



2020 | ENERGINET

ANNUAL MAGAZINE

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ANNUAL MAGAZINE

Energinet's annual magazine 2020 provides an easy-to-read update of Energinet's activities, and the opportunities and challenges the company is facing.

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NUMBERS THAT TALK



SPEEDING UP THE TRANSITION

Energinet was established to ensure that all Danish citizens, businesses, schools, hospitals, etc. have a secure supply of electricity and gas.

The Danish law stating the purpose of Energinet's work stipulates that we must ensure the security of the energy supply, while also creating room for the integration of more renewable energy, in a way that is affordable to society.

What is rapidly changing at the moment is not the task Energinet has been charged with. This remains the same. One thing that is changing in 2019 and 2020 is that more ambitious political and popular goals for climate action are being set than before. The other thing that is rapidly changing is the technological conditions and possibilities for achieving our task.

In other words, Energinet's task is the same. It is the possibilities and conditions for performing this task that are undergoing historically profound changes right now in 2019 and 2020.

Green energy for a better world is Energinet's new vision, and here in our annual magazine 2020 you can find examples of how we are seeking to achieve it.



CAN YOU MAKE A DIFFERENCE?

We are living in an age of man-made climate change, and halting this may be the most important challenge in the history of mankind. Thomas Egebo, CEO of Energinet, met with two adults of the future to discuss what security of supply and green energy have to do with the responsibility for ensuring a habitable planet in the future.

ELSE: What do you think of the new climate changes?

I'm actually a bit worried about it, because it's not very good, you know. It's causing the ice to melt in Greenland and at the North Pole. This will make the seas rise, and there will be more floods. And there may also be more rain, as we are seeing in Denmark right now. So I would prefer it if we didn't have these climate changes.

VIOLA: Do you think you can make a difference?

I think we all can. You have probably heard a lot about climate change and how bad this is. At Energinet, we're working to help Denmark use green energy from wind turbines, solar power and something called biogas. Because if you only use green energy, it's good for the climate.

Else: What will happen if the climate changes continue?

If we don't slow down the climate changes, it will get very hot in some parts of the earth. We may not feel that so much in Denmark, but perhaps they will in Africa or Australia, and then living conditions may become unbearable for the people there. It might also become harder to grow vegetables and grain if it gets too hot. Then people will starve, and that's obviously not good.



ELSE: Will it make a big difference in Denmark if the climate changes continue?

Yes, if we look many years into the future. Perhaps one day when you're getting old. I know that's far in the future, but Denmark may look a little different if we don't stop these climate changes. Places which are dry land today, may be flooded. Many of our cities and towns are on the coast, so the sea does not have to rise much before there will be flooding. We have also seen it on television over the last few days, because it has rained so much in February.

VIOLA: That was all the questions we have...

Ok, they were really good questions. But tell me what you are doing yourselves – is there anything you two do differently at home?

“... Denmark may look a little different in the future if we don't stop these climate changes.”

VIOLA: We have some metal straws at home which are good for the climate, because we don't have to throw them out...

So you can use them again and again? Yes, many say that using plastic is not a good idea. It never really disappears, and when we burn it, it's also bad for the climate. Reusing things is a really good idea overall.

ELSE: My stepdad became a vegetarian, and now my mother is too...

How about you, are you also a vegetarian?

ELSE: No!

OK. But the most important thing in relation to the climate is to use green energy instead of energy from oil, coal and natural gas. If every country in the world used only green energy, we would actually have solved this climate problem. If Denmark can give other countries good ideas on how to get to the point of using only green energy, we will have made a big difference!



Viola Laursen Harbo

Eight years old and in 1st grade at Birkhovedskolen in Nyborg. She enjoys horse riding with Else in her spare time.

Else Boe Danbjørg

Ten years old and in 4th grade at Birkhovedskolen in Nyborg. She enjoys horse riding with Viola in her spare time.

Thomas Egebo

58 years old and CEO of Energinet. In his spare time, he enjoys reading books, collecting mushrooms in the woods and listening to opera.

HYDROGEN IS COMING

– BUT WHAT DOES IT HAVE TO DO WITH ENERGINET?

Power-to-X is on everyone's lips, at a time when the members of the Danish parliament have to agree on climate action plans that can fulfil the target they have agreed on – a 70% reduction in Danish greenhouse gas emissions by 2030.

Many things also indicate that Power-to-X will become a key technology for climate reductions in those sectors of society in which energy consumption cannot be electrified directly. Put simply, it has to make ships, aeroplanes and parts of industry green via indirect electrification, while heat pumps and light transport run directly on electricity.

Using Power-to-X, part of Denmark's abundant wind and solar energy can be used to make hydrogen from water via electrolysis. Combined with carbon from sources such as biogas, hydrogen can be further refined into green fuels, which can ultimately make air and sea transport climate neutral.

It is therefore not surprising that Power-to-X is on everyone's lips. But what does this have to do with Energinet, the Danish state-owned enterprise responsible for security of supply, power lines and gas pipes?

We asked one of Energinet's experts on Power-to-X, Carsten Vittrup, to explain. Carsten Vittrup has been closely involved in Energinet's work with Power-to-X since spring 2018.

Just a few years ago, no one was talking about hydrogen and Power-to-X. Now it is on everyone's lips. What has happened?

In energy circles, this is something we have been talking about for many years. We may have just called it electrolysis, or power-to-gas, instead. It has long been expected to become a reality sometime in the

future, but in recent years, that future has moved closer. There are many reasons for this, but no doubt one key reason is that it has become much cheaper to produce electricity from wind and solar power over the past 5-10 years. This means that Power-to-X using green electricity is no longer extremely expensive. It is now perhaps only 2-3 times as expensive as the fossil alternative – with the prospect of becoming reasonably competitive within the foreseeable future.

Since March 2018, Energinet has published a series of analyses which identify hydrogen and Power-to-X as the next big thing in the energy sector – why have they prepared these analyses?

We perform long-term analyses because we do long-term planning and make long-term investments. We are responsible for securing the electricity and gas infrastructure for the current energy system, but also for ensuring that it can service the next 20, 30 or 40 years. The pipes and cables we invest in have a very long service life. In order to make sensible long-term investments, it is vitally important to analyse possible developments and trends in the energy landscape – for the next few years, as well as for the lifetime of the assets we are planning for.

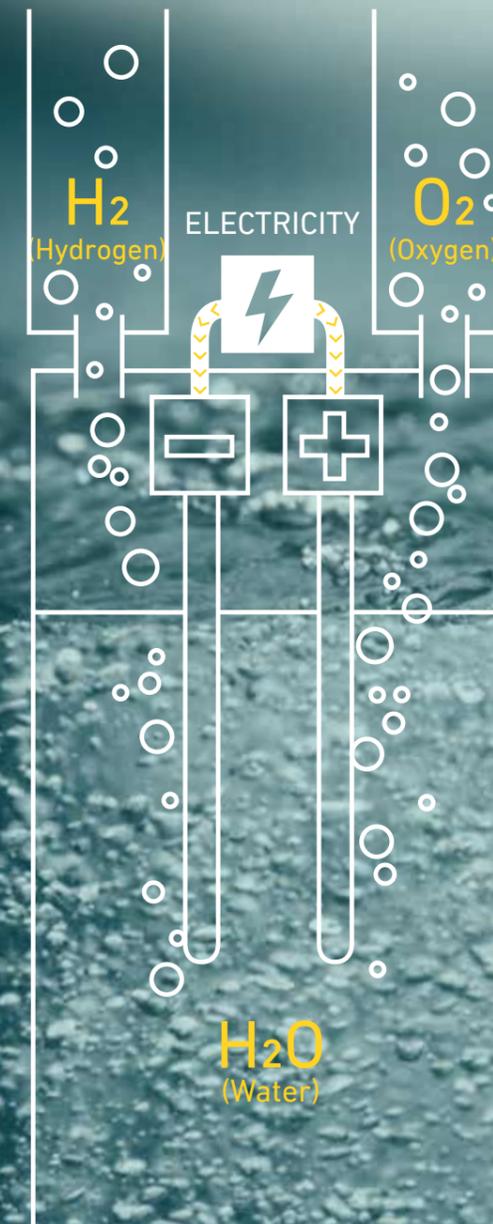
You and Energinet have seen a lot of interest from players in the energy sector following the series of analyses Energinet has published.

Yes, that's correct. The 'System Perspective 2035' analysis from March 2018 looked at hydrogen and Power-to-X in depth. One of the things we analysed was when Power-to-X could become competitive (as cheap as the fossil alternative) in various scenarios.



ELECTROLYSIS

Electrolysis is a well-known technology which can now be used to advance the transition to green energy, because the price of energy from wind and solar power is dropping. By running electricity from renewable energy sources through water, water molecules can be split into green hydrogen and oxygen. The oxygen can be utilised or released harmlessly into the atmosphere. The hydrogen is used to make 'things from wind'.



THINGS FROM WIND

Green hydrogen via electrolysis and Power-to-X will become a key technology in the next phase of the transition to green energy. Hydrogen makes it possible to create things from wind that previously required the use of fossil raw materials. Examples include plastic products, green fuels for heavy road transport, aeroplanes or ships, and fertilizer. Hydrogen can also be used directly as energy for transport via fuel cells or in high-temperature industrial processes etc.

Energinet will not produce any hydrogen or green fuels directly, but we must avoid 'getting in the way' and be ready to integrate them into the energy system when they come.

Carsten Vittrup, Energy Strategy Consultant, Energinet



The analysis was received positively, but there were also a number of players who reported seeing a considerable willingness to pay extra for green alternatives. We therefore did a subsequent topical analysis in 2019, where we looked at whether there was a chance that Power-to-X could become widespread before it becomes directly competitive with the fossil fuel alternative. In the topical analysis based on the new premise, we concluded that hydrogen and Power-to-X actually have a good chance of gaining a considerable foothold before 2030. Time horizons are important, as they have a major impact on the infrastructure and market design that we need to prepare for. Energinet will not produce any hydrogen or green fuels directly, but we must avoid 'getting in the way' and be ready to integrate them into the energy system when they come.

Could it be that Energinet's analyses of future scenarios for hydrogen and Power-to-X will become part of a self-fulfilling prophecy?

