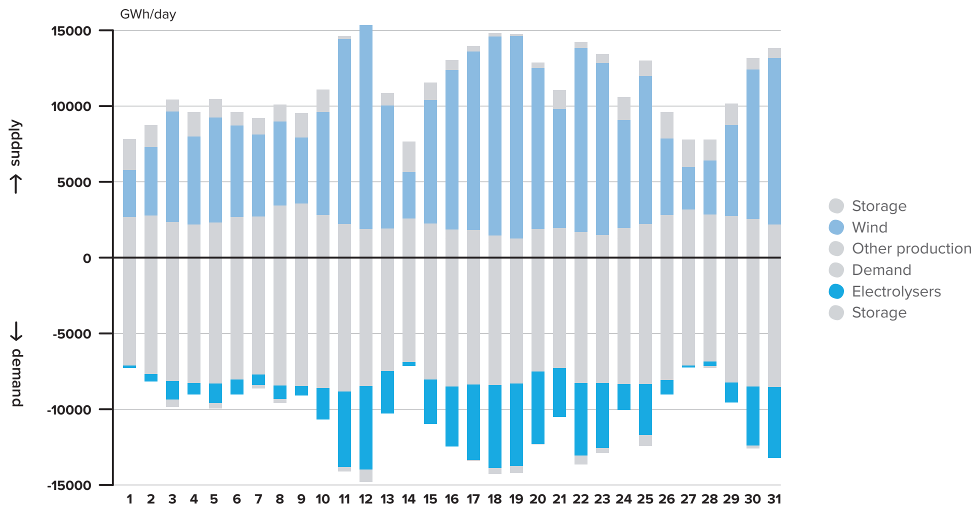
Hydrogen supply mix in Belgium

In Belgium, the limited wind and sun potential is supplemented by huge imports of electricity from the North Sea Cluster (offshore wind) and from France (nuclear). **As most renewable electricity in Belgium is directly used, the potential for electrolysers to absorb excess renewables is low**.

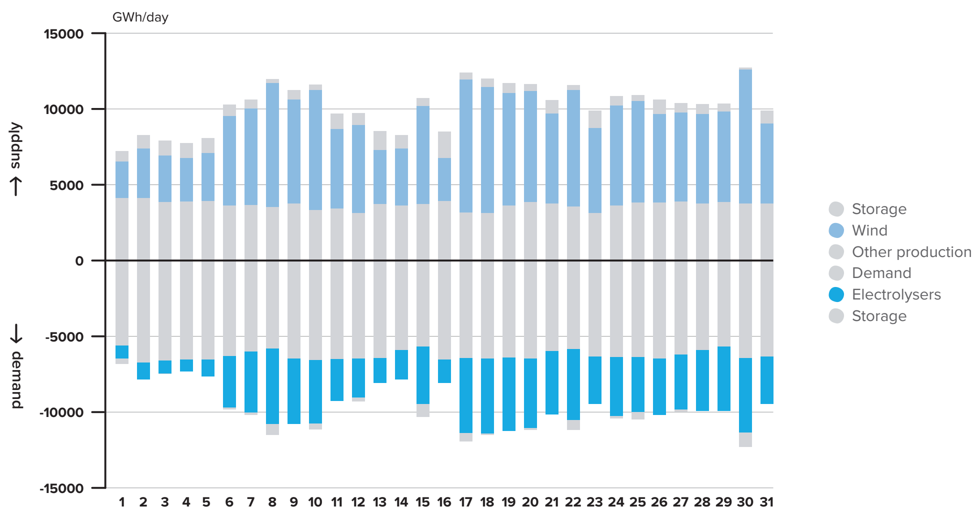
Belgium is the only country that imports hydrogen from overseas by ship in the Global Ambition scenario. Overseas import of hydrogen requires converting hydrogen to derivatives such as ammonia or methanol for efficient shipping. The North Sea Integration Model currently does not make a distinction between gaseous hydrogen, ammonia and Hydrogen supply mix in Belgium. Consequently, no final conclusion can be drawn regarding these overseas imports. Adding ammonia and methanol is among the next steps of further developing the model.

3 Electrolysers boost offshore wind deployment

Electricity produced by offshore wind can be transported directly to markets or electrolysed at sea. In that case, electrolysers act as demand machines absorbing excess wind electricity, avoiding the need to cut off production and improving the value of offshore wind.

