

18/19

TenneT
Today

Electricity at your
fingertips, 24/7

Delivering power
over land and sea

We keep the

lights



41
mln

Delivering electricity to 41 million people in the Netherlands and large parts of Germany

on

Who are we?

You may have never heard of TenneT, but that's ok. We'd rather you experience the benefits of what we do – delivering electricity to 41 million people in the Netherlands and large parts of Germany.

Doing this safely and reliably, 24 hours a day and 365 days a year, is a massive responsibility. We are driven by our mission to ensure the lights stay on and that power is available, at the flick of a switch, whenever and wherever you need it.

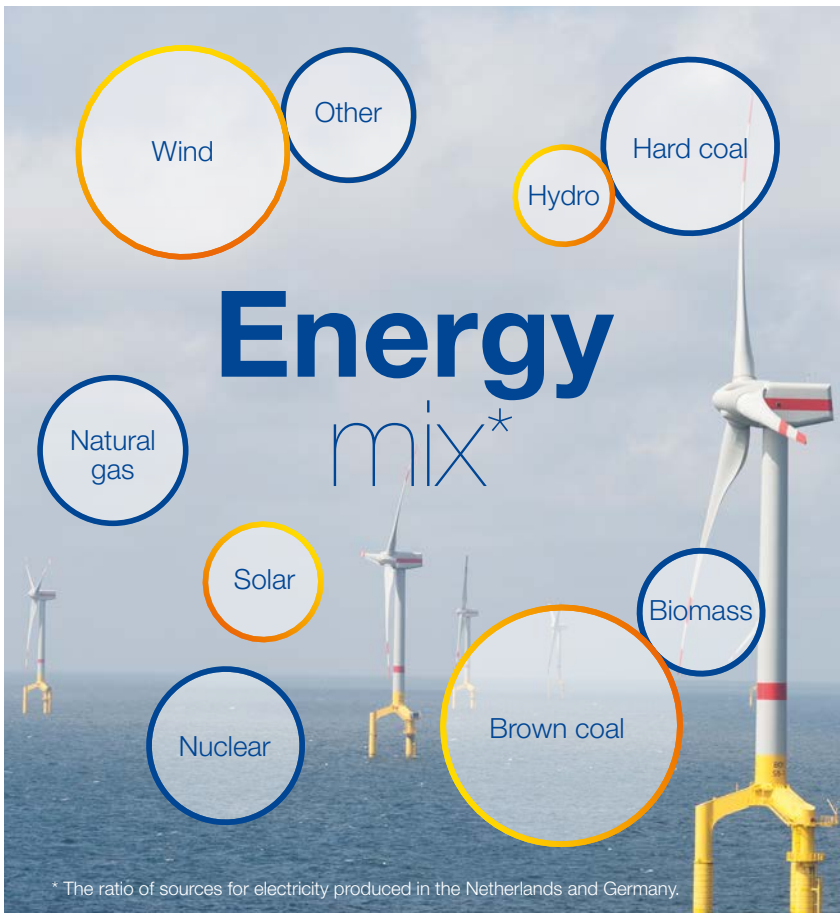
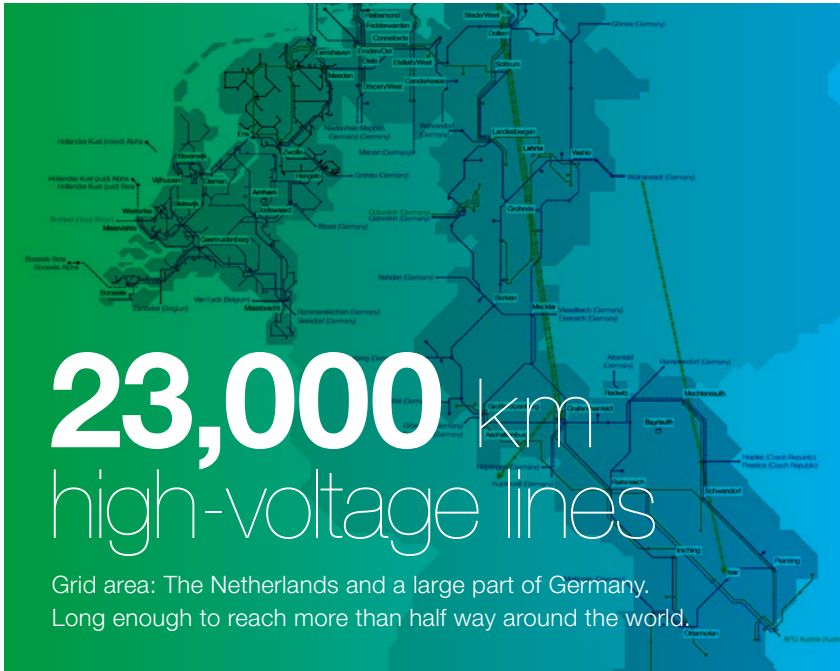
To do this, we design, build, maintain and operate a high-voltage grid stretching across land and sea. This carries electricity from where it is made – including wind, solar, biomass, fossil and nuclear power – to where it is used. Keeping these different sources of power in balance – safely and securely – is a critical part of our work.

Because we all demand more renewably sourced electricity, we need to carry it over longer distances, from wind farms far out at sea or from solar panels on people's homes. We carry it across borders, over ground, underground, across 23,000 km of high-voltage lines.