'Self-fulfilling prophecy' are strong words, but by simply talking about and analysing the trend, I have no doubt that we are helping to accelerate it. But this is probably also necessary. Changing gears in the green transition for production methods and energy consumption has huge inertia. For example, consider the electric car. In principle and in the analyses, this has been a good idea for perhaps 20-30 years, but it was not until a visionary and extremely wealthy person like Elon Musk developed the Tesla electric vehicle that the entire industry felt compelled to seriously change track.

But yes, I think it has an impact when a major energy sector player like Energinet says it believes a technology could become relevant.

What is Energinet's next important step in this area?

The first stage of Power-to-X – green hydrogen from electrolysis – is making a serious move in

the countries around us. I feel that the question of Denmark's role in relation to this trend is becoming a matter of urgency. Should Denmark seek extensive use of electrolysis in the energy system, with the many potential benefits it entails? Would this mean that Denmark needs to have a few well-placed hydrogen pipes? If so – do these need to be coordinated with other countries? It is essential to consider this. The EU has a major focus on hydrogen, and our neighbour, Germany, has plans for a network of hydrogen pipes, which currently stop at the Danish-German border on the drawing board. The industrial production in Germany and the Netherlands means that these countries have a much larger existing hydrogen demand than Denmark. It is also worth noting that Germany defines itself as an importer of green hydrogen in its hydrogen strategy, due to the limited scope for further wind and solar power expansion. This is something that Denmark has in abundance.



ENERGINET'S PUBLICATIONS ON POWER-TO-X

March 2020: System perspectives for the 70% target and large-scale offshore wind power

January 2020: New wind power for hydrogen-PtX – strategic action plan

November 2019: New wind power – Energinet's strategy

June 2019: Trends and future perspectives for the electricity system

April 2019: PtX in Denmark before 2030

March 2018: System perspective 2035

FROM NATURAL GAS TO HYDROGEN

The gas grid and the two gas storage facilities under Danish soil were built for natural gas in the 1980s, to reduce our dependence on imported oil. They may soon serve a new purpose. The natural gas pipelines and storage facilities may become an important link between the production and consumption of green hydrogen, Power-to-X and electro-fuels.

The photographer has just said goodbye to Hans-Åge Nielsen and Stine Grenaa Jensen. They are now warming up again inside the administration building of the gas storage facility on Zealand. They have just completed a photo shoot in front of the facility, in the wet windy weather many Danes will remember February 2020 for.

While the two gas experts posed in front of the gas storage facility in Stenlille, Zealand, it is actually the other Danish gas storage facility in Lille Torup, in

northern Jutland, that is relevant when talking about hydrogen and Power-to-X.

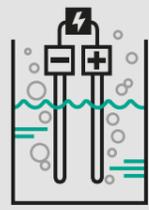
The Lille Torup facility is part of the Green Hydrogen Hub consortium, established in 2019. The consortium will analyse opportunities for establishing a complete chain of green hydrogen production, storage and usage as an energy source for industrial processes, or as a component in chemical products such as green fuels.



GREEN HYDROGEN HUB – A PTX-INDUSTRY CLUSTER BETWEEN SKIVE AND HOBRO



Green electricity for hydrogen production is supplied by electricity suppliers in the area



Local electrolysis plants extract hydrogen from water using green electricity



Green hydrogen is stored in local hydrogen storage facilities, which can store very large amounts of energy



Green hydrogen from storage supplies energy to industrial processes or is used as a component in green fuels

More about software than hardware

Hans-Åge is Chief Project Manager at Gas Storage Denmark. Gas Storage Denmark is owned by Energinet, and operates the two Gas storage facilities in Lille Torup and Stenlille as a single business. Especially in the winter when consumption is high, large gas suppliers need to be able to draw on stored gas. The two gas storage facilities sell them storage space, and are important to Danish security of supply.

Hans-Åge is based in Stenlille, where he currently spends almost all his time working towards incorporating gas storage facilities into new value chains based on hydrogen and Power-to-X, and to thereby advance the transition to green energy. Stine works in Energinet's Ballerup office, where she heads the strategic development of the gas system at the transmission level.

It's not so important that the two for convenience have been photographed at Stenlille on Zealand, while it is actually the gas storage facility in Lille Torup which is part of the Green Hydrogen Hub. For despite the fact that the gas hardware in terms of storage space and facilities is impressive (the Eiffel Tower could fit inside each of the seven underground caverns in Lille Torup), the highly specialised knowledge and experience Hans-Åge, Stine and their colleagues have accumulated is just as valuable an asset in the quest to advance hydrogen and Power-to-X.

Or as Stine says, "It's more about software than hardware". Hans-Åge adds: "Operating a high-pressure gas storage facility requires lots of experience in operation and safety. Calculating the thermal dynamics in the gas flow and capacity conditions in the storage facilities is

also a highly specialised skill. We therefore have a low entry barrier to getting into hydrogen storage, because we just need to copy what we are already doing."

Gas storage facilities can ensure a stable supply of hydrogen

Energy storage is one of the top items in the 'bucket list' for the transition to green energy. If you take an interest in the transition to green energy, you are no doubt aware that we need more offshore wind turbines, more electric vehicles and better possibilities for storing renewable energy for use during times when it is not windy and the sun is not shining.

It may be less well-known that energy storage is one of the greatest strengths of the gas system. "Security of supply is key, also for green hydrogen and the use of hydrogen in industrial processes or as a component in green fuels," says Hans-Åge. "The wind only blows some of the time, but industry will need to be able to use the green hydrogen all of the time. When there is surplus production from renewable energy sources such as wind and solar power, this can be used by electrolysis factories to produce hydrogen. But the players who use hydrogen in industry, and those who produce green fuels, will need access to hydrogen all the time. This is where the gas storage facilities come into the picture."

An industry which uses green hydrogen for steel production or to make green fuels or the like cannot stop production when the wind is not blowing. It is therefore necessary to be able to store green hydrogen.

One of the benefits of energy in molecules (gases such as hydrogen) rather than electrons (electricity)



is that it can be stored in very large quantities, far exceeding the capacity of even the largest batteries. For example, a gas storage facility like Lille Torup can store energy corresponding to several months of Danish electricity consumption.

Climate neutrality in all sectors is the goal

The mandate legislators have given Energinet is to ensure equal access to the public supply grids for electricity and gas, and to integrate renewable energy in ways that are affordable to society. It is therefore not a goal in itself for Energinet to preserve the gas system, beyond the elements which are deemed likely to support legislated policy objectives for the transition of the energy supply.

"Hardly a day passes without a new report being released which concludes that hydrogen and Power-to-X is a key technology..."

"Hardly a day passes without a new report being released which concludes that hydrogen and Power-to-X is a key technology – in order to reach the goal of a 70% reduction in Danish greenhouse gas emissions in 2030, as well as climate neutrality in 2050," says Stine.

She makes no predictions about the role the gas system will have in a climate-neutral Denmark in 2050, but she believes that as Power-to-X becomes widespread in the years ahead, there will be a need to transport and store gases such as hydrogen, methane (natural gas or upgraded biogas) and CO₂. There is no great benefit in having green hydrogen in storage facilities underground if it cannot be transported to where it needs to be used via pipes:

"I think it is likely in the coming years that we will see a separate hydrogen grid in parallel with the conventional gas grid, in one form or another. Gas in the gas grid will continue to consist of methane molecules for many more years, as we have to provide for the transit of gas from Norway to Poland. However, the gas grid must also be used to collect biogas from the increasing number of biogas plants around Denmark. After 2030, this biogas must be put to use in whatever applications are right at the time."

What the right conditions for biogas and other green gases will be after 2030 are difficult to predict precisely. A likely scenario is that biogas will make a major contribution to reducing greenhouse gases emissions from agriculture, and that excess CO₂ from biogas together with green hydrogen can be used in the production of green fuels. These green fuels will in turn become key in transforming energy consumption from planes and ships to green energy.

The transformation the energy sector undergoes from now on will therefore have a major impact on how other sectors can make the transition to more climate-neutral activities.

ENERGY STORAGE

Hydrogen can store far larger amounts of energy than electricity in batteries. It would require 54,000 battery banks the size of the world's largest battery storage facility – Tesla's Hornsdale Power Reserve in Australia – to provide the same capacity as the two Danish gas storage facilities combined (10 million MWh).

ENERGINET AND THE WORLD

Energinet shares its knowledge and experience from integrating renewable energy into electricity systems with much of the world through its consultancy business, Associated Activities.

International partnerships and consultancy

Energinet participates in a number of international partnerships, which are coordinated by the Danish Energy Agency and financed from Danish sources. Denmark has partnerships with 15 countries, which together account for over 50 per cent of the world's population and more than 60 per cent of global greenhouse gas emissions. Energinet is currently participating in 12 of the programmes, and also provides independent consultancy services to seven countries.

"During the past ten years, Energinet has shared practical experience from the Danish electricity system with other countries. We are seeing strong demand for our knowledge about efficient and safe integration of large volumes of wind power, and are

advising on system operation, electricity markets, transmission planning, network codes and connecting offshore wind farms," says Peter Jørgensen, Director of Associated Activities in Energinet.

In step with the next phases of the green transition, Energinet will also be able to advise on new types of solutions, such as sector coupling using power-to-X, utilising large-scale offshore wind and digitalisation.

"Our employees in the field work with these things in practice on a daily basis. This allows us to provide advice our partners can translate into specific action, and give them results that make an impact on the bottom line. We also gain considerably from exchanging experience internationally," says Peter Jørgensen.



ETHIOPIA: PROMOTING WIND ENERGY



"In our experience, it is best to keep it simple. We have to help them to do it themselves, and it is important to show that it does not need to be high tech. The key is to make it easy to understand and manage processes, data and coordination."

Thomas Krogh, Operations Engineer, Nan Qin, Senior Engineer, Henrik Haag Jensen, Senior Operator

GERMANY: CALCULATING GRID STABILITY



"We have made the DSAlight application available as open source, so everyone has easy access to it. We want to share our knowledge and give inspiration to colleagues from other TSOs, to allow complex grid stability calculations to be handled more easily and reliably."