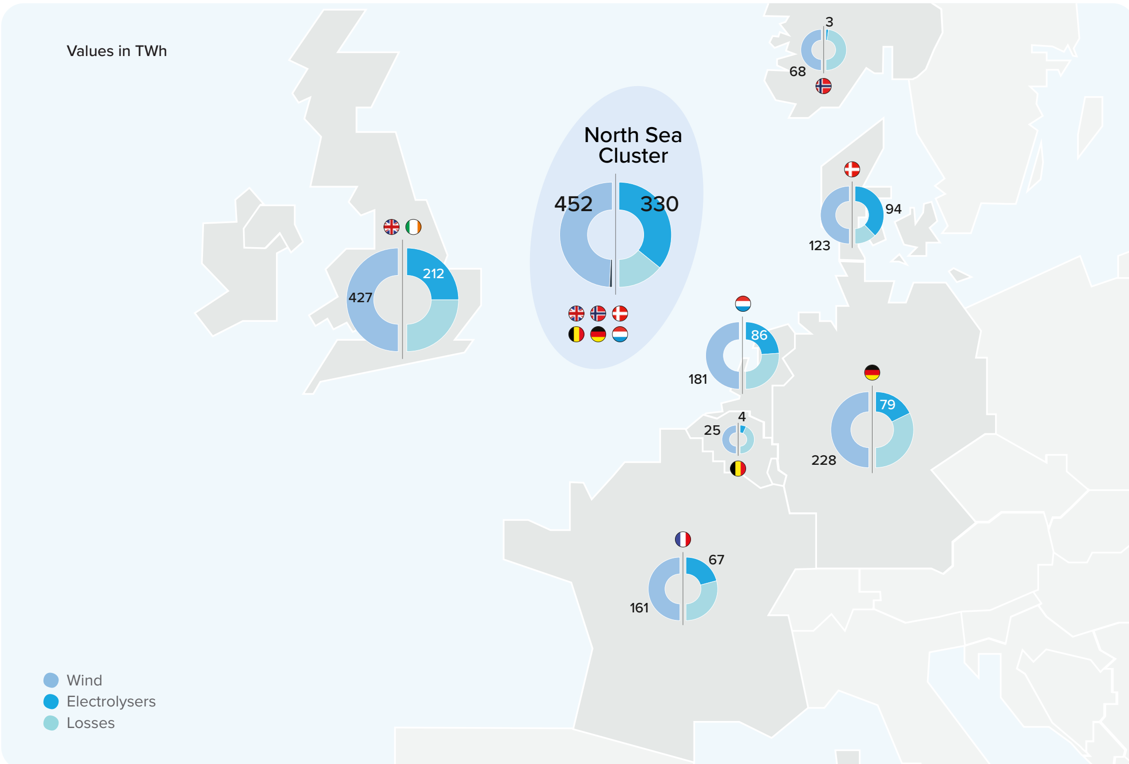


January 2050: the electricity balance in the North Sea countries for each day in January shows a perfect correlation between offshore wind production and electrolysis. When electricity production exceeds demand, electrolysers produce hydrogen for immediate use or storage and avoid the need to cut off wind capacity.



July 2050: the boosting role of electrolysers can also be seen in summer. Despite lower electricity demand and less wind production, the higher production of solar PV closer to local demand makes that wind is partially electrolysed into hydrogen.

When excess electricity from far offshore wind needs converting into hydrogen, it is cheaper to electrolyse at sea because transporting hydrogen is cheaper than transporting electricity first and then electrolysing it onshore. This explains why more electricity feeds electrolysers in the North Sea Cluster, which is farther from demand zones than the near offshore windfarms of the countries around the North Sea.



2050: in the optimal energy system, two-thirds of wind electricity produced in the North Sea Cluster is converted to hydrogen. For all offshore wind electricity, including near-offshore wind, 48% of the production is transported as electricity to demand zones, while 52% is converted to hydrogen.

What without hydrogen production at sea?

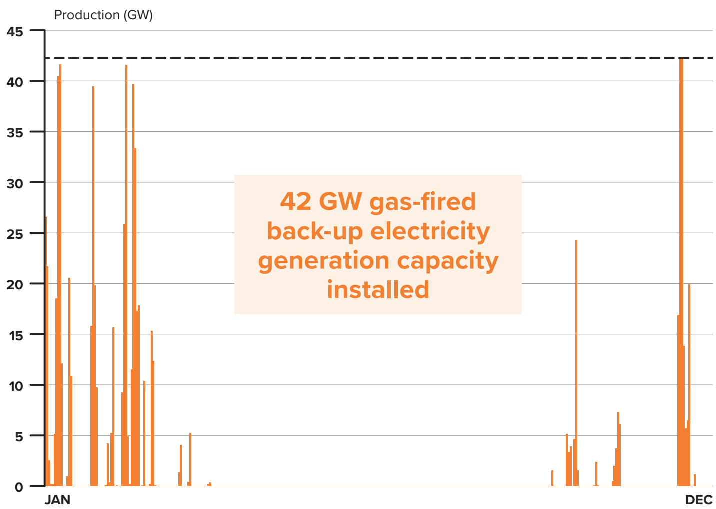
In the **absence of offshore electrolysers**, the optimised energy system installs much less offshore wind in the North Sea Cluster: 79 GW instead of 107 GW, leading to a **decrease of offshore wind production by a third**. In addition, without offshore electrolysers, the amount of **offshore wind being cut off increases from 3% to 10%**. Consequently, **more electricity has to be generated onshore to produce hydrogen and more hydrogen has to be imported**.

4 Dispatchable power generation is needed in winter

North Sea countries

Renewable electricity generation is mostly variable production: it depends on the availability of wind and sun.[5] Despite the efficient combination of wind and solar resources across the North Sea countries and the daily balancing provided by pumped hydro and batteries, supply cannot meet demand at all times. During some periods, the electricity system needs back-up capacity that can be ramped up on command. In the optimal energy system, this back-up capacity is provided by gas-fired power plants.

In the North Sea countries, 42 GW of back-up capacity is needed, but it runs only 5.1% of full-load hours over a year, and only in winter. In the Distributed Energy scenario, gas-fired capacity increases to 72 GW.