It's easy to take electricity for granted. After all, it's a basic expectation in a modern, always-on society. But it's getting harder to feed our power-hungry world in a sustainable way. Renewable electricity holds huge promise for our planet and presents unprecedented challenges for industry and government. At TenneT, we are at the forefront of this energy transition, providing the infrastructure that facilitates the clean power revolution.

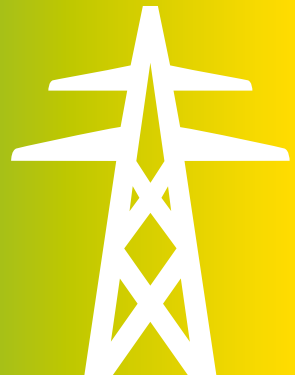
We are TenneT – welcome to our world

TenneT at a glance



Secure supply

We work tirelessly to avoid power outages by investing in and maintaining our grid.





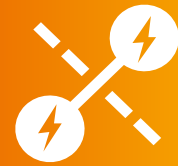
4,000

Number of employees



2.3

Investments in fixed assets 2018 (EUR billion)



14

Interconnectors linking cross-border electricity markets



12 years' experience

Building grid connections for offshore wind farms in the North Sea (DoWin3 pictured).

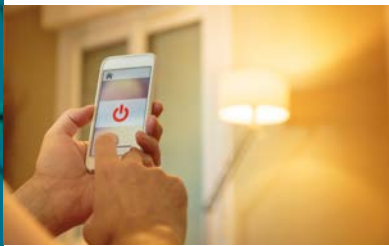


738

Stakeholder meetings, listening to the concerns and needs of local communities.

The image shows two utility workers in safety gear (hard hats, safety glasses, and harnesses) working on a power line tower. They are positioned on a metal platform, and one worker is actively handling a cable. In the foreground, a large, vertically oriented insulator with many stacked discs is visible. The entire scene is overlaid with a semi-transparent green filter. The text "Our responsibilities to you" is written in white, with "Our" and "responsibilities" in a bold sans-serif font and "to you" in a thin, lowercase sans-serif font.

Our
responsibilities
to you



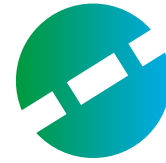
Secure supply

Our biggest responsibility is to ensure a safe, reliable and secure supply of electricity to 41 million end-users, 24 hours a day, 365 days a year. Last year we achieved 99.9988% reliability across our grid, ensuring that power is available, when and wherever you need it.



Delivery to end-users

Ensuring power is at your fingertips means carrying electricity from wherever it is generated to the end-users. Often, this is far away over land and sea, requiring a complex infrastructure of high-voltage connections that needs to be built, maintained and expanded to cater for society's growing and changing energy needs.



Connecting across borders

With the challenges of integrating renewable electricity into the grid and balancing supply and demand, it makes sense to build an integrated electricity market in North West Europe. TenneT is leading this integration by helping electricity to be easily supplied and traded at a fair price.

Making sure that over 41 million people across the Netherlands and Germany enjoy uninterrupted access to electricity is the foundation of our business. It is a huge responsibility that we are proud to meet, every minute of every day.

Staying **switched on**



In today's connected world, we assume that power will always be available, when we flick a switch or reach for a power outlet. We rely on electricity to power every aspect of our lives – at work, home and on the move. As the grid operator for the Netherlands and large parts of Germany, we make sure this power reaches users reliably and safely, from a wide range of sources and transported across great distances. It's a vast task, and getting more complicated as more renewables are introduced into the energy mix. By nature, power generated by the sun or wind is volatile, which makes it harder for us to balance supply and demand for electricity in the grid. To manage this, we need to be more innovative, agile and forward-thinking than ever before.

Security of supply also means investing in new assets, performing necessary maintenance and linking our grid into the North West European network. This saw TenneT invest €2.3 billion in critical infrastructure last year – including new high-voltage power lines, new cross-border connections and offshore platforms far out in the North Sea to bring wind-generated electricity onto the mainland. Upgrading and future-proofing our network in this way allows us to maintain our record as one of the world's most reliable grid operators. Although very occasional outages can occur, we are proud to say we keep the electricity flowing 99.99% of the time.