Michal Powalko, Senior Engineer

ENERGY AND THE WORLD

-  PARTNERSHIP PROGRAMMES
-  CONSULTANCY SERVICES



OFFSHORE WIND FARM EXPANSION

There is great potential for establishing offshore wind farms on the east coast of USA, and US authorities and electricity companies are currently preparing the administrative and technical framework for such expansion. Energinet is contributing to this process by sharing its experience from planning, preliminary studies, tenders and grid connection. Both state and federal authorities are showing great interest in learning from Denmark's many years of experience. The work is being done in cooperation the Danish Energy Agency and the Danish Embassy in Washington.



CALCULATING GRID STABILITY

Energinet has developed an IT tool called DSALight (Dynamic Security Assessment), which calculates the current stability of a power system simply with the press of a button. This is something that previously took an experienced engineer several hours to perform. The tool is to be used in control centres, for example when system stability is under pressure due to several production units dropping out at the same time.

Energinet has presented the tool to its European TSO colleagues, and has initiated collaboration with German Amprion GmbH, which has adapted the tool to their IT system based on advice from Energinet.



ESTONIA



GERMANY



UKRAINE



GEORGIA



TURKEY



EGYPT



SAUDI ARABIA



INDIA



ETHIOPIA

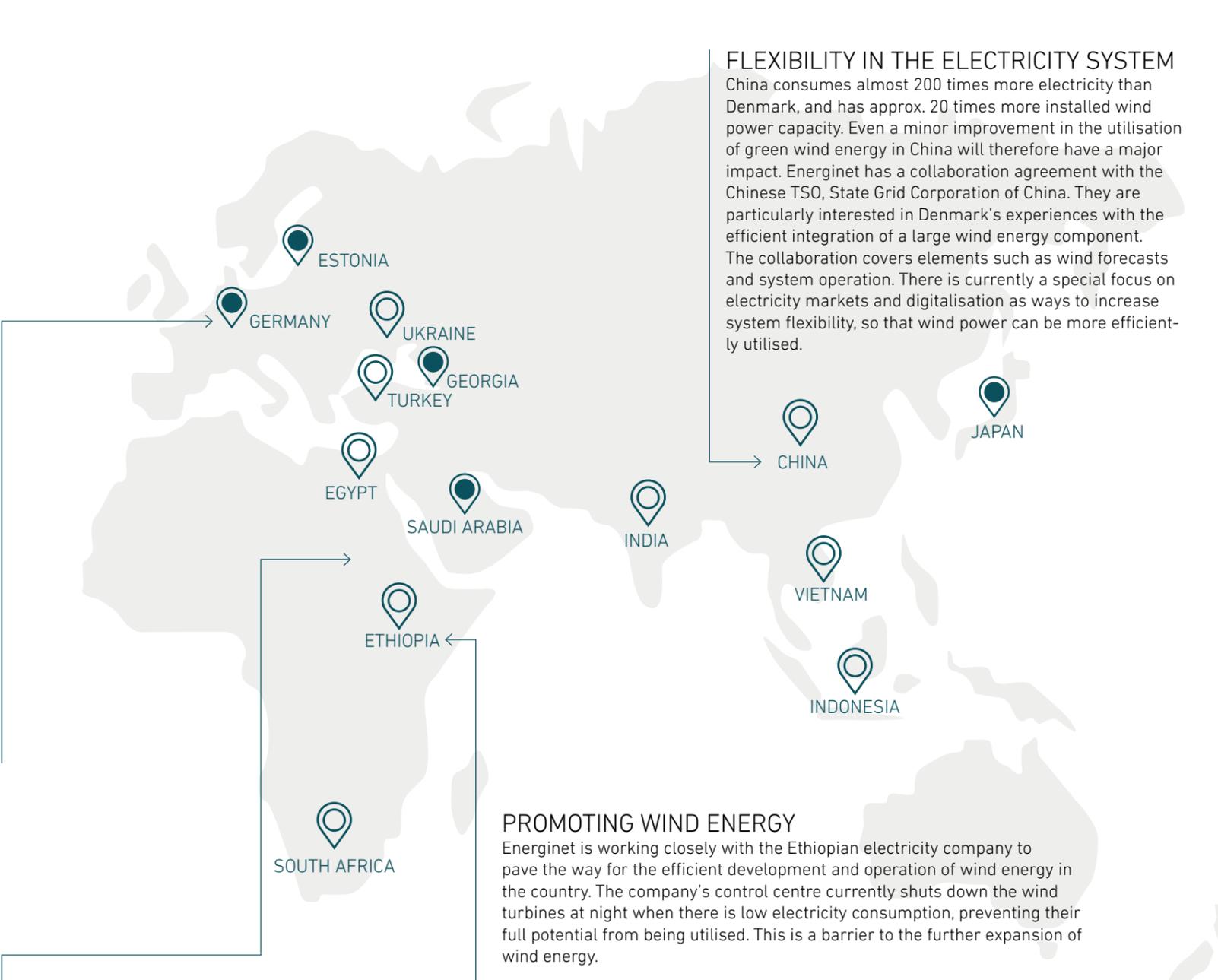


SOUTH AFRICA

EAST AFRICA:

MARKET-BASED ELECTRICITY TRADING

Eastern Africa Power Pool (EAPP) is a regional cooperation organisation for the development of the electricity sector in 10 countries in north-east Africa. Energinet and other consultants have shown via a pilot project that implementing market-based electricity trading between a few of the countries based on European principles will lead to significant benefits. The World Bank has since calculated a similar benefit from increased trade throughout the region. Energinet is currently contributing to a project financed by the World Bank which is preparing the EAPP and member countries for market-based system operation and greater trade in the region.



FLEXIBILITY IN THE ELECTRICITY SYSTEM

China consumes almost 200 times more electricity than Denmark, and has approx. 20 times more installed wind power capacity. Even a minor improvement in the utilisation of green wind energy in China will therefore have a major impact. Energinet has a collaboration agreement with the Chinese TSO, State Grid Corporation of China. They are particularly interested in Denmark's experiences with the efficient integration of a large wind energy component. The collaboration covers elements such as wind forecasts and system operation. There is currently a special focus on electricity markets and digitalisation as ways to increase system flexibility, so that wind power can be more efficiently utilised.



CHINA



JAPAN



VIETNAM



INDONESIA

PROMOTING WIND ENERGY

Energinet is working closely with the Ethiopian electricity company to pave the way for the efficient development and operation of wind energy in the country. The company's control centre currently shuts down the wind turbines at night when there is low electricity consumption, preventing their full potential from being utilised. This is a barrier to the further expansion of wind energy.

As a first step in the process of optimising the electricity system, Energinet has developed a simple operational tool for the control centre based on Excel and free data. The tool contains wind and electricity consumption forecasts, as well as data for the available hydropower capacity, which is Ethiopia's primary energy source. This makes it possible to predict imbalances in the electricity system. Do we have enough resources? Can we power up the wind turbines and keep the hydropower in reserve, for sale at a later time? This lays a foundation for the Ethiopian company to start using data to make decisions about operations and profitable investments.

CORPORATE SOCIAL RESPONSIBILITY

GREEN ENERGY FOR A BETTER WORLD

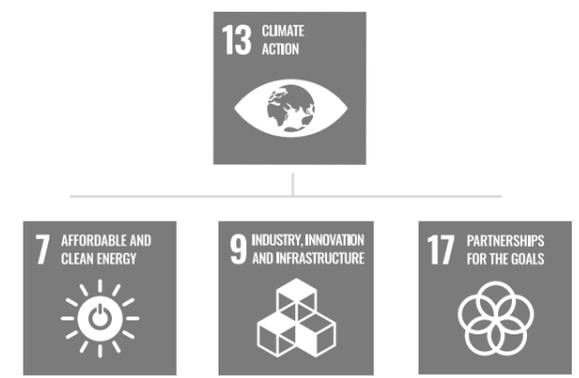


Energinet adopted a new vision in 2019: Green energy for a better world. This vision clearly expresses that our social responsibility extends beyond Denmark's borders.

Our primary task is to demonstrate that Denmark can implement the green transition of the energy system, while maintaining a high level of security of supply and keeping costs at a level which is affordable to society. If Denmark is successful, this may help pave the way for green transitions in other countries.

On the heels of the new vision, Energinet formulated a CSR policy based on the UN's sustainable development goals. A 100% green transition for energy systems is one of the most important keys to halting global climate challenges, and global goal 13 on climate action therefore serves as the general guide for our CSR initiatives.

We have also given priority to three global goals, which we have a special responsibility to contribute to as we perform our core task.



Energinet can make a difference in the world by helping to lead the way in the green transition, and sharing knowledge with other countries that have not come as far as Denmark.

“I am working to give my children a better climate”
 “Spread knowledge and nudge people in a green direction”
 “Be part of something that we can be proud to look back on in 2050”



WHAT IS IMPORTANT TO YOU?

We received a lot of input from employees in May 2019 when Energinet kick-started a renewed and stronger focus on the company’s social responsibility. The high energy and the suggestions put forward on the day hit the nail on the head: It is human engagement that drives sustainable development.

Energinet needs new solutions in the second phase of the green transition, and we can only find them with the help of managers and employees, who are driven by curiosity and dynamism.

Internal engagement is also what drives the reduction of Energinet’s own global footprint. We are implementing a number of employee suggestions for more sustainability in our daily work.

These initiatives include a sustainable canteen, climate compensation for flights, a green travel policy, replacing diesel vehicles with electric vehicles, improved waste sorting, reducing paper usage and energy-efficient operation of our office buildings.

By allowing the grass to grow, mowing it once a year and removing the cut grass, a wild meadow will eventually be established.



LET IT GROW

At Energinet’s head office in Erritsø, we decided to stop fertilizing and mowing the grass on 10 hectares of land in 2019, and instead allow a natural meadow to develop. This provides habitats for vulnerable butterflies, bees and other insects.

We own a total of approx. 300 hectares of land at all our electricity and gas plants, and we also have the opportunity here to give nature more space. Energinet is working to promote biodiversity by sowing insect-friendly floral mixes instead of grass, installing sedum

roofs on buildings, building swallow nesting shelves and nest boxes, planting trees and shrubs and establishing water holes and stone walls.