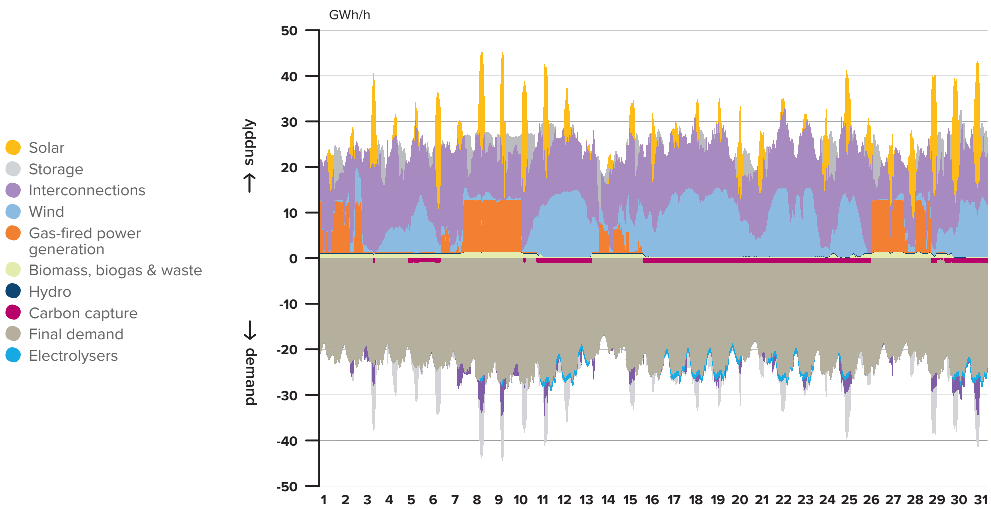


2050: gas-fired power plants are a vital fall-back solution.

5. Run-of-river hydro and biomethane are considered variable production technologies. Run-of-river hydro power depends on the availability of water in rivers, and biomethane depends on the biogas production process. By contast, hydro electricity generation from dams provides dispatchable production capacity. Pumped hydro is considered to be a storage technology because the net production over time is 0.

Belgium

A significant portion of the required gas-fired back-up capacity in the North Sea countries is located in Belgium (11.6 GW out of a total of 42 GW). **Compared to other North Sea countries, Belgium has lower renewable electricity potential and higher energy demand**. The country therefore needs more dispatchable back-up capacity that can be ramped up on command, especially in winter. The lack of wind and solar PV potential in the country increases the events when renewable production combined with imports from neighbouring countries does not cover final demand.



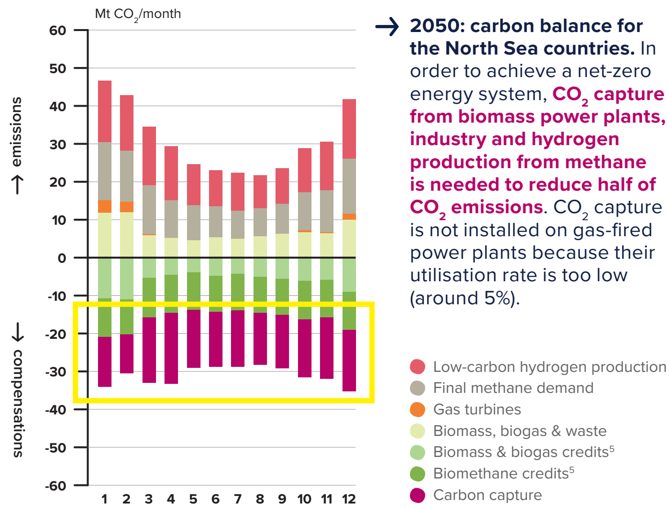
January 2050: electricity supply and demand in Belgium.

5 CO_2 capture, transport and storage are key to achieve net-zero

CO_2 capture compensates half of CO_2 emissions

A balance of CO_2 emissions/ withdrawals can be drawn on the same model as the supply/demand balance of energy carriers. As the energy system is net-zero across the North Sea countries, emissions equal withdrawals on a yearly basis.

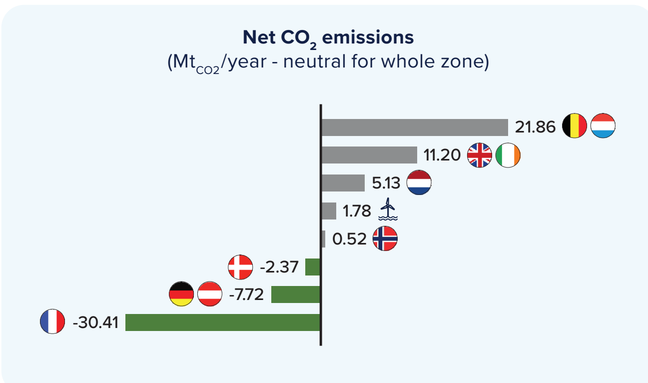
CO_2 emissions come mainly from final methane demand and demand for hydrogen production from methane. Biomass & waste also produce CO_2, as do gas-fired power plants.



