

# DENMARK GREEN GREEN HUB DENMARK

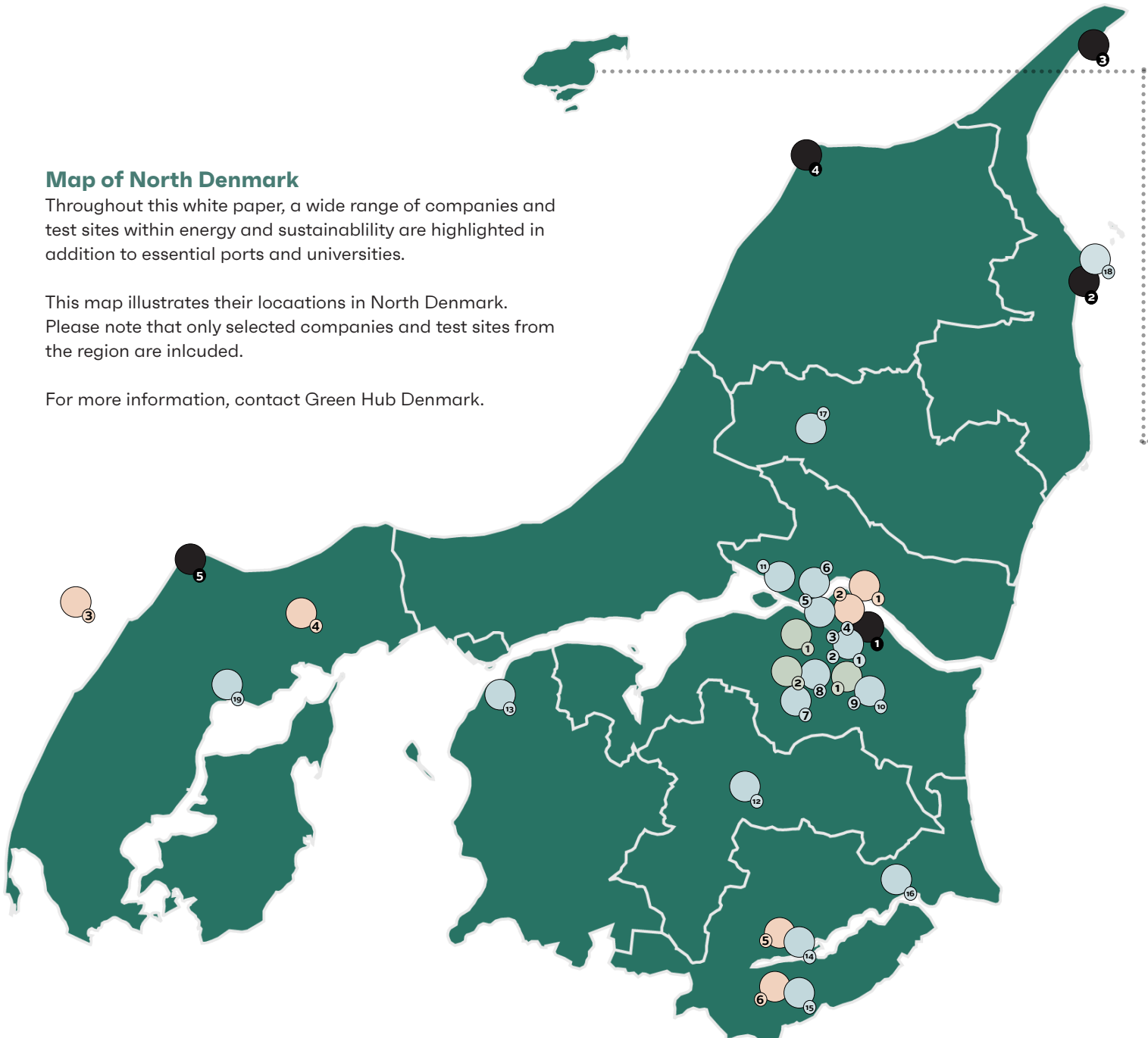
**Discover the cutting-edge skills,  
technologies, companies and  
test facilities in North Denmark**

## Map of North Denmark

Throughout this white paper, a wide range of companies and test sites within energy and sustainability are highlighted in addition to essential ports and universities.