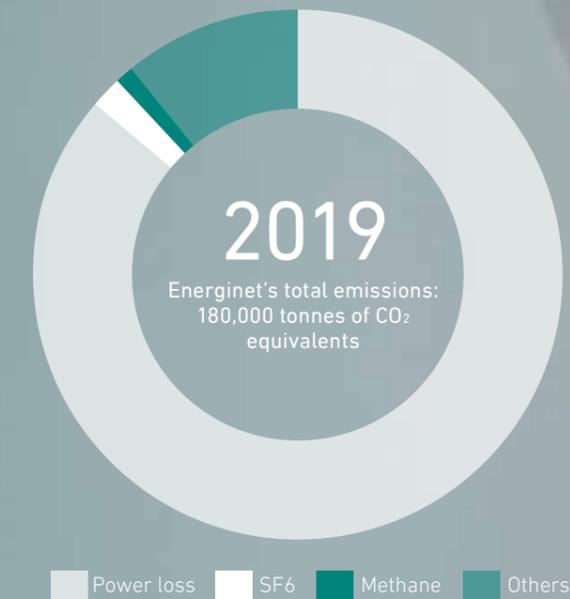
When Energinet builds new plants, we have the opportunity to take local flora and fauna into account in the design. We did this when we built the new Klim Fjordholme high-voltage substation in northern Jutland, in close cooperation with Jammerbugt municipality and the The Danish society for Nature Conservation.

ENERGINET’S OWN CARBON FOOTPRINT

Operating the electricity and gas system consumes resources and impacts on the climate, and this is where Energinet has its biggest carbon footprint. The biggest item in Energinet’s climate accounts is the loss of energy in the grid when electricity is transported from A to B. After this, the two main culprits are methane emissions from the natural gas grid, and the use of SF₆ Gas as an insulation medium in high-voltage installations.

We aim to reduce carbon emissions from operation of the systems, and we have action plans for each of the three items mentioned above, to ensure continuous progress is made. Our carbon footprint depends largely on the volume and type of energy we move within the electricity and gas transmission grids.

We are setting a carbon reduction target for Energinet in 2020.



LINK TO SWEDEN PREVENTED BLACKOUT

An acute power shortage could have blacked out parts of Zealand in early October 2019 if Sweden had not given assistance to the Danish electricity grid.

The fact that Sweden's electricity system is connected to Denmark became a vital factor for the power supply on Zealand on 8 October.

Following a series of unforeseen incidents in the Danish electricity grid, Energinet's control centre was close to ordering local utility companies to shut down power to selected parts of Zealand – a 'brownout' – to prevent a complete blackout.

There have been no occasions in recent years where a brownout has disconnected electricity consumers from the grid.

This means that Energinet is succeeding in its primary task – ensuring that Denmark's security of supply is maintained.

The employees at Energinet's control centre in Erritsø ensure that it happens. They monitor the electronic map of the nation's electricity grid 24/7 to ensure that the main grid fulfils its purpose – providing a stable power supply to residents and businesses.

To achieve this, control centre employees must always be one step ahead, and predict and prevent incidents which could have a negative impact on the power system, to the best of their ability.

600 MW lost without impact on consumers

However, some incidents cannot be predicted. What happened on 8 October 2019 is such an example. Bjæverskov substation – a major 400 kV substation in the Eastern Denmark grid – suffered a short circuit.

Electricity consumers were not impacted, despite the

electricity grid suffering a drop, and the fact that the Kontek transmission link to Germany also dropped out.

The electricity system is designed and operated so that it does not shut down simply because some of its plants drop out.

But then something else unexpected happened. The Avedøre CHP plant in Copenhagen totally stopped its electricity production. And then another unforeseen problem occurred: The Rødsand 2 wind farm south of Lolland shut down.

“You sit there in a situation like that wondering if people will get stuck in elevators.”

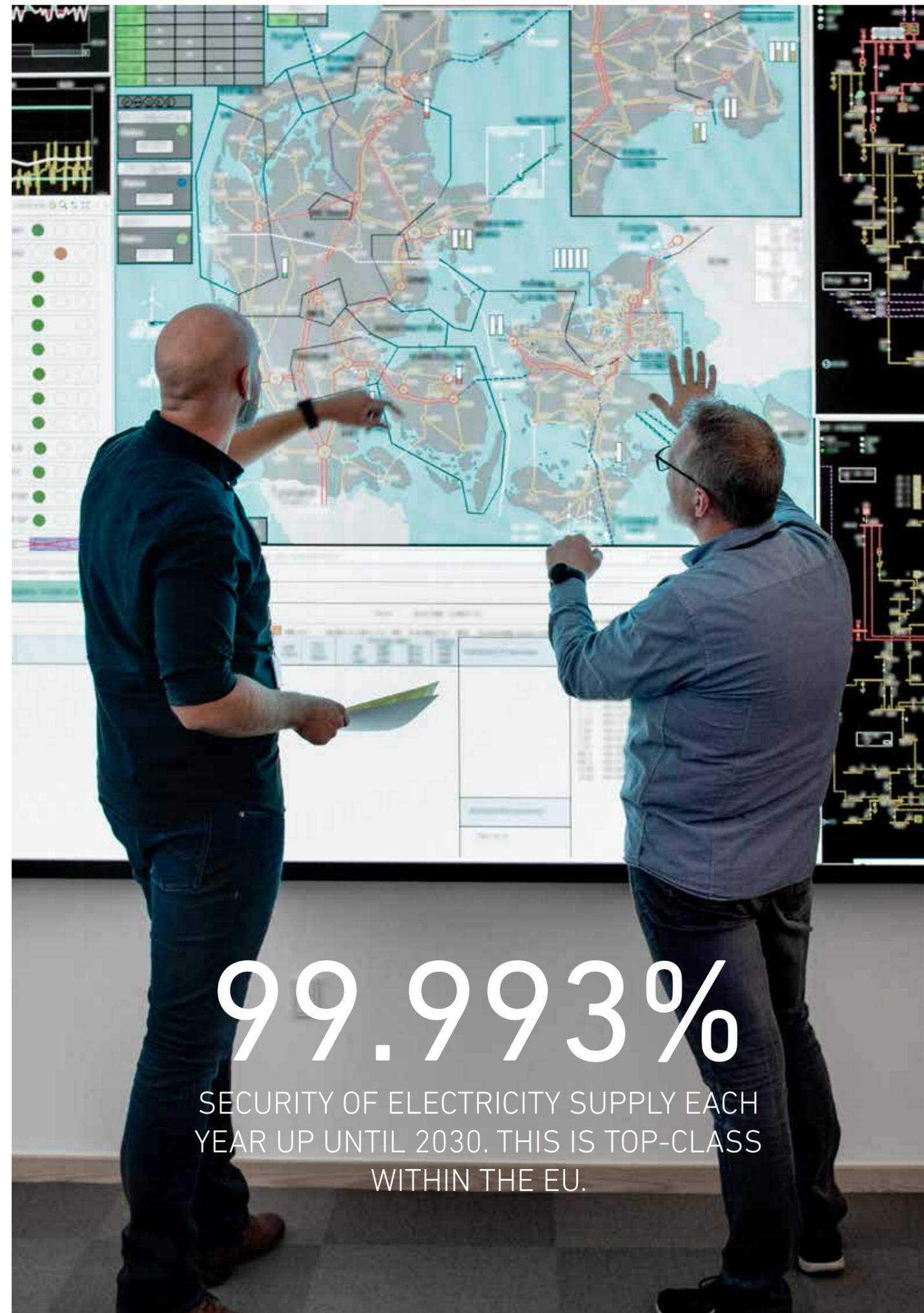
These four incidents within just a few minutes put the power system under more pressure than it is designed to handle.

Trained in emergency situations

Within four minutes, East Denmark lost a total of 1100 MW of electricity generation. For a traditional power station with a normal production time, this would correspond to the annual electricity consumption of more than two million households.

The engineer on duty that day, Henrik W. Andersen, has never been a situation before where he was close to having to brownout the supply to some parts of Zealand.

However, he and his colleagues in the control centre have rehearsed such situations, and they could easily



99.9993%

SECURITY OF ELECTRICITY SUPPLY EACH YEAR UP UNTIL 2030. THIS IS TOP-CLASS WITHIN THE EU.

have needed to draw on this brownout training on 8 October.

"You sit there in a situation like that wondering if people will get stuck in elevators. And about traffic lights, and other places where it is vital that power is available. Luckily, it has never been necessary on my watch," says Henrik W. Andersen. He also notes that even though it would be difficult to push the button in such a situation, it is better than the entire system going down.

But it never came to that. The lights never went out on Zealand. Alarm clocks did not turn off just before 7.00 that morning.

To try to fill the large power shortfall, Energinet activated all of the electricity system's manual reserves in East Denmark. Until these were up to steam, the missing power was supplied via the international interconnection from southern Sweden, which thereby prevented a total blackout on Zealand.

We pulled through together

Our efforts were successful. But not without consequences. The grid south of the Swedish capital, Stockholm, was critically overloaded by having to supplying the extra power to Denmark.

Energinet stayed in close contact with Svenska Kraftnät for a few hours.

If they had given the signal, the control centre in Denmark was ready to disconnect consumers to avoid a potentially catastrophic outage in East Denmark and Sweden, according to Klaus Winther, Area Manager for Electricity System Operations. It actually took about two hours from when the original incident in occurred in Bjæverskov until the situation was stabilised.