→ **2050: carbon balance for the North Sea countries.** In order to achieve a net-zero energy system, **CO_2 capture from biomass power plants, industry and hydrogen production from methane is needed to reduce half of CO_2 emissions**. CO_2 capture is not installed on gas-fired power plants because their utilisation rate is too low (around 5%).

Net-zero across the North Sea countries

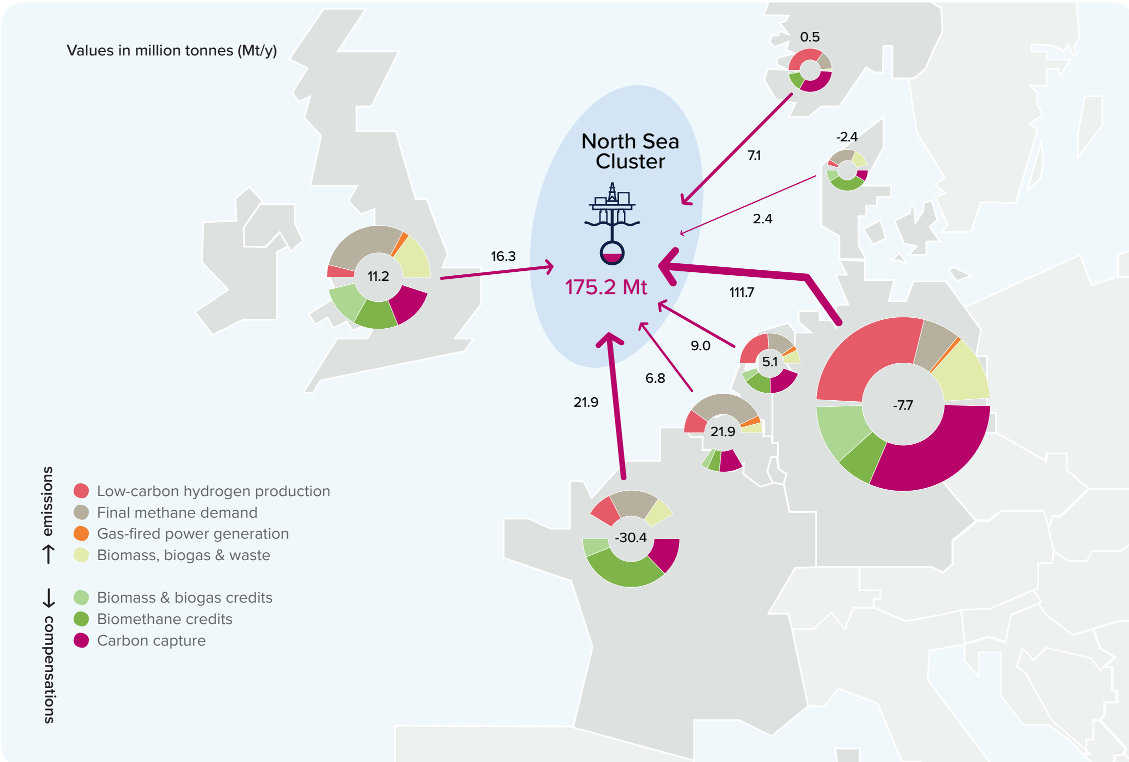
In the optimal energy system, each technology gets installed in the countries where it offers the best value compared to its cost. Consequently, the net-zero energy system will be achieved across all countries, while each individual country may not achieve net-zero emissions. A country with net-positive emissions will have to purchase CO_2 emission rights from countries with net-negative emissions. This is efficient because achieving net-zero in a country with net-positive would cost more than reducing emissions in the net-negative country.



↳ **2050: carbon balance across the North Sea countries.** Countries where it is cheaper to reduce emissions compensate the higher emissions of countries where it is more expensive. **Belgium has significant net-positive CO_2 emissions because of the lack of renewable electricity and the high energy demand**. France, on the other hand, has significant net-negative emissions because of nuclear electricity and low methane demand.

5. Biomethane, biogas and biomass are produced from biological sources. They release CO_2 when used but these emissions are compensated because they have absorbed CO_2 in their biological origination process. The credits shown in the graph represent this level of compensation, determined in accordance with the Renewable Energy Directive III.

CO_2 transport and storage: North Sea Cluster storage potential is vital



2050: CO_2 flows into the North Sea Cluster. Captured CO_2 is transported to the North Sea where it is permanently stored. **The assumed potential of 175 Mt CO_2 per year of CO_2 storage is fully used**. All countries around the North Sea install export capacity. **Belgium exports 6.9 Mt CO_2** per year and the bulk of CO_2 exports comes from Germany.

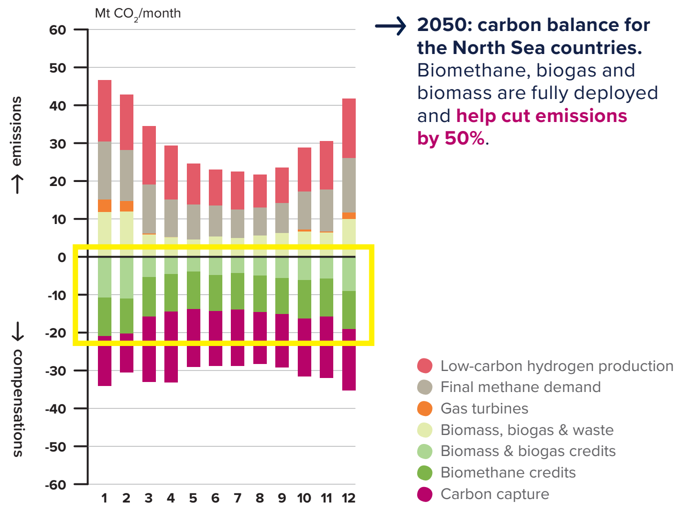
The North Sea CO_2 storage potential is a key parameter for the optimal energy system

The CO_2 storage potential of 175 Mt CO_2 per year is a dimensioning parameter for the optimal energy system.