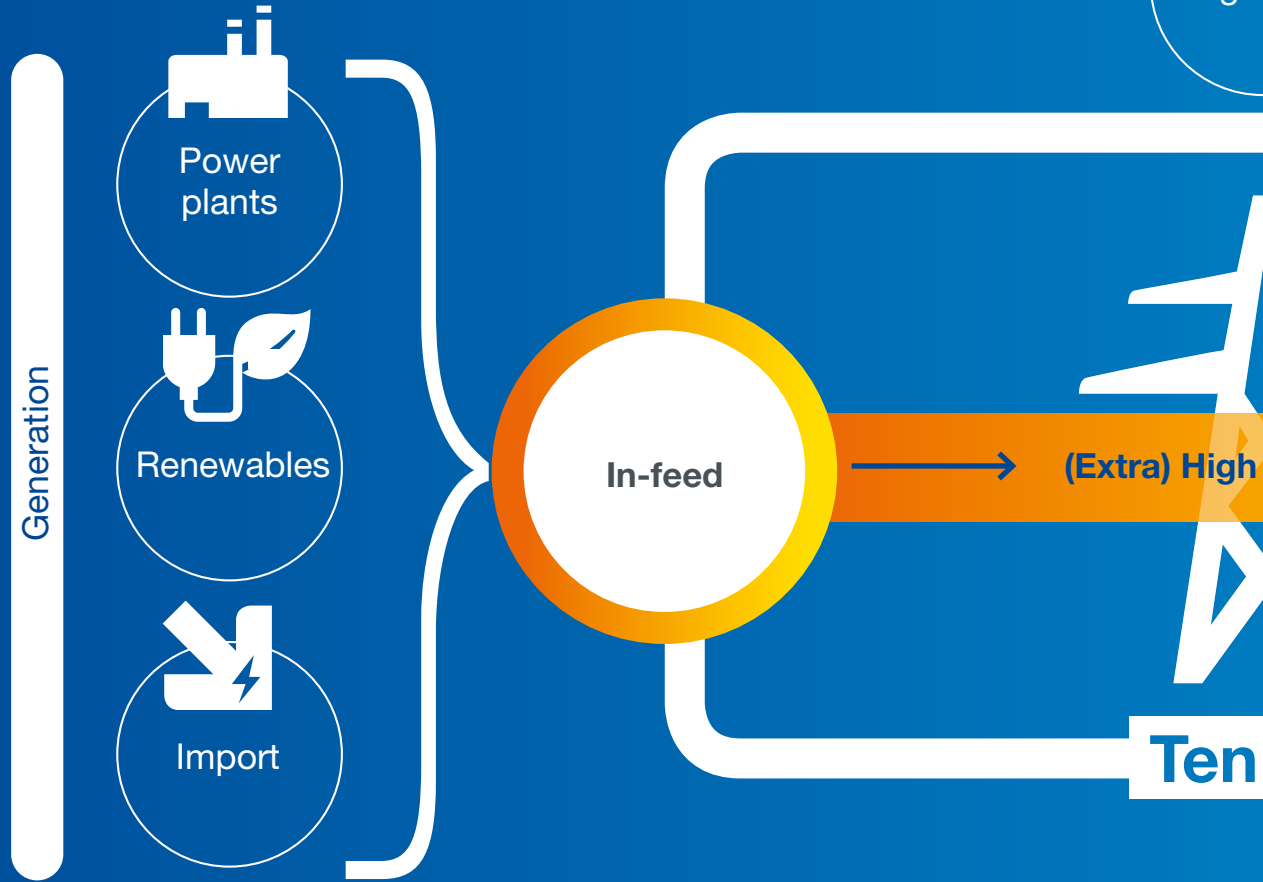
Connecting renewables onshore

More and more wind and solar parks are being built in the Netherlands for the generation of sustainable energy. TenneT ensures that the energy generated from these onshore sources is connected to the grid via high-voltage lines and cables and transported to households and businesses. With the Sustainable On Land programme, TenneT (Grid Services) is now working to adapt its grid infrastructure to accommodate this, especially in the north (Groningen, Drenthe, Friesland), and to a lesser extent in the southern Netherlands. These include building new connections and expanding existing high-voltage stations.