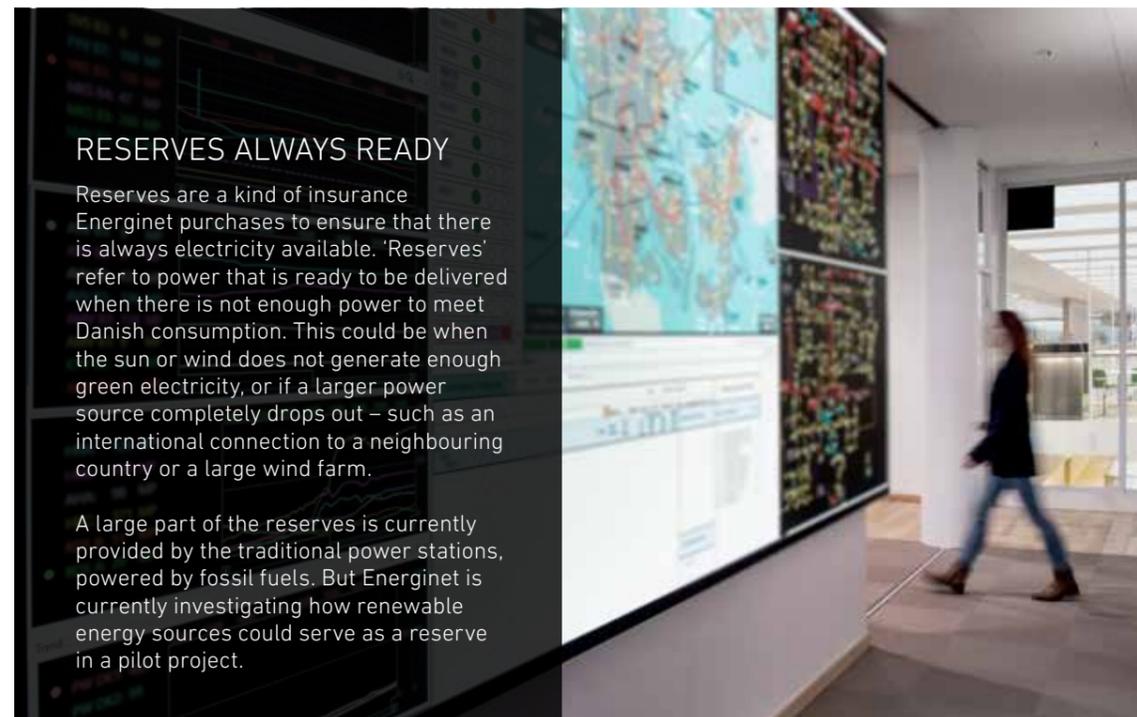
He adds that Energinet and Svenska Kraftnät reviewed the operating instructions afterwards – to learn from the incident.



WHAT IS A BROWNOUT?

When Energinet effects a brownout, it is the last tool in the control centre's toolbox to protect consumers from a complete power outage – a blackout – after all other measures have been taken. A brownout is a manual load-relieving measure. It means that a large group of Danish electricity consumers have their electricity disconnected for up to two hours, to keep the majority of electricity consumers and the grid online.

There have been no brownouts in the Danish transmission system in recent years.



RESERVES ALWAYS READY

Reserves are a kind of insurance Energinet purchases to ensure that there is always electricity available. 'Reserves' refer to power that is ready to be delivered when there is not enough power to meet Danish consumption. This could be when the sun or wind does not generate enough green electricity, or if a larger power source completely drops out – such as an international connection to a neighbouring country or a large wind farm.

A large part of the reserves is currently provided by the traditional power stations, powered by fossil fuels. But Energinet is currently investigating how renewable energy sources could serve as a reserve in a pilot project.



0.5 kW

A household averagely consumes power at a rate of 0.5 kWh (0.0005 MWh), pr. hour. On your electricity bills, this corresponds to around 4-5,000 kWh per year.

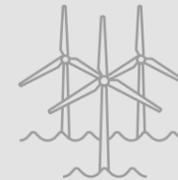
10 MW



It takes 2-3 local CHP plants to generate enough power to meet the average annual electricity consumption of 20,000 households.



400 MW



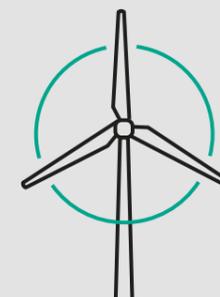
Denmark's largest offshore wind farm, Horns Rev 3, can generate enough power to meet the average electricity consumption of 400,000 households.



600 MW



The largest Danish power stations can generate enough power to meet the average electricity consumption of 1.2 million households.



1000 MW is the same as 1 GW. The total offshore wind power potential in the Danish part of the North Sea alone is 40 GW. The Danish Government and its supporting parties have decided to investigate the possibility of an energy island with 10 GW of offshore wind power.

INNOVATION AT ENERGINET

Energinet is involved in multiple research and development projects in Denmark and abroad. You can see a selection of projects below of various types, content and scope. Energinet budgeted DKK 26 million for specific strategic research and development projects in 2020.

RESEARCH INTO CABLE LAYING

Additional power lines and cables are an inevitable part of the transition to green energy and the electrification of Danish society (electric vehicles, heat pumps etc. running on green electricity). Energinet is working jointly with universities and manufacturers in the DANPAC 2020 research project to develop new cable laying technology and methods to improve the utilisation of electricity cable capacity.

DATA-DRIVEN PLANNING FOR TREE PRUNING

Energinet is developing a new way to monitor the need for tree pruning along overhead lines. In the past, staff have inspected overhead lines from the ground. This can now be done using laser technology from a drone or helicopter (LiDAR technology). In combination with intelligent imaging software, the laser can create an accurate picture of the vegetation in proximity to the overhead lines. This can then be used as a basis for Energinet's planning of pruning operations in cooperation with landowners. The first scan will be done in 2020, and Energinet expects to have completed the transition to data-driven planning for tree pruning in 2022.

LARGE SCALE OFFSHORE WIND POWER

Energinet is working with partners in Germany and the Netherlands on the North Sea Wind Power Hub, which is looking at the possibility of one or more energy islands in the North Sea. Based on investigations in July 2019, the consortium is recommending that the North Sea's wind potential towards 2030 be harvested by rolling out of a number of 10-15 GW energy islands. If Europe is to reach the targets set in the Paris agreement, annual expansion of approx. 7 GW will be required, to lay the foundation for green energy for several hundred million Europeans.

HYDROGEN IN THE GAS GRID

Energinet, the Danish Gas Technology Centre and IRD Fuel cells are jointly investigating whether and at what volumes hydrogen can be fed into the gas grid and mixed with the natural gas already flowing in it. Trials are being conducted in the gas grid near Varde, in a closed circuit between two disconnected gas stations in Helle and Agerbæk. The trials have so far shown that 12% hydrogen can be mixed in without causing operation problems. In 2020, the goal is to investigate mixing 25% hydrogen into the gas grid.

FLEXIBLE WIND TURBINES

The power cables from Lolland to Zealand are under pressure. This is because Lolland's local electricity consumption is too low to take up all the electricity from renewable energy sources produced on a windy or sunny day. In 2020, a pilot project on Lolland will test a local market for flexible RE production, where wind turbine owners and their balance responsible electricity suppliers can earn money by reducing production at times when this will benefit the grid.

GREEN GAS ROUND TRIP

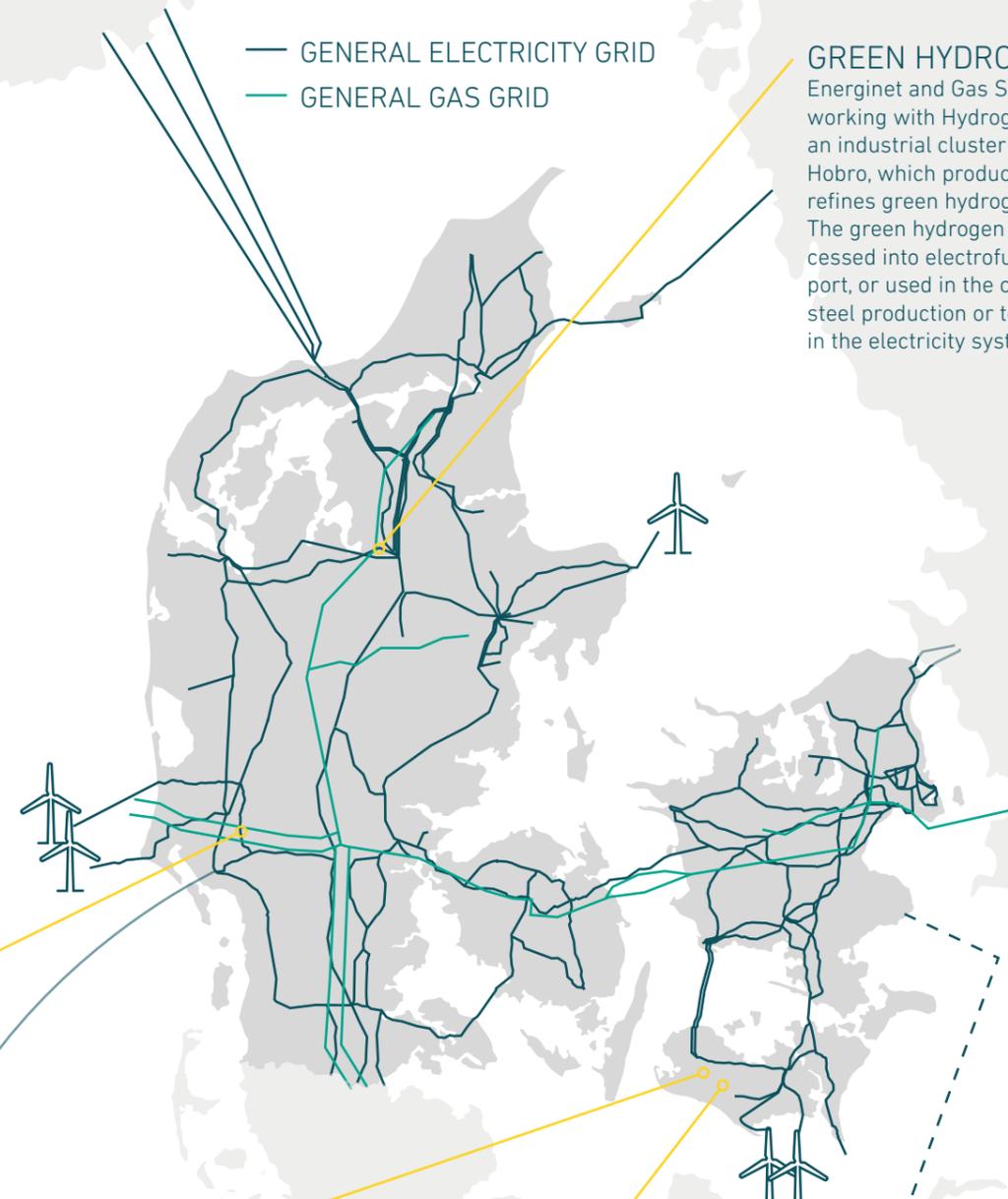
Livestock and sugar production on Lolland create large amounts of bio waste, which can be used to produce biogas. This biogas can meet a large portion of the energy consumption by industry, which is currently met by fossil fuels. Energinet will investigate during 2020 whether it is cost-effective to extend the gas grid to Lolland and Falster. This will also allow the rest of Denmark to benefit from the large volumes of locally produced biogas on Lolland and Falster, which exceed the needs of local industry. Energinet will also investigate whether future hydrogen production and transportation in the new gas pipeline could help take up the extensive RE resources on Lolland, reducing the need for extra power lines.