- If this capacity is increased to 225 Mt CO_2 per year, more hydrogen production from methane with carbon capture is installed and replaces imports of hydrogen by ship.
- If this capacity is further increased, Direct Air Capture capacity is installed (technology for capturing CO_2 from the air).
- The optimal energy system does not require more than 300 Mt CO_2 per year of CO_2 storage capacity.
- As **more CO_2 storage capacity** is installed, the CO_2 abatement cost decreases sharply.
- Conversely, if **no CO_2 storage capacity** is installed, the CO_2 abatement cost rises dramatically.
- Note that electrolysers remain in all cases: in addition to producing hydrogen, they are necessary to optimize the offshore wind production in the North Sea Cluster.

6 Biomethane, biogas and biomass are also powerful allies in achieving carbon neutrality

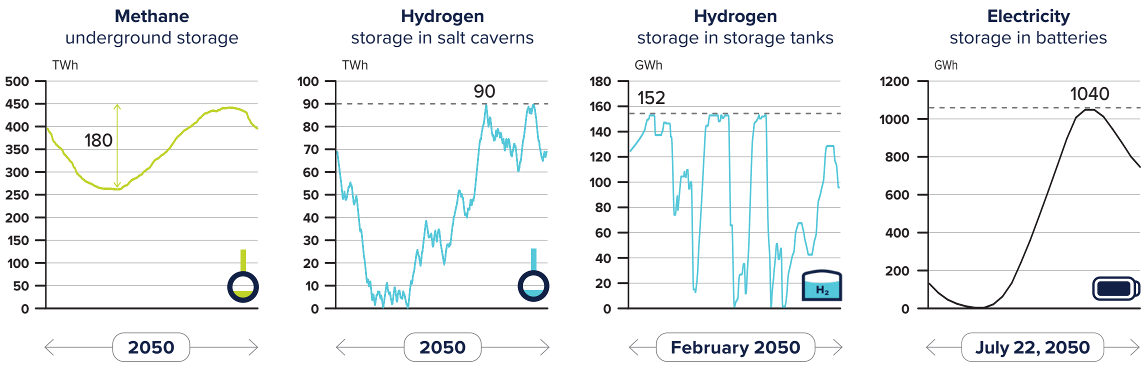
Biomethane, biogas and biomass are produced from biological sources. They release CO_2 when used but these emissions are compensated because they have absorbed CO_2 in their biological origination process. The credits shown in the graph represent this level of compensation, determined in accordance with the Renewable Energy Directive III.



→ **2050: carbon balance for the North Sea countries.** Biomethane, biogas and biomass are fully deployed and **help cut emissions by 50%**.

7 Energy storage is essential to provide energy at the right time

As more variable energy is integrated into the energy system (e.g. wind and sun), **storage becomes increasingly important to supply energy at the right time, together with flexibility of demand**. Depending on the production and consumption profiles of the different energy vectors, a variety of storage technology is needed for balancing supply and demand. **Each storage technology is used to its best potential in the optimal energy system.**



2050: Longer-term molecule storage is essential to complement daily battery storage.

Methane storage is the cheapest technology for storing energy, making it best suited for seasonal storage. In the optimal energy system for the Global Ambition scenario[6], 180 TWh of existing underground gas facilities are still used. They store excess methane production or imports in summer for use in winter: methane storage is used for 1 full cycle per year.[7]

Hydrogen storage is more expensive: it can better respond to shorter-time storage needs such as absorbing hydrogen from excess wind electricity production. Hydrogen can be stored in two ways:

→ Salt caverns currently used for natural gas could be repurposed to store hydrogen, providing a capacity of 90 TWh. As storing hydrogen in salt caverns is about three times more expensive than methane storage, this capacity would be used more often, combining a seasonal profile with shorter-term storage: hydrogen storage is used for 3.3 full cycles per year.

→ Hydrogen storage tanks provide a very high injection/withdrawal capacity but are more expensive. 152 GWh would be installed with a profile closer to wind production: hydrogen storage is used 24 for full cycles per year.

Batteries have less storage capacity and are more expensive than hydrogen and methane storage. Due to their higher cost, batteries are used for storing electricity for short durations – typically one day. 1000 GWh of batteries is installed in the optimal energy system, mostly to help integrate solar PV into the electricity system: battery storage is used for 120-230 full cycles per year.