This map illustrates their locations in North Denmark. Please note that only selected companies and test sites from the region are included.

For more information, contact Green Hub Denmark.



### Ports

1. Port of Aalborg
2. Port of Frederikshavn
3. Port of Skagen
4. Port of Hirtshals
5. Port of Hanstholm

### Universities

1. Aalborg University (AAU)
2. University College of Northern Denmark (UCN)

### Test sites

1. Nordyllandsværket
2. Blade Test Centre
3. DanWEC Test site
4. Test Centre Østerild
5. Hydrogen Valley
6. HyBalance

### Companies

1. Blue World Technologies
2. European Energy
3. Siemens Gamesa Renewable Energy
4. Bladt Industries
5. Aalborg Portland
6. Aalborg Forsyning (Utilities)
7. Liftra
8. Aalborg CSP
9. EMD International
10. Aalborg University Hospital (NAU)
11. DESMI
12. DVI Energi
13. Logstor
14. Ballard Power Systems Europe
15. Eurowind Energy
16. PowerCon
17. Brønderslev Forsyning (Utilities)
18. M.A.R.S Inc.
19. Thisted Varmeforsyning (Utilities)

## Executive Summary

Denmark has set the ambitious goal of reducing CO<sub>2</sub> emissions by 70 pct. before 2030 with the aim of reaching climate neutrality by 2050. However, the ambitions are even greater in North Denmark. Across the region there is an agreement to be completely free of fossil fuels by 2040.

In North Denmark, collaboration is key and an essential part of the region's DNA. Companies, public organizations, ports, universities, and private citizens all get involved in solving the immediate climate challenges together and create comprehensive, holistic and sustainable solutions. Commitment, dedication and accountability is powering the green transition in North Denmark, and the process and platform for collaboration is scalable. It encourages partnerships on an even larger national and international scale - and you are invited to join us.

Green Hub Denmark is a public-private collaboration platform working to push the green transition by utilizing the strong Danish ecosystem within energy and sustainability.

### The technologies

As the challenges of climate change are increasing, new technologies are emerging. Green Hub Denmark is working to embrace the new possibilities and seek sector coupling wherever possible. In North Denmark, some of the prosperous technological progresses are made within:

- > **Wind energy**
- > **Power-to-x**  
incl. **methanol fuel cells, e-methanol and hydrogen solutions**
- > **Carbon capture utilisation and storage**
- > **District heating and cooling technologies**

### The companies

The region is packed with first-mover green tech manufacturers and companies focused on energy, infrastructure and storage. The pioneering energy companies in North Denmark are raising the bar for green innovation, sector coupling and time-to-market. They are leading the way within the above-mentioned technologies and on their path proving new concepts and improving existing structures.

### The research

Behind the commercial solutions are impervious scientific research conducted at the best engineering university in Europe and one of the very best in the world, Aalborg University. The research and results made at this institution is recognized world-wide and the problem-based research model, often referred to as the Aalborg-model, is attracting students, researchers and partnerships from all over the world.

### The test sites

Making the ideas and concepts come alive can take years of planning and testing but having a wide range of large-scale test sites in the nearby area is making a significant difference for green progress in North Denmark. In fact, the region is known as a living lab for testing of all kinds of different sustainable technologies. The close connection between the companies, the university researchers and the test sites are qualifying the solutions, improving the foundation for test and demonstration and increasing the pace of the commercialization process.

### The ports

An important factor in connecting the stakeholders and creating sector couplings is the ports around North Denmark. They provide a central infrastructural element and is often a key partner for the green stakeholders in the region.

The ports are increasingly moving towards a hosting role and a facilitator of innovative business parks with unique logistic, transport and supply chain options. The ports represent the gateway to the world and to offshore installations in the nearby seas.