GREEN HYDROGEN HUB

Energinet and Gas Storage Denmark are working with Hydrogen Valley to promote an industrial cluster between Skive and Hobro, which produces, stores, uses and refines green hydrogen on a large scale. The green hydrogen can be further processed into electrofuels for heavy transport, or used in the creation of fertilizer, steel production or to help create balance in the electricity system.

— GENERAL ELECTRICITY GRID

— GENERAL GAS GRID



POLAND'S AMBASSADOR: BALTIC PIPE IS A VITAL PROJECT FOR US

In Denmark, Baltic Pipe is being criticised for digging up the countryside and extending the lifetime of a fossil energy system. In Poland, the gas pipeline is seen as vital to the country's security of supply and independence, and as a necessary stepping stone to a green future. Ambassador Henryka Moscika-Dendys understands the Danish resistance and defends Poland's need for the project.

Baltic Pipe has received criticism in Denmark, particularly from landowners and local citizen groups. How do you perceive this criticism?

I have the deepest respect for the Danish debate. It is always a difficult situation as a landowner when a gas pipeline has to pass through your land. It is completely different to discuss an abstract project on the drawing board. So I have the deepest respect for the landowners' concerns and resistance.

However, I always try to address them by explaining the importance of Baltic Pipe to Poland and the rest of Central Europe. Baltic Pipe will have a major impact on the green transition in Poland and its neighbours, and will be crucial to security of supply for the entire region. We need access to more gas if we are to help Poland and its economy transition, and Baltic Pipe will give us access to Norwegian gas via Denmark. The project is also receiving funding from the EU, and is on the list of key infrastructure projects and aligned with the EU's third energy package.

Is there also local resistance in Poland?

No, things are very different. We have not seen any protests in Poland because the Polish situation is quite different. The general view in Poland is that Poland will simply not be able to undergo a green transition without gas.

Can your compatriots understand why Baltic Pipe is being criticised in Denmark?

The people of Poland are of course concerned about the criticism of Baltic Pipe in Denmark. We are therefore trying to explain why the gas pipeline is so important. We are all – in Denmark and Poland – concerned about climate change, and the Polish energy system is currently very dependent on coal. But gas will make it possible to undergo a green transition, in an economically viable manner. Gas emits around 60% less CO₂ than coal, approx. 99% fewer polluting particles and 80% less smog. Air pollution is one of the most important issues in the public debate in Poland, and if we introduce gas into the Polish energy system on a large scale, it will mean more than just helping the global climate and reducing annual CO₂ emissions by 70 million tonnes. If we reduce coal consumption, we can also avoid 25,000 deaths each year, so Baltic Pipe is a vital project for us.

Is Baltic Pipe seen as a green project in Poland?

It is perceived as a project which makes it possible to transition the Polish energy system, while also



guaranteeing security of supply. The people of Eastern and Central Europe are very concerned about our energy security and stable supply.

Is an independent energy supply a bigger factor in the Polish debate than the green transition?

Undoubtedly. Due to our geographical location, the issue of energy supply is of far greater consequence in Poland than in Denmark. We do not have a Norwegian neighbour with hydropower who can come to our aid if it is not windy or sunny. The international connections in my region – Central Europe – do not have enough capacity to ensure that we can be supplied from foreign sources.

In the Danish debate, we sometimes hear that Baltic Pipe is not the road to a green transition because it will be used to transport natural gas. How do you respond to that?

Yes, it is a fossil fuel project, but in the future it could become greener and could be used to transport green gases. It could potentially also be used to transport CO₂ for storage. Experts have identified both of these as possibilities.

Baltic Pipe is quite a small gas pipeline. Compared to the other pipelines in the Baltic Sea (Nord Stream 1 and 2 between Russia and Germany, ed.), Baltic Pipe is 11 times smaller, but it will have a major impact on the Polish energy system and contribute strongly to its green transition.

Does Poland have a goal of becoming climate neutral?

This question is the subject of much debate in Poland right now, for example in connection with the EU's goal of climate neutrality in 2050. In relation to energy production, we are in a different position to many other EU countries because of our history. We have built up an energy system based on our own resource – coal. But like Western Europe, we have reduced the use of coal in our energy mix from 97 per cent in the early 1990s to 78 per cent in 2019. We are also investing heavily in renewable energy – primarily onshore and offshore wind power and solar cells, and the government is putting a lot of effort into modernising the energy system. However, our energy consumption is also rising rapidly. I don't feel that we are less ambitious than Denmark, but we are trying to base the transition on realism and facts. The transition will be very expensive, not only because the power grid has to be modernised. Hundreds of thousands of people are also dependent on jobs in the coal industry. But you could say we are a little more modest than you are.

In Denmark people often say: 'Poland should go straight to renewable energy – why use natural gas as a steppingstone?' Won't Baltic Pipe lead to dependence on fossil energy, making the green transition even more difficult?

Let me be clear: With the current technology and possibilities, we cannot go directly to 100 per cent green energy. Bear in mind that even in Denmark, oil, gas and coal still account for much of the energy mix. Poland has green aspirations, and wants to contribute to the fight against climate change, but we also need to be realistic:

Poland is the fifth largest economy in the EU. We have extensive industry, 38 million inhabitants, and our energy consumption is rising as we develop and our GDP grows. Gas is a vital bridge to green technologies. We need it before we can become completely green, and that is the goal for all developed countries.

TWO BENEFITS FOR DENMARK

Lower energy bills

Baltic Pipe will generate billions in revenue, leading to lower gas bills for Danish gas consumers. The biggest gas consumers (typically large enterprises) will save more than DKK 1 million per year. For ordinary households the savings will be DKK 100-125 per year.

Improved security of supply

A pipeline from Norway to Poland will provide new sources of supply to Denmark and hence better security of supply.

TWO BENEFITS FOR POLAND

Independence

Poland currently receives much of its gas from Russia, but wants greater independence from supplies from the east.

Lower CO₂ emissions

Poland is a major consumer of coal. Since natural gas emits around half as much CO₂ as coal, the project can contribute to reducing CO₂ emissions. Baltic Pipe can also support the integration of renewable energy, as gas-fired power stations work better with fluctuating energy sources such as wind and solar power.



I really appreciate what Energinet is doing to reassure the affected landowners and explain the importance of Baltic Pipe. Energinet is doing its utmost to ensure that all the work on Baltic Pipe is done in accordance with all rules and guidelines.

Ambassador Henryka Moscika-Dendys



ABOUT BALTIC PIPE

Baltic Pipe is a gas pipeline that will connect the Norwegian Europipe 2 gas pipeline in the North Sea with the Danish and Polish gas systems. The project obtained all necessary regulatory approvals in 2019 and was thus able to move on to the construction phase. The project is the joint undertaking of Energinet and GAZ-SYSTEM S.A., the Polish gas transmission company.

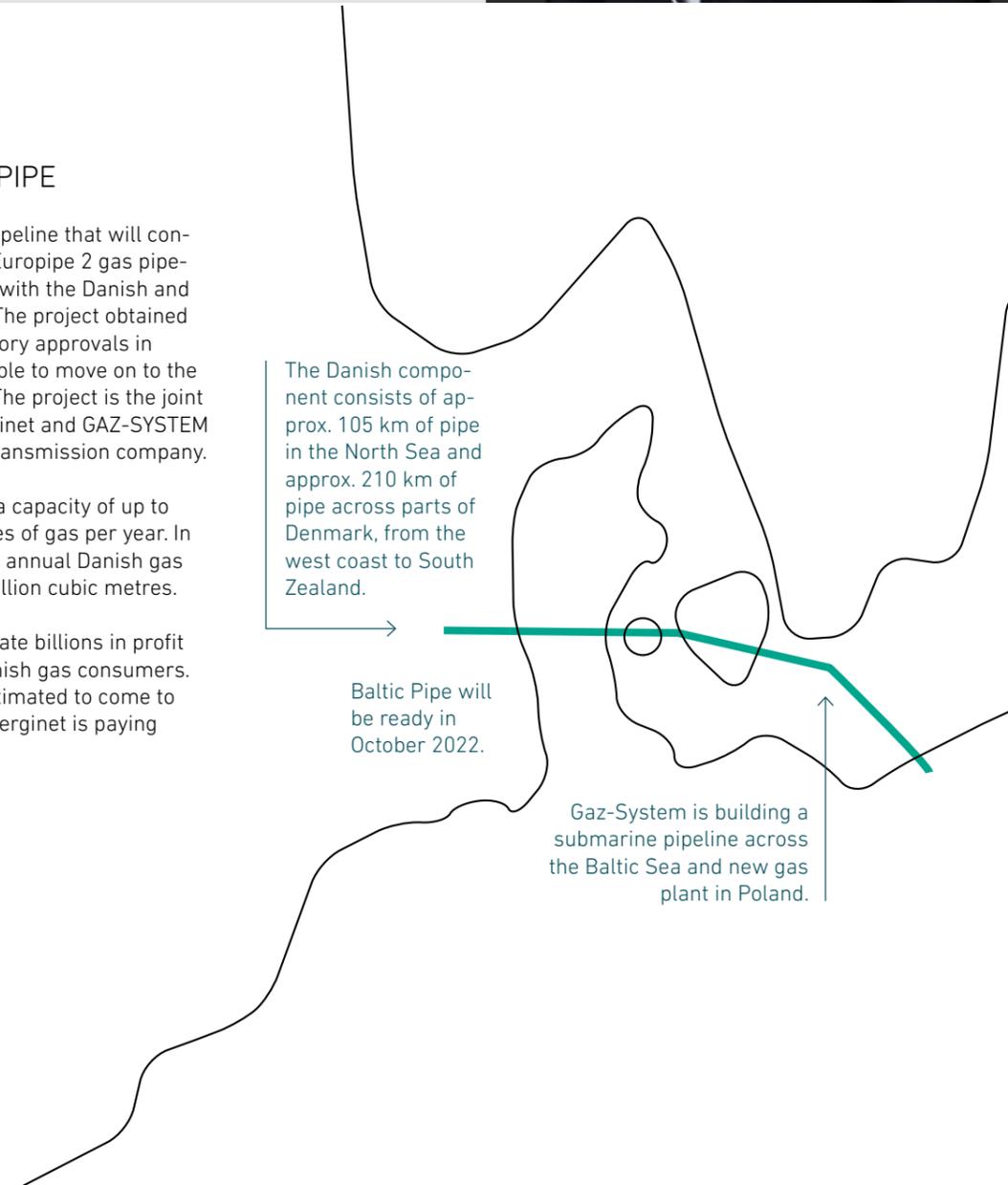
Baltic Pipe will have a capacity of up to 10 billion cubic metres of gas per year. In comparison, the total annual Danish gas consumption is 2.5 billion cubic metres.