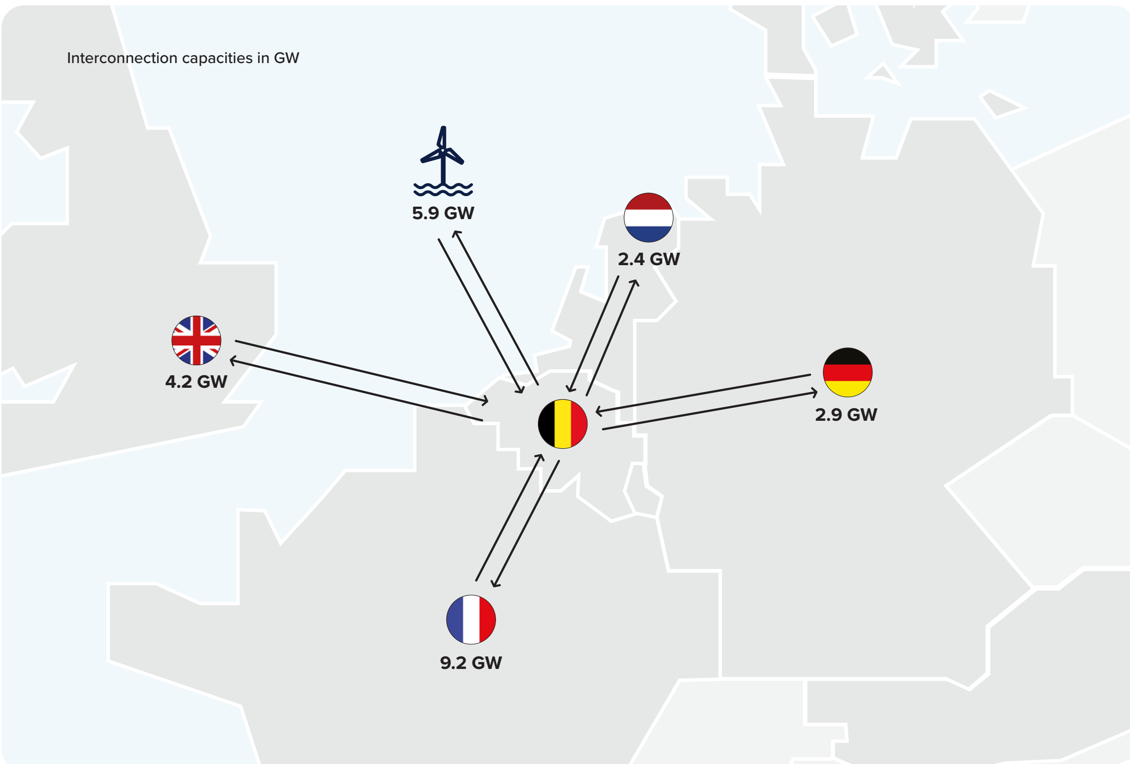
6. Results are similar for the Distributed Energy scenario, except that no hydrogen storage tanks are needed.
7. The usage of storage capacity is calculated as the sum of all energy injected (or withdrawn) from the storage over the year, divided by the storage capacity. This yields the number of full cycles per year.

8 Interconnection capacities optimise the energy system and ensure security of supply

The North Sea Integration Model installs each technology where it has the most value for the energy system of all North Sea countries. As the supply/demand balance of each energy carrier in each country is different, connecting them through interconnection capacities reduces the cost of the energy system as a whole.

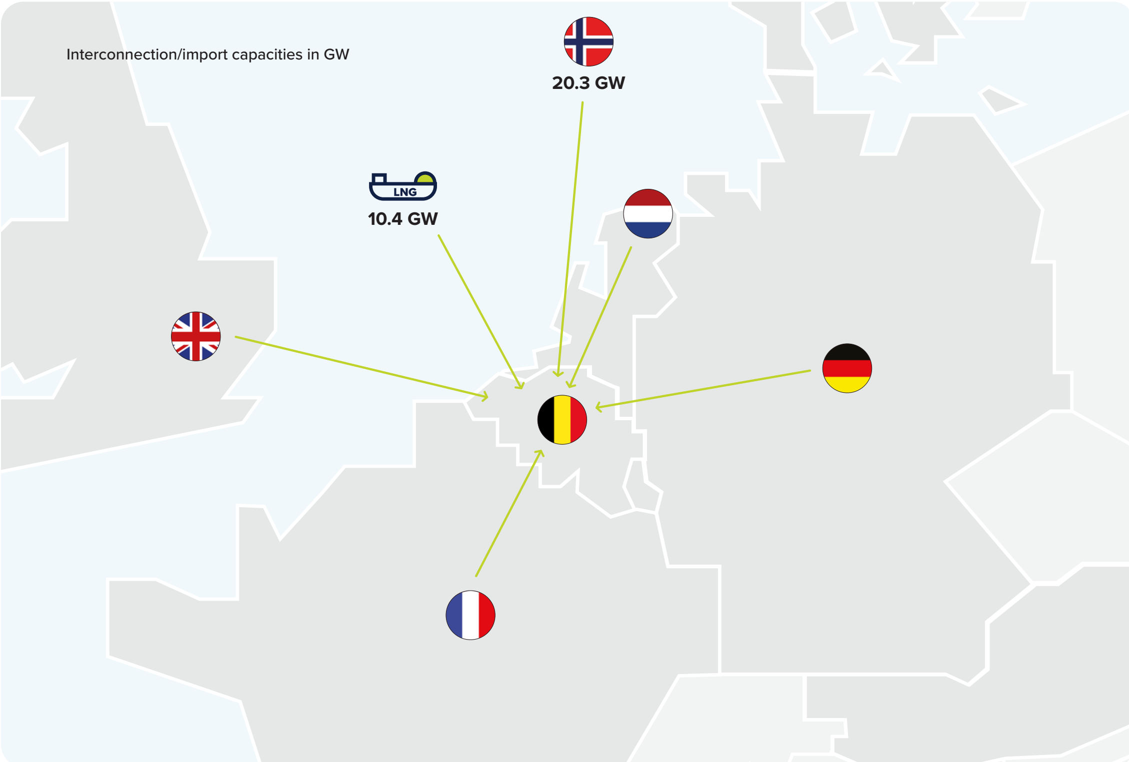
For example, when too much renewable electricity is produced in one country and not enough in another, interconnections bring electricity to the right place. **The optimal energy system takes into account that transporting electricity is more expensive per energy unit than transporting hydrogen, which in turn is more expensive per energy unit than transporting methane, leading to an optimal mix of electricity, hydrogen and methane interconnections.**