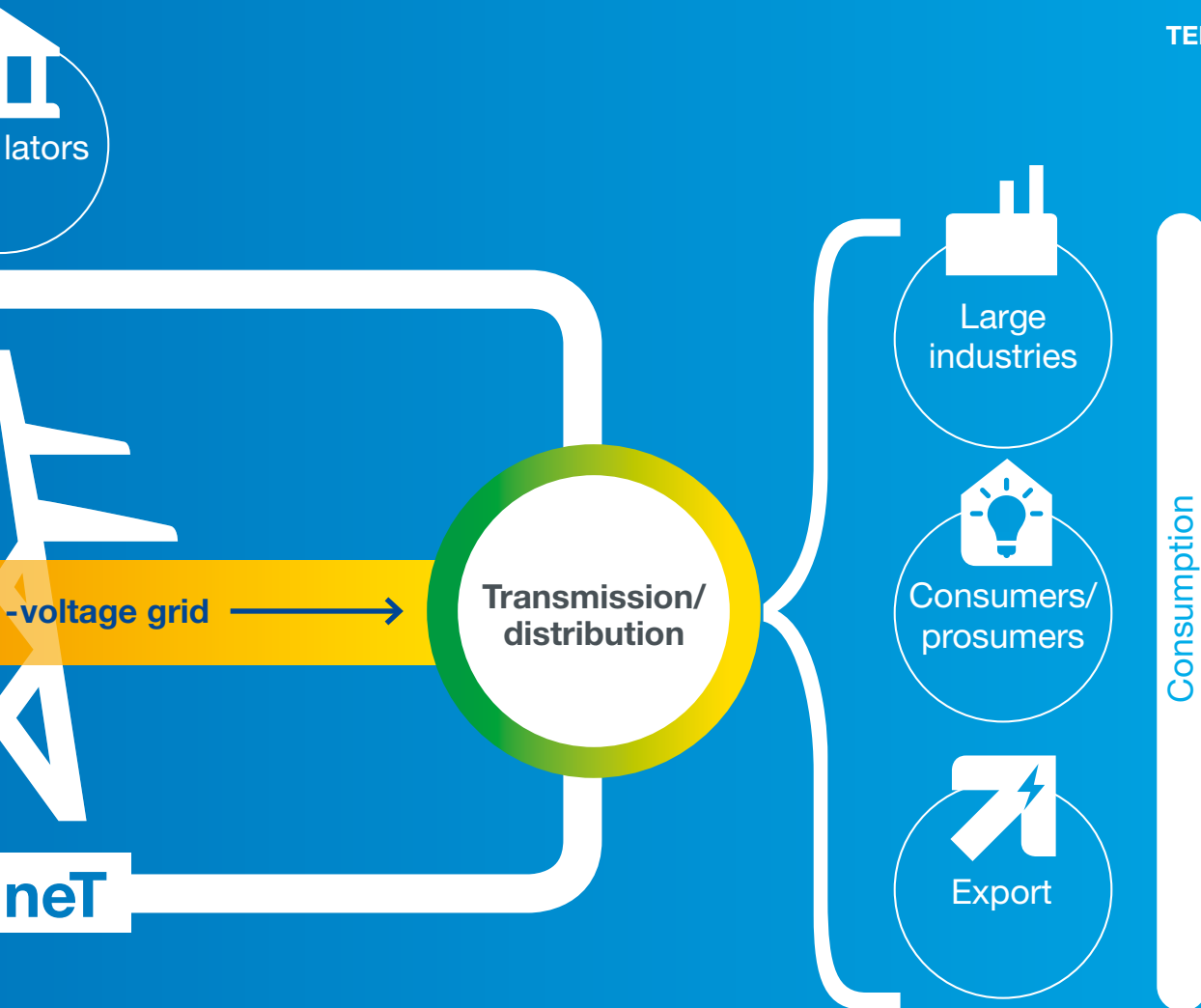
DolWin3: Securing offshore supply

DolWin is a cluster of offshore grid connections in the southwestern part of the German North Sea. They play a critical role in providing a secure supply of electricity as they connect offshore wind farms to the onshore transmission grid via 160km of high-voltage cable, half of which is under the sea. The completion of DolWin3 in 2018 means a 900MW connection is now in operation, providing enough electricity for one million households.



A simple guide to the grid

What is the electricity grid? And how does it bring electricity from where it is made to where it is used? It is a high-tech and complex system that we are proud to build and maintain for the benefit of society.



Power generation

In the old days, electricity was generated in conveniently located power plants, burning fossil fuels like coal or gas. A lot of the electricity is still produced this way, but more and more of it is generated from renewable sources like the wind, sun or biomass. Wind farms can be far out at sea, while solar panels can be placed anywhere, including on the roofs of our houses. Our challenge is to make sure this electricity can be efficiently integrated into our grid.

...connection

This is no easy task. Connecting wind power generated offshore requires us to build offshore connection systems far out at sea, linking the wind farms to the onshore grid. Meanwhile, solar power also needs to be connected. We also continue to connect traditional power plants into the grid, although their share of electricity production is falling as we use more and more renewables.

...and transmission

One of our biggest challenges is carrying electricity across the long distances from where it is made to where it is consumed, for example from the North Sea to Southern Germany. We do this across 23,000 km of high-voltage lines and cables, which we also connect across borders so we can share electricity with our neighbours.

A man with curly hair and glasses, wearing a white button-down shirt, is seated at a wooden table. He is smiling and looking towards the camera. On the table in front of him is a white teapot, a white teacup on a saucer, and a silver pitcher. To his right, there are some papers and a small black figurine on a side table. The background shows a wall with a framed collage of photos and a clock on the left.

Meeting society's appetite for electricity doesn't just mean building more power lines and pylons. As we expand our network, we must do so responsibly, building dialogue and acceptance with local communities.

Responsible & engaged

Consumers and businesses across the Netherlands and Germany rely on the electricity we supply, giving us a critical role in society. However, the infrastructure and technology needed to deliver electricity to your door involves some unavoidable impact on local communities. As a result, our work involves a delicate balance: what is good for and desired by society is not always welcomed at a local level.

We meet this challenge by ensuring we are always responsible, engaged and connected. Responsible in how we fulfil our role in society, engaged in how we build acceptance for our actions and connected in our dialogue with stakeholders. Whenever we start a new project, we engage with everyone affected, listening to their concerns and needs, and providing all information about the project to evaluate and discuss.

We want all stakeholders' views to be listened to and considered.

During 2018, we held 738 public meetings and events in the Netherlands and Germany, with over 12,500 visitors and participants. And that's not all. For larger projects, we open dedicated information centres, going the extra mile to ensure everyone has the chance to make their voice heard and helping us minimise the impact of our work.

Information centres in Germany and the Netherlands

During 2018, we opened an information centre in Dankern, Germany to give local people the information they need about a new AC cable under construction between Dörpen and Niederrhein, and an information centre in Wilster, for the new DC cable construction of the German - Norwegian interconnector NordLink. In the Netherlands, we opened another centre in Kruiningen to inform and listen to stakeholders interested or affected by the building of the high-voltage connection between Borssele and Rilland.

Geertruidenberg workshops

When TenneT began planning a new 380 kV connection between Rilland and Tilburg in the Netherlands, the proposed route included the municipality of Geertruidenberg, with plans to re-locate an overhead cable underground. TenneT gave the Geertruidenberg town council the opportunity to decide the location of the underground cable. Design workshops were organised, where options were considered and discussed with local stakeholders. The results were presented at an information evening for Geertruidenberg residents.