**We invite you to explore the remarkable green solutions and vast opportunities that are available in North Denmark.**

**Enjoy!**

## Green Hub Denmark

Green Hub Denmark is a public-private partnership and a collaboration platform for national and international stakeholders to meet and form new powerful relations and synergies.

The partnership was born to empower the green transition within new and existing companies in Denmark and attract ambitious green business to North Denmark.

Green Hub Denmark enables testing and demonstration of green solutions and execute projects within the green transition through the strong Danish tradition for collaboration between the business community, the public organizations, the research institutions and the private citizens.

### The region is a living lab

The region of North Denmark is known as a living lab for green companies. This is due to the many research and testing activities made by the universities, but also because of the dedicated companies spread all over the region who contributes to this North Danish ecosystem of green innovation and development.

The region contains several small- and large-scale test sites across the entire area where new technologies and solutions are tested and demonstrated. Large offshore and onshore territories enable further development in the region and construction of new sites and facilities.

To mention but of the existing test facilities in the region:

- > **The National Test Center for Large Wind Turbines in Østerild**
- > **Danish Wave Energy Center in Hanstholm**
- > **Blade Test Centre at the Port of Aalborg**
- > **HyBalance in Hobro is demonstrating the use of hydrogen**



HyBalance demonstrates the use of hydrogen in energy systems

## Norbis Park

In 2016, Aalborg Utilities bought Nordjyllandsværket, the local coal-fired power plant, from Vattenfall. The coal is to be replaced by other sustainable alternatives and the plan is to phase out fossil fuels completely by 2028.

In the coming years, the area around Nordjyllandsværket will be transformed into a physical large-scale test facility. The area will host facilities for research, development, testing and demonstration of new technologies within the area of climate, environment, energy, and water. We call the area Norbis Park – a contraction of N for the north, Orbis (circle) and park (gathering place). This is exactly what our ambition is to establish: A business area in the north, where we think and work circular within the green-tech area. Together and towards a sustainable future.

We are particularly interested in, how we can attract companies and sectors that have a circular vision incorporated in their business model. It is our belief that the pillars of future sustainable societies are built on partnerships and organizations uniting their knowledge to collaborate on providing new life and value to the residues, that today are referred to as waste. Our primary foci are energy production, wastewater management, drinking water supply and sustainable technologies that add value to one or more of these supply sectors.

The ambition is to create a vibrant area for world-class innovative green solutions and lead the way within future energy testing and technology. Furthermore, Nordjyllandsværket is to encourage partnerships and triple helix collaborations as new circular resource flows are tested and proven – pushing forward the green transition.



Heatcube will be installed at Nordjyllandsværket  
Visualization: Friis & Moltke Architects

## Signed contract: The first installation in the green test center

In November 2021, Aalborg Utilities signed the contract for the first installation in the green test center.

The specific unit is named Heatcube and is a thermal battery produced by Kyoto Group.

The battery can use multiple renewable energy sources to heat molten salt to over 500 degrees Celsius. The high-temperature salt is then used to produce steam or a combination of electricity and hot water for industrial use and as input to district heating systems.

The installation is expected to be ready at the end of 2022.



## Fjord PtX

**Power-to-x plant in Aalborg will produce green methanol from local waste-based CO2**

Aalborg Forsyning, Reno-Nord and Copenhagen Infrastructure Partners will build a Power-to-x plant at the area around Nordjyllandsværket.

### **The location provides access to a unique infrastructure:**

- Electricity supply - 400 kV high voltage
- Interaction with local wind power production
- Possible behind the meter-scenario

The project is set to commence in 2028 and will accommodate an electrolyses plant of between 300-400MW. The coming facility will produce hydrogen from the electrolysis plant, following which CO2 from the waste incineration plant Reno-Nord will be used to convert it to green methanol that can be used as heavy transport fuel.