Belgium - electricity interconnections



2050 - As Belgium needs to import about half of its electricity from neighbouring countries and the North Sea Cluster, there is a significant need for interconnection capacity because of a.o. insufficient renewable electricity production. In the optimal energy system, 5.9 GW of interconnections would be needed with the North Sea Cluster to import bulk electricity mainly in winter, and 9.2 GW to import electricity from France. In order to enable optimal balancing across countries, 4.2 GW would be needed with the UK, 2.4 GW with the Netherlands and 2.9 GW with Germany.

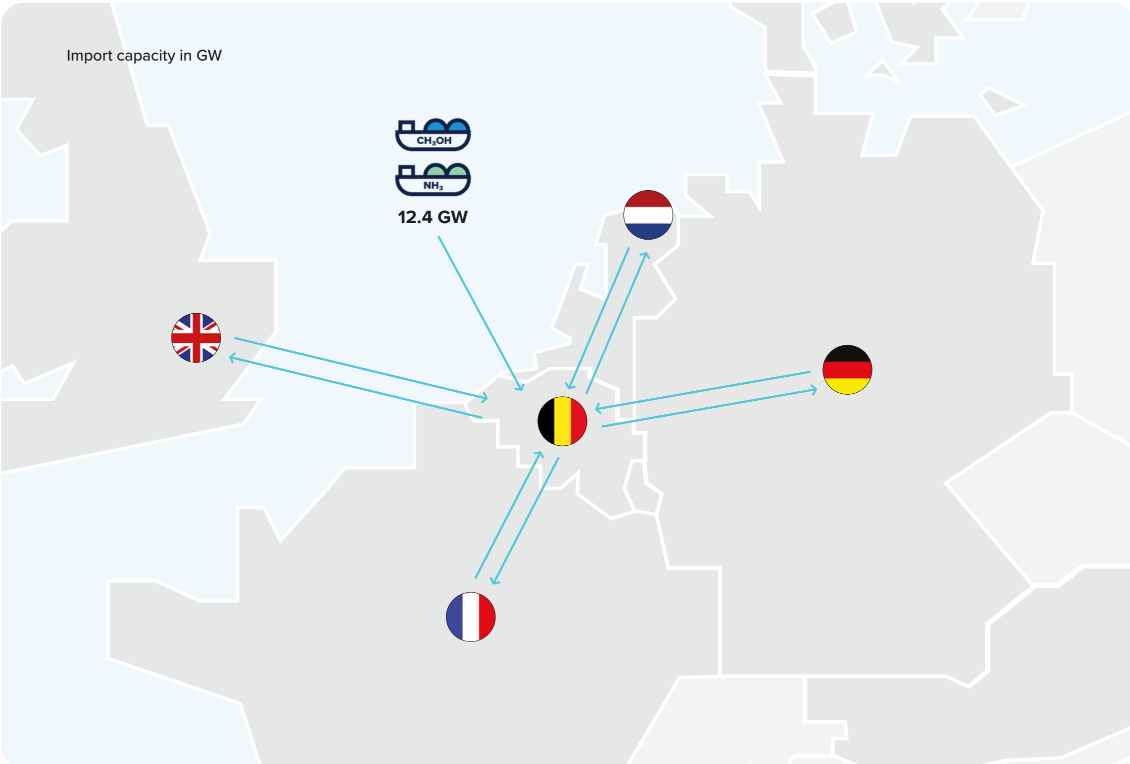
Belgium - natural gas imports and interconnections