Connecting across borders: Doetinchem-Wesel

A good example of our work to strengthen the cross-border electricity market in North West Europe is the 380 kV, 57 km-long connection between Doetinchem in the Netherlands and Wesel in Germany. Capable of carrying up to 1,500 MW of electricity, the Doetinchem-Wesel connection is the result of years of planning, preparation and construction together with Amprion, our fellow grid operator in Germany. This is the 14th cross-border interconnector constructed by TenneT and the fourth between the Netherlands and Germany. This demonstrates our ongoing work to develop an integrated electricity market in North West Europe, helping to ensure a stable, secure, affordable and consistent supply of power. This is all the more important as more renewables are fed into the grid, making it more important for electricity to be traded and supplied seamlessly and quickly across borders.

Some of our most important projects

Harnessing North Sea wind: Borssele

The Borssele area in the North Sea off the Dutch coast is critical for the Netherlands to meet its renewable energy targets. It is the site of a massive offshore wind farm that TenneT is tasked with connecting to the onshore grid. To do this, TenneT is bringing two connections of 1,400 MW into operation in 2019 and 2020. This involves building new offshore transformer platforms and linking them to the mainland via four high-voltage AC cables. The onshore Borssele substation is being expanded to accommodate this and convert the voltage level from 220 kV to 380 kV so the electricity can be distributed to households across the country.

Energy from new sources: Project Sonnen

In the future, decentralised energy sources will become increasingly important to maintain the balance between the supply and demand for electricity. To explore this, TenneT is involved in a highly innovative pilot project with seven partners: Engie, Enova, Escozon & Energie Samen, Next Kraftwerke & Jedlix, Scholt Energy & Enervalis, Sympower and Vandebron. Using blockchain technology - an encrypted digital record of transactions - the project models how electricity can be exchanged between different sources, including wind, solar, combined heat and power (CHP), electric cars and electric pumps. During the pilot project, new data communication technologies will be tested to see how these different sources of flexible generating capacity exchange the required information for balance maintenance purposes.



Promoting the energy transition: Westküstenleitung

Germany's most northerly state, Schleswig-Holstein, is also its windiest. By the year 2025, experts predict that 37 terawatt hours of electricity from renewable energies will be generated in this region – enough to power 10 million households per year. This makes it a critical area to link into the high-voltage grid. TenneT's West Coast Line (Westküstenleitung) is designed to do this via a 380 kV and 140 km-long AC power line running from Brunsbüttel to the Danish border. Expected to come into operation in 2022, this strategically important line will help transport vast amounts of wind power to end-users further south. The West Coast Line is one of the most important projects in Germany's Energiewende and is also on the European Commission's list of Projects of Common Interest (PCI), supporting the EU's energy and climate policy.