Baltic Pipe will generate billions in profit for Denmark and Danish gas consumers. The investment is estimated to come to DKK 12-16 billion. Energinet is paying approx. half of this.

The Danish component consists of approx. 105 km of pipe in the North Sea and approx. 210 km of pipe across parts of Denmark, from the west coast to South Zealand.

Baltic Pipe will be ready in October 2022.

GAZ-SYSTEM is building a submarine pipeline across the Baltic Sea and new gas plant in Poland.



COBRA CABLE PASSES CLIMATE TEST

The 324 km long power cable from Denmark to the Netherlands was opened on 4 November 2019 after a successful four-month test period. Eco-friendly methods from the procurement phase are now showing their value in the form of major energy savings on the cable.

When Energinet buys materials and technology for its systems, producers' bids are assessed based on both the purchase price and the costs of 40 years of operation.

When purchasing the equipment for the Cobra cable, the project team formulated a specific environmental policy to give bidding producers an incentive to supply equipment with lower CO₂ emissions during operation due to smaller transmission losses etc.

At the other end of the Cobra cable, TenneT in the Netherlands was happy to agree on the criteria.

"Cobra is now in operation and we can see that the strategy worked. Transmission losses and hence CO₂ emissions from Cobra are 40 per cent lower than for the existing international connections," says Annette Ikkast, Legal Director at Energinet.

Insistence on CO₂ reductions

Energinet is refining the procurement strategy to ensure that eco-friendly production methods and low transmission losses are incorporated, leading to lower lifetime CO₂ emissions (lower Total Cost of Ownership).

"CO₂ emissions from Cobra are 40 per cent lower than for the existing international connections"

In addition to reducing the total carbon footprint in connection with procurement, Energinet is continually working to exploit heat losses from its plants using heat pumps and linked district heating systems. These solutions also reduce Energinet's total carbon footprint.



There is a huge plant inside the converter substation that converts alternating current (AC) to direct current (DC). This conversion is necessary because both the Netherlands and Denmark have alternating current flowing in their grids, but the 324 km long transfer is best achieved using direct current.

Photo: Siemens Energy

Introduction of environment policy

The Cobra cable was also a frontrunner for dialogue with producers on other environmental aspects.

"We discussed with them whether they have an environment policy for their purchases of raw materials and the like and subsequent waste collection and disposal. We also asked whether they use certified products," says Poul-Jacob Vilhelmsen, who was chief project manager on the Cobra cable for 10 years.

His experience was that it was new for producers to be asked about such matters in 2013-2015. Even though the responses were not weighted directly when the contracts were awarded, it still gave the producers an incentive to focus on eco-friendly production and installation in the future.

Dialogue with substation neighbours

The electrical connection to the Netherlands via Fanø is connected to the grid in Endrup, near Bramming. There are already a number of electrical installations here.

In dialogue with residents near the substation, Energinet made a big effort to create a building around the 6,000 square-metre converter substation that blends into the landscape as well as possible. Variegated aluminium sheets have been used to create the illusion of a forest landscape along the 21-metre-tall building, when viewed from a distance.

Virtual reality provided futuristic ribbon cut

Cobra was officially opened from here on 4 November with a ceremony and a connection to the Netherlands via Internet from the high-speed fibre cable that runs along the power cable.

Using this, Thomas Egebo, CEO of Energinet, had a virtual meeting with Manon van Beek, CEO of TenneT, on the seabed between the two countries. In a futuristic moment, wearing VR headsets, they first shook hands and then pressed the button and declared the Cobra cable open.

It has been 40 years since Denmark last opened an electricity connection to another country.

TRANSMISSION LOSSES EXPLAINED

When a cable transfers electricity from A to B, some of the electricity is lost in the process. This is called transmission losses, and the lost electricity has carbon emissions just like all other electricity. When Energinet invites tenders on a project, producers are encouraged to deliver a product with the lowest possible electricity losses and consumption, at a competitive low price.

RESIDENTS MOVE HIGH-VOLTAGE LINE

Following a number of meetings with residents and consultations, and dialogue with hundreds of landowners, Energinet's final proposal for a new 400 kV connection between Idomlund and the border now looks very different. Over half of the original proposal has been changed.

"You don't listen."

"Everything is decided in advance – it doesn't help to protest."

"As a small landowner, I can't do anything against a proposal from a large, state-owned company."

Many such comments were made after Energinet presented a preliminary proposed route for a new 400 kV interconnection between Idomlund near Holstebro and the border on 10 September 2019.

"I totally understand why people who are at risk of having electricity pylons and overhead lines in their neighbourhood or on their land say such things, because many people just want the link somewhere else," says Christian Jensen, chief project manager for the 170 km interconnection, comprising around 450 36 metre tall 37 metre wide pylons.

"But we have actually listened and been in dialogue with many many landowners, in order to jointly find the best possible location, and approx. half of the route has now been moved from the location in our original proposal. Many landowners have made very constructive suggestions, which have made the proposal for the final route better suited to local wishes and needs," he says.

Christian Jensen has stood face to face with a few thousand residents at public meetings, and he has spoken on the phone with hundreds of landowners, to answer questions and listen to their concerns.

"There are, of course, many critical voices, and that is often the lasting impression – one of criticism and resistance – that is left in the public debate. But there are actually many good conversations and constructive suggestions which contribute to changing and adapting the route proposal. We are not overly

attached to our own first proposal. We actually need lots of input from the people who know the area best in order to ensure the best possible solution. That is why we emphasised the fact that what we presented initially was a preliminary proposal, and that we wanted a lot of input from local residents," says Christian Jensen.

But even though extensive sections of Energinet's proposed route have been changed, there are still many places where it has not been possible to meet all the wishes of residents. There are conflicting interests in many places, given that everything from proximity to homes, protected natural habitats, municipal plans for new residential areas or business development, protected burial mounds, rare animal species, landscape conditions and many other factors have to be taken into account in the location of the pylons.

"In many places there is just no good, obvious location for a 36 metre tall pylon. There is the 'least bad' location, and a number of even worse alternatives. I fully understand that it is worrying and frustrating for many residents to have an electricity pylon planted in their neighbourhood – it is not something most people want to see."

In December 2019, following more than 18 months of dialogue with residents, municipalities etc., Energinet presented a final proposal for the route between Endrup and Idomlund. This was followed in March 2020 by a final proposal for the southern section from Endrup substation to the Danish-German border.

This will undergo public consultation during 2020, and the Danish Environmental Protection Agency is expected to issue an EIA permit for the project in late 2020, at which time the route will be final.



UNDERGROUND CABLES OR OVERHEAD LINES?

Technical studies have shown that it is possible to implement up to 15 per cent of the 400 kV AC connection from Holstebro to the border using underground cables. The 170-km-long proposal therefore contains 26 km of underground cable.

Underground cables behave differently to overhead lines, and 400 kV cables result in too much 'noise' in the power grid – in the worst case, components in the power grid and equipment could break down.



LINE ROUTE

- ORIGINAL PROPOSAL
- FINAL PROPOSAL

CABLE RESEARCH

Energinet is a world leader in relation to installing long sections of underground 400 kV AC cables, and we are investigating how we can bury even longer sections to reduce the impact on residents affected by new interconnections.

We are working with universities, international partners etc. DKK 23 million has been allocated to the research project.



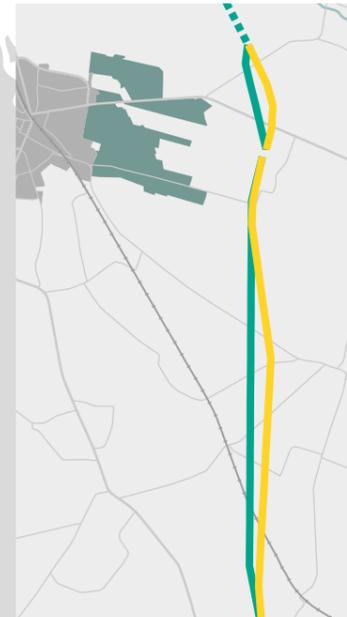
Næsbjerg east of Varde

The original proposal made the power line as short as possible, but there were a number of landowners that felt severely impacted. Since Varde municipality was willing to route the line further to the west, this was the end result. This was a relief to many, although it brought the line significantly closer for a few others.



Between Gredstedbro and Ribe

The initial proposal was that the new overhead line should follow the existing 150 kV overhead line as closely as possible. This meant that the open landscape further east would be free of technical installations, which is often what the authorities want. However, local residents wanted the power line to be placed further east, where there are fewer dwellings. Energinet acceded, resulting in less impact overall, although some homes have ended up closer to the installation than before.