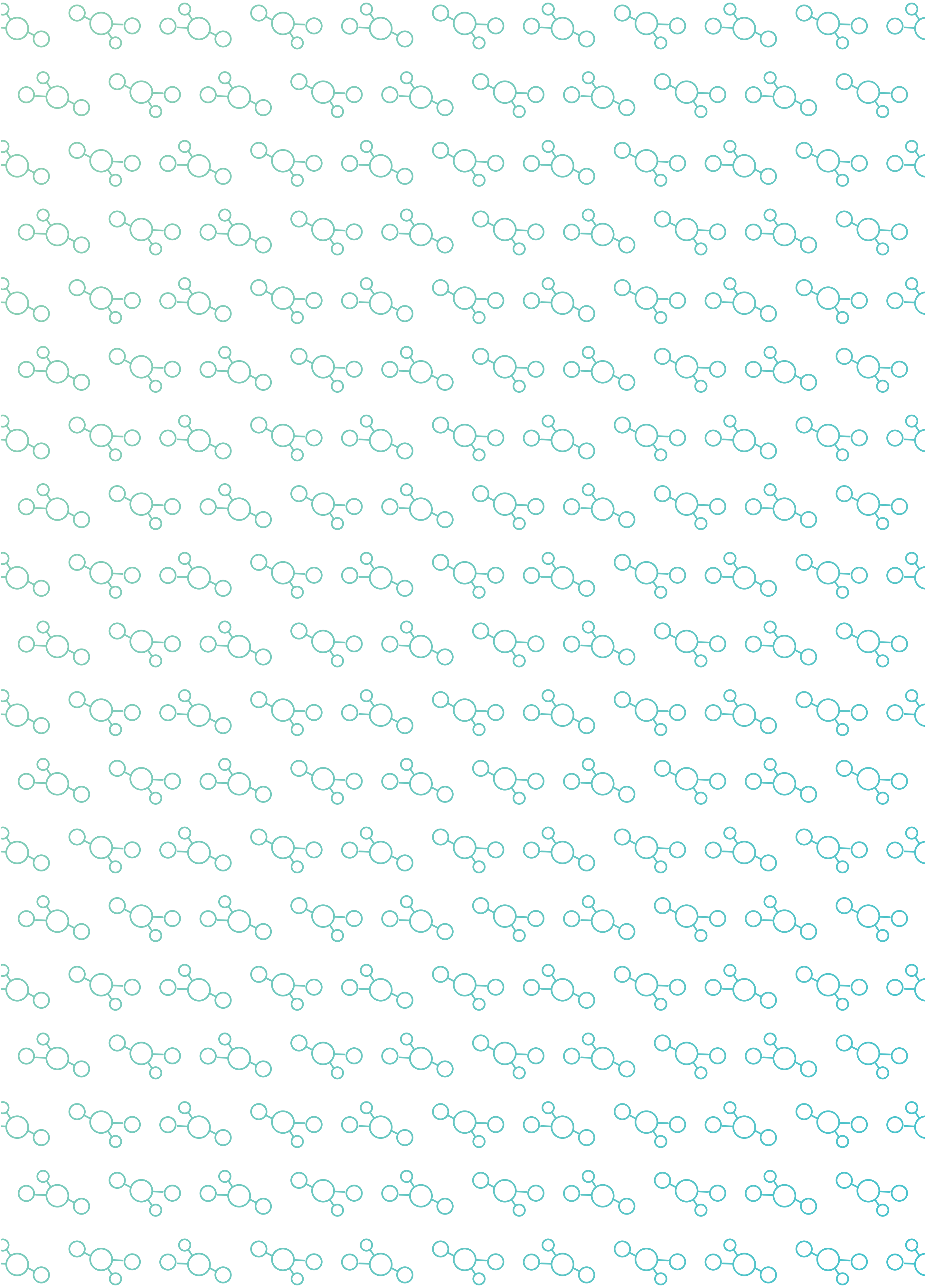
2050 - The existing natural gas infrastructure is still used for methane imports and cross-border flows in the optimal energy system. An LNG import capacity of 10.4 GW is fully used for the bulk import of methane from overseas. A capacity of 20.3 GW from Norway is used to import methane with a strong seasonal profile. The interconnection capacity with France is used when gas-fired power plants run and hence necessary to help ensure security of electricity supply. The interconnection capacity with the UK, Germany and The Netherlands shows its value as methane fallback across countries when needed but does not reflect its repurposing potential.

The long-term planning for the natural gas infrastructure provides for its progressive repurposing for hydrogen and CO_2 transmission. Including this repurposing in the North Sea Integration Model is among the next steps in its further development.

Belgium - hydrogen imports and interconnections



2050: at this stage, the North Sea Integration model shows 12.4 GW capacity for an import terminal in Belgium. Among the next steps in further developing the model is to include parameters enabling to calculate hydrogen flows from and/or to Germany, the UK, France and The Netherlands.



Our key findings from running the North Sea Integration Model

1. **A net-zero energy system in the North Sea countries in 2050 is realistic and will need both electrons and molecules**

2. **Renewable electricity generation gets massively built**

3. **Electrolysers boost offshore wind deployment**

4. **Dispatchable power generation is needed in winter**

5. **CO_2 capture, transport and storage are key to achieve net-zero**

6. **Biomethane, biogas and biomass are also powerful allies in achieving carbon neutrality**

7. **Energy storage is essential to provide energy at the right time**

8. **Interconnection capacities optimise the energy system and ensure security of supply**

Fluxys: facts and figures

- Independent international industrial infrastructure group
- 1 300 employees worldwide
- 28 000 km of gas pipelines
- Terminals in Belgium, France, Greece and Chile
- Underground gas storage in Belgium
- Active in Belgium, France, United Kingdom, The Netherlands, Germany, Switzerland, Albania, Greece, Chile, Brazil and Oman
- In Belgium and Germany new infrastructure ready to switch to hydrogen as soon as market demand requires to do so

More about Fluxys

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