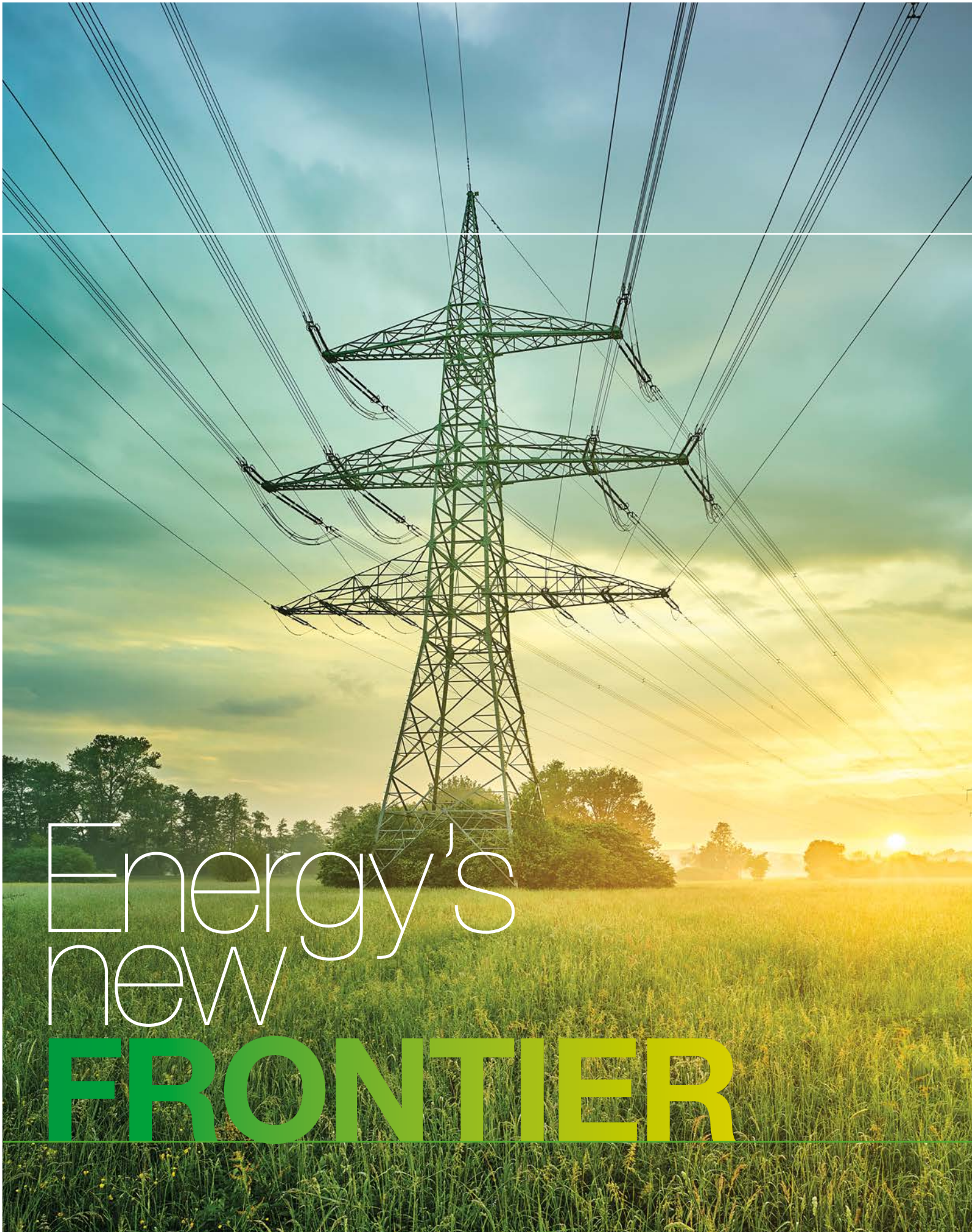


18/19



Building a
greener future

What is
green hydrogen?



Energy's
new

FRONTIER



The future of energy is one of the most contentious and complex issues facing the world today. It hinges on a central dilemma. On the one hand, our society has an insatiable demand for power. On the other, the fossil fuels we have historically relied upon are contributing to a potentially catastrophic rise in the Earth's temperature.

The good news is that we have an answer. A wholesale transition to renewable energy – and, in the process, the phasing out of carbon-based fuel – is possible. A recent report by consultants McKinsey predicts that solar and wind will account for half of global electricity generation by 2050, up from 25% today. By mid-century, that share could reach 75%.

The challenge is how to achieve this energy transition on the scale and at the speed we need. It is a once-in-a-lifetime quest for our entire industry, sparking a new age of ground-breaking invention and collaboration the world over. Some are calling it the new industrial revolution.

As a cross-border, interconnected energy company working closely with government and partners across the energy spectrum, TenneT is at the centre of this revolution in Europe. We experience first-hand society's relentless demand for electricity – expected to double globally by 2050 – and we meet this demand by connecting more renewable electricity into the grid, and by making the grid smarter through continual innovation. Step by step, and together with many partners, we are helping to build a new energy future.

June 2019

TenneT Holding B.V. and TenneT TSO B.V.

Mariëndaal Centre of Excellence,
Utrechtseweg 310, 6812 AR Arnhem,
The Netherlands, T +31(0)26 373 1111
servicecenter@tennet.eu

TenneT TSO GmbH

Bernecker Straße 70, 95448 Bayreuth,
Germany, T +49 (0)921 507 400
info@tennet.eu

Concept & Design:

DartGroup, Amsterdam,
The Netherlands

Copy: Stampa Communications,
Amsterdam, The Netherlands

How to feed the world's energy demands while protecting the planet from climate change is one of the most urgent issues facing society. To meet ambitious climate targets, governments need industry players like TenneT to adopt innovative new strategies.

Working towards a **greener**

Last year was an important one for TenneT, as the Dutch government formulated a new action plan to combat climate change.

The draft Klimaatakkoord (Climate Agreement) published in July, saw the Netherlands set itself an ambitious target to cut greenhouse gas emissions (mainly carbon dioxide) by 49% in 2030 compared to 1990. That's 48.7 megatons more than previously called for.

This agreement involved an intensive process of consultation, including five Climate Tables of energy sector players and other working groups. TenneT was

directly involved, helping to formulate an extensive package of agreements, measures and instruments that should reduce Dutch CO₂ emissions by the 49% target over the next 11 years.

Now, work is underway to put these plans into action. TenneT is closely involved in discussions on how the costs of the required investments will be met, while ensuring that energy remains affordable for all. There are also huge infrastructural targets, such as a plan to bring 3.5 gigawatts of new wind farm capacity on stream in three zones off the Dutch coast

by 2023 (Borssele, Holland Coast North, Holland Coast South).

TenneT is working on solutions to connect these new power sources to the grid. This critical work will help the Dutch government achieve its target for renewable energy sources to account for at least 16% of Dutch electricity supply by 2023.