Southeast of Tarm

The power line has to run to a new 400 kV substation. The initial proposal followed the existing 150 kV overhead line as closely as possible, to minimise the extra impact in the area. When a number of neighbours proposed a change, their wishes were followed as far as possible. As a result, pylons and overhead line have been moved between 150 and 300 metres. Some new landowners will be more severely affected, but overall, the solution has less impact.



DIALOGUE AROUND THE MAP

Large public infrastructure projects such as the 170 km long high-voltage interconnection have to undergo an environmental impact assessment by the authorities, and therefore also two public consultations. In addition to the official consultations, Energinet invited citizens on several occasions to come and make suggestions and give input, in order to jointly find the best and least disruptive solutions. For example, Energinet held eight dialogue meetings in September 2019, inviting residents from Tønder in the south to Holstebro in the north. At these meetings, the preliminary routing proposal was presented on long tables, and affected landowners and neighbours had the opportunity to talk about their property and local area. A lot of useful input, views and suggestions for alternative locations flowed out of these meetings.

WE NEED TO INVOLVE MORE

We need to involve more people, even though we do not always know who is affected and by what.

The green transition is leading to major changes in all parts of society, and it is also making its mark on the landscape. In ways that many residents would prefer to avoid: high-voltage pylons, overhead lines, biogas plants, etc.

“We are making great efforts to involve the world around us – from our early analyses of how the energy systems will develop, to being in close dialogue in the final stage with residents who may be impacted by electricity and gas systems. But we must also recognise that in future we need to involve even more people, at an even earlier stage,” says Torben Glar Nielsen, Technical Director at Energinet.

The changes resulting from the green transition, and especially the speed at which they are happening, require even greater understanding and acceptance from the population.

In ten years, the share of wind and solar power in the electricity system has grown from 18 to 50 per cent, but in 2030 all electricity production must be completely green. In 2014, no biogas plants had yet been connected to the grid, but now 40 plants are producing approx. 11 per cent of the gas in the pipes, and in 2023 the figure is expected to be 30 per cent. Gas plants are popping up everywhere, power stations in cities are closing down or drastically reducing their output, and new wind turbines and solar cell parks far from the consumption centres are

now generating our electricity. In addition to all this, electricity consumption is expected to double in the coming decades, so that green electricity can replace petrol, diesel, gas and oil in cars, and be used in district heating heat pumps etc.

This demands new offshore wind farms, higher capacity interconnections and perhaps completely new solutions that are not currently part of the Danish energy landscape, such as plants that can convert wind energy into hydrogen.

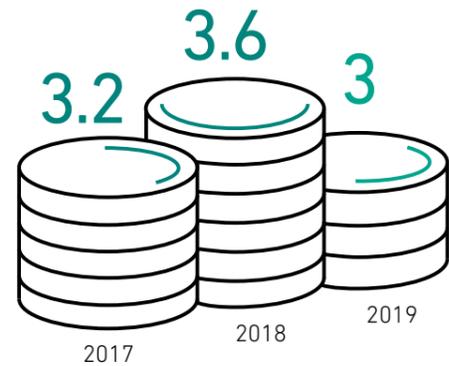
“We need to activate all parts of society to ensure that we choose the right technologies, find the right solutions and place plants in the right locations. And perhaps the solution is not even new plants, but local electricity markets in which companies can get paid for consuming electricity when it is very windy – solutions that may be cheaper than new electricity infrastructure.

We also need to involve municipalities and local communities in this work, even if we cannot always say who will be affected and what the solution will be beforehand,” says Torben Glar Nielsen.

The Folketing (Danish Parliament) also wants Energinet to involve the outside world at an earlier stage, and to see more transparency in the choice of solutions. One requirement is that in future Energinet must prepare a new long-term development plan, in which the Folketing demands earlier and broader involvement.

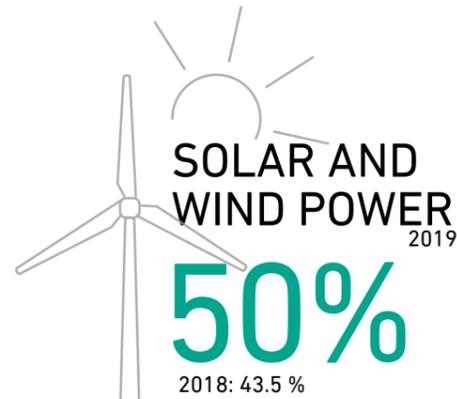
NUMBERS THAT TALK

Energinet acts in the interests of society by making large investments in the development, operation and maintenance of the public electricity and gas grids at transmission level in Denmark. These pages present a selection of the most recent figures (2019), which provide some insight into Energinet's finances and value creation for society.



FIXED ASSET INVESTMENTS (DKK billions)

Energinet is a very plant intensive company. The establishment, operation and maintenance of a modern electricity and gas grid, including international connections, requires considerable investment.



The share of energy from wind and solar power is increasing. 2019 saw a new record, with 50% of energy production from wind and solar power in relation to Danish electricity consumption.

HIGH SECURITY OF SUPPLY FOR ELECTRICITY 2019

13 sec.

In 2019, the average down time per consumer, related to the part of the electricity grid owned and operated by Energinet (the transmission grid), was 13 seconds.

CO2 REDUCTIONS IN THE ENERGY SECTOR

Energinet estimates that the energy sector will have to reduce its carbon emissions by two thirds by 2030 in order to meet the 70% goal.

Carbon emissions from the energy sector in millions of tonnes per year 31



This cannot be achieved without very extensive direct and indirect electrification, including Power-to-X and green fuels.

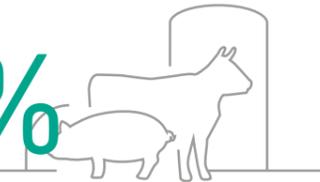
SOLAR AND WIND POWER ON MARKET TERMS



Solar panels, installed on land under commercial terms, will particularly accelerate the green transition. Energinet and the Danish Energy Agency jointly monitor all potential RE projects in which interest is reported around Denmark. The figures in the 'RE pipeline list' reveal an explosive boom

BIOGAS 2019

19%



Biogas in the gas grid accounted for 12% of Danish gas consumption in 2019, while a further 7% was made up of biogas directly used for CHP. It is estimated that biogas will be able to meet the total Danish gas consumption in 2035.

ANNUAL REVENUE for 2019 (DKK billions)

4.3

Annual revenue derives primarily from tariffs collected from energy consumers for the operation and development of the public electricity and gas grids.

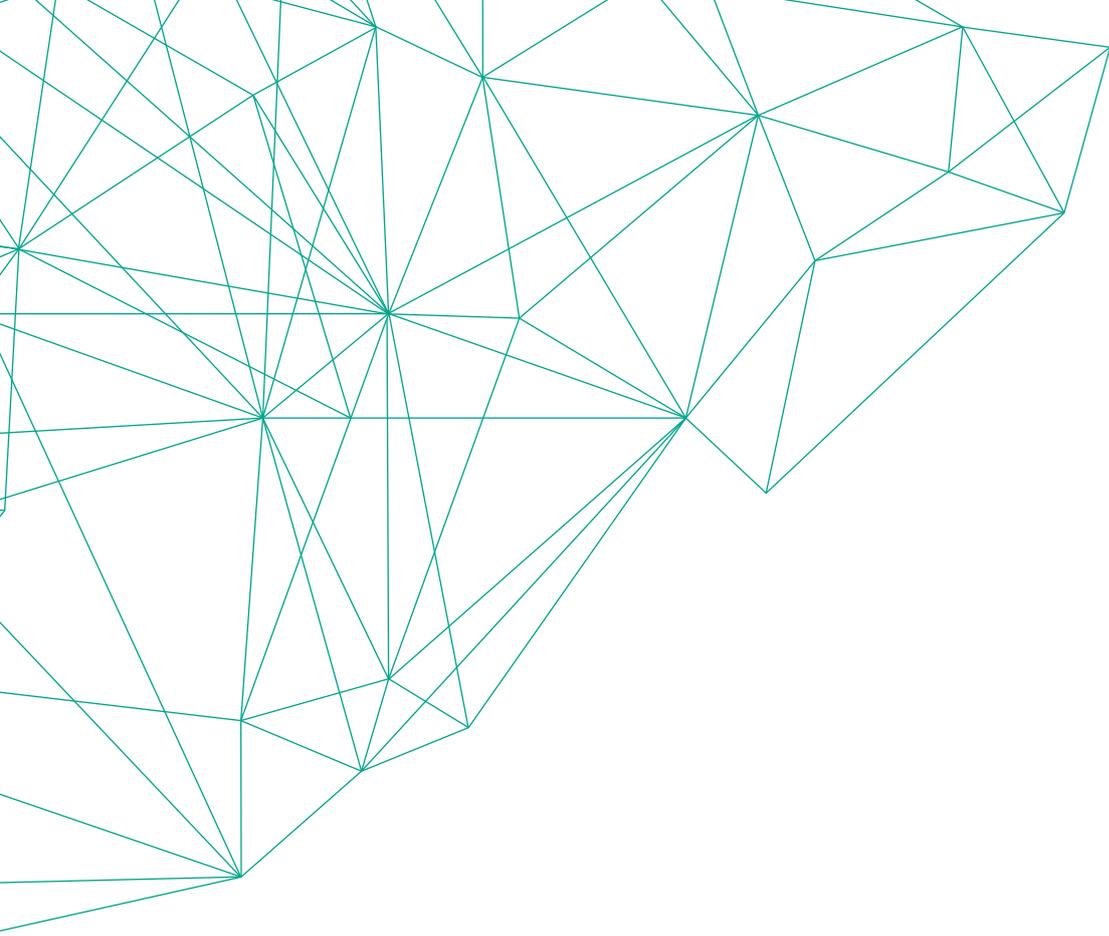
NON-PROFIT PRINCIPLE (DKK millions)



Energinet is not permitted to generate a profit. The company's profit or loss therefore cannot be read on the bottom line.

In 2019, Energinet charged consumers DKK 314 million less than the actual costs turned out to be. This relatively high shortfall was due to several unexpected breakdowns in 2019.

If the costs in a given year have been lower than the revenue, there exists a debt to consumers which Energinet repays in the following years. If the costs in a given year have been higher than the revenue, there is an amount receivable from consumers which is collected over the following years.



ENERGINET

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