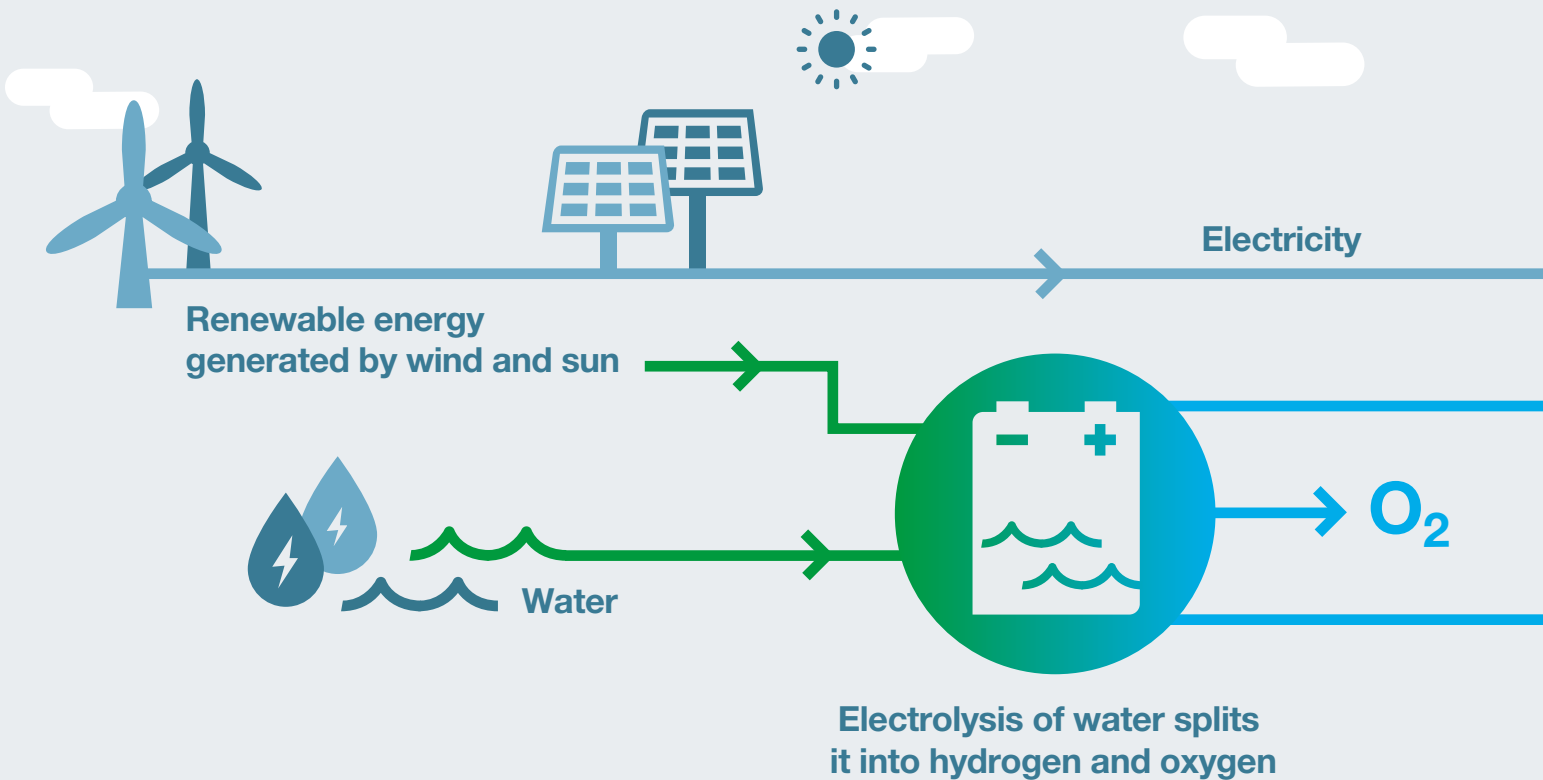
Supporting the Energiewende

Germany's Energiewende is one of Europe's most ambitious climate reduction policies. It raises the bar for the share of renewables, targeting 65% in 2030. By the same date, it aims to reduce CO₂

world

emissions by 55%, compared to 1990. These targets go beyond European Union legislation and the policies of other European states. Renewables will have to be dramatically ramped up to hit these targets, especially as the German government has also committed to decommissioning all of its nuclear power plants by 2022 and coal-fired plants by 2038. One of the biggest priorities for achieving these goals is harnessing the wind power generated in the north and transporting it to consumers in the south. As one of Germany's four grid operators, TenneT plays a

critical role in building the infrastructure to do this, and is investing heavily to connect onshore and offshore wind farms to the grid with projects like DolWin3 – a 160 km DC connection linking the south-western part of the German North Sea to the onshore grid. It is also building new north-south interconnectors overland, like the Westküstenleitung running along the west coast of Schleswig-Holstein. With projects like this, TenneT is driving the energy transition bringing bold projects to life that will help us all enjoy a greener future.



Vision 2050

combining the power of

Building an energy system based on renewable electricity requires us to cope with large fluctuations in wind and solar power production. Cutting-edge power-to-gas technology may be an answer, helping us to ensure a safe and reliable supply of electricity, whatever the weather.

In the Netherlands, TenneT worked with the gas network operator Gasunie on a joint study exploring how energy infrastructure can be integrated. The project, called Infrastructure Outlook 2050, proposes a scenario where electricity and gas energy infrastructure are seamlessly co-ordinated. By bringing these two power systems together, we can

provide the flexibility our energy system needs.

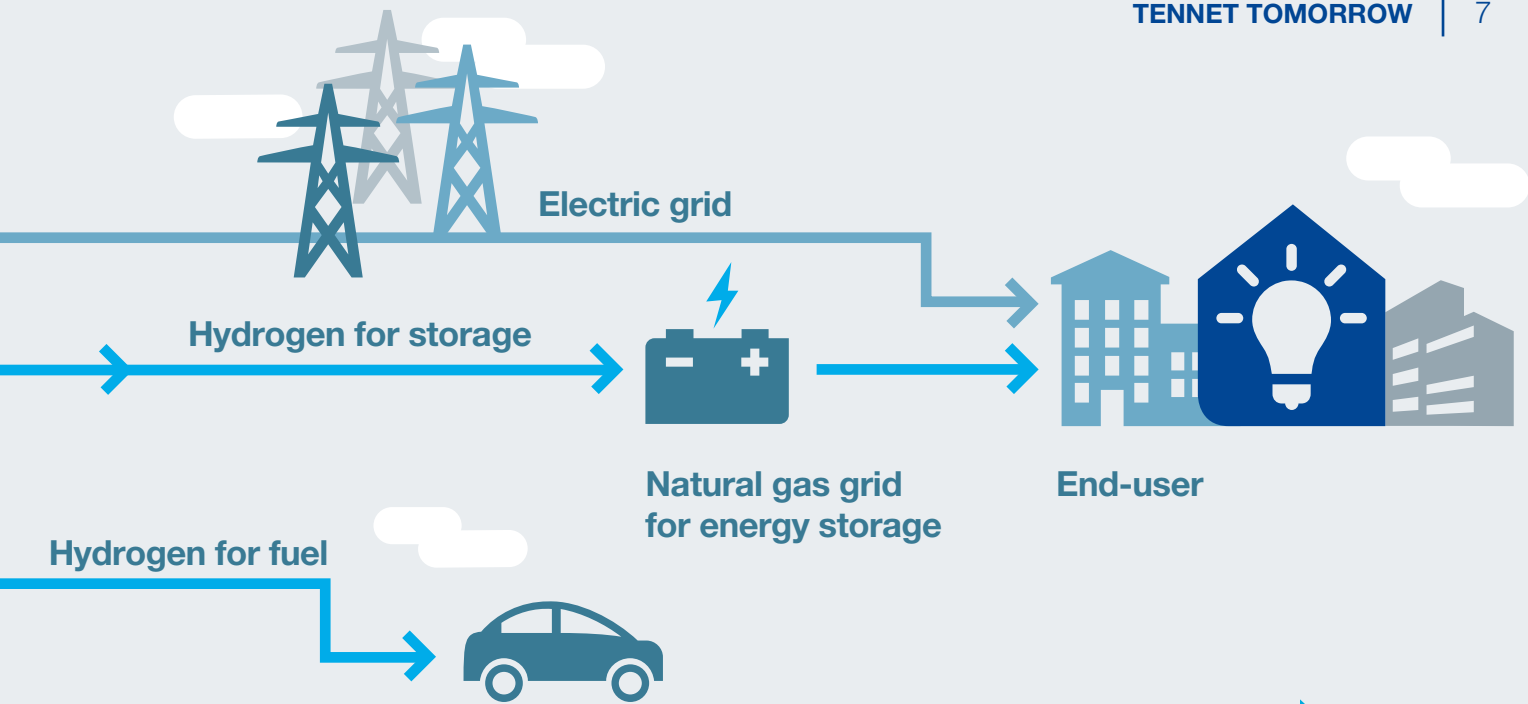
Why do we need to do this?

To meet the 2050 emission targets set in the Paris Agreement, national governments need a complete overhaul of the current fossil fuel-dominated energy system. New solutions are urgently required. Although many hope electricity produced from

the sun and wind will meet our needs in 2050, it is only part of the solution. But how can the gas and electricity systems come together?

Green hydrogen

The answer is one of the most advanced of all energy innovations – so-called ‘green hydrogen’. Put simply, this is green electricity converted into hydrogen. This involves the electrolysis of water,



electricity & gas

using renewably-generated electricity, which splits it into hydrogen and oxygen.

As well as being a carbon-free alternative to natural gas, green hydrogen has an important benefit: it can be stored. This helps to solve a key problem in the energy transition, as storing electricity in gas form will help to even out the imbalances between the supply and demand of renewable electricity. Of course, we can also do this with batteries, but even the largest batteries can't meet our huge energy demands for very long. We need bigger-

scale solutions and green hydrogen may be one of the answers.

Green hydrogen can also be imported. This gives countries another flexible option if they can't generate enough renewable electricity at home. And, as well as being able to use it in the electricity grid, green hydrogen can also be used as a zero-emission fuel to power trains, trucks and cars.

Element Eins pilot

TenneT is testing this groundbreaking new technology in a pilot

project with Gasunie and Thyssengas called Element Eins. A power-to-gas installation with a capacity of 100 MW is being built in Lower Saxony, Germany, and is expected to go into operation gradually from 2022. Showing how the electricity and gas power systems are physically coming together, the test site is located near a TenneT transformer station where electricity from offshore wind turbines is distributed. By bringing electricity and gas together in this way, we can create a new kind of energy system, capable of serving our needs in a green energy future.



Investing for the future

To ensure that our 41 million end-users in the Netherlands and Germany continue to enjoy a secure supply of electricity, TenneT plans to invest approximately EUR 35 billion in its network over the next 10 years. This involves ambitious onshore and offshore projects in both countries.

Investment in energy infrastructure has never been more important – not only by TenneT, but all players in this complex and fast-changing market. Our sector must rise to the challenge of the energy transition, using ground-breaking technology and innovations to meet society's demands for cleaner energy and help governments achieve ambitious climate targets.

Although many of these targets are just a few years away, the fight against climate change demands a long-term plan of action. To this end, our investment plans look as far ahead as 2035 or even 2050. We must be ambitious, plan for the unexpected and think the unthinkable to meet the challenges of the future.

For the next decade, our investments in the Netherlands and Germany aim to build the backbone to drive the energy transition, with solutions that accommodate and balance renewables in the electricity supply, connect across borders, allow renewable electricity to be stored and transported further, and link the offshore and onshore grids. All the while, we strive to keep the cost for society as low as possible, and minimise the impact on the natural environment and local communities.