### **The plant is expected to**

- recycle 180.000 tonnes of waste-based CO2 annually
- produce 130.000 tonnes of green methanol annually
- produce 130GWh of excess heat annually

## Research within green transition - Aalborg University

Research and innovation play a crucial role when combating climate change and aiming for the Danish goals to reduce greenhouse gas emissions. This applies from the first budding ideas to the development of new technology and all the way to testing and demonstration of solutions on a large scale. Research is not least important when it comes to the necessary linking of technologies and sectors.

Aalborg University (AAU) is part of Green Hub Denmark. The university is mission-driven implying that the search for knowledge always begins and ends in partnership with society at large, with real problems in mind. On a daily basis, researchers from AAU work with businesses, organisations and public sector authorities. Globally, nationally and regionally.

The research conducted at AAU is recognized worldwide with highly specialised researchers helping to solve the global climate challenges through dedicated research and innovative partnerships. In several international lists of university rankings, AAU is regarded as one of the best engineering universities in the world.

Within the scope of this White Paper, AAU has a longstanding track-record of delivering groundbreaking solutions and insights which support the national and European missions for a low emission society:

- **Power-to-x**
- **Carbon Capture Utilization and Storage (CCUS)**
- **Wind Energy**
- **District Heating**

**Aalborg University has several times been rated as Europe's very best university within engineering.**

[www.aau.dk](http://www.aau.dk)

### Power-to-x

AAU is a frontrunner in research and demonstration of Power-to-x technologies in close collaboration with industry and in national and European mission-driven partnerships. The Power-to-x research mission takes an interdisciplinary approach to the design and implementation of future sustainable energy systems.

The energy storage and grid balancing capabilities of the systems are central aspects of the research and is a key balancing technology that can be integrated with combined heat and power plants.

The common goal is to push the green transition by continuing the development and optimization of production of green fuels such as biofuel and e-methanol for heavy-duty transport and sustainable aviation fuels.

### Carbon Capture Utilization & Storage (CCUS)

The objective of the Circularity and Carbon Capture research at AAU is to create closed carbon loops by recovering sustainable carbon from materials or CO<sub>2</sub>, reusing this carbon in pristine materials and fuels to achieve neutral or even negative emission impact.

The research includes capture of CO<sub>2</sub> by photosynthesis and storage in biomass and ecosystems with subsequent biorefining of the produced biomass. Development of sustainable point source and direct air CO<sub>2</sub> capture, CO<sub>2</sub> transportation and storage technologies provide the link between emissions control and Power-to-x applications.



### Wind Energy

Research of the university aims to solve the main challenges of wind energy, lowering the cost of energy and ensuring reliability within energy production through e.g. innovative foundations, power electronics, blade technology etc.

Currently, AAU is also contributing substantially to enhancing the value of wind energy to the energy system through system integration (P2X), improving the cyber-security of wind farms and enhancing the social and environmental acceptability of wind turbines in combined efforts to de-risk the roll-out of onshore and offshore wind energy in Denmark, Europe and the world.

### District heating

AAU research has contributed significantly to the development of district heating and cooling systems. For instance, the European Commission as well as leading international industries have benefitted substantially from the contributions of state-of-the-art knowledge center, 4DH (Strategic Research Centre for 4th Generation District Heating Technologies and Systems) featuring prominent AAU researchers.

Currently, one example of challenges calling for research-based solutions is the enormous potential for integration of surplus energy from e.g. data centres in the heating and cooling systems.

**Aalborg University is particularly specialized in green energy and green transport, within which areas the university's researchers account for more than one third of all Danish research articles.**

**Almost 90 % of Aalborg University's researchers in the green research field have in recent years collaborated with a company or a public authority.**

**More than 60 pct. of the collaborations within the green area have led to innovation in a company.**



## Research within green transition - University College of Northern Denmark

University College of Northern Denmark (UCN) is an education and knowledge institution of applied sciences and provide higher education and perform research, development and innovation activities within the four main areas of business, social education, health and technology.

UCN performs research into real life challenges and has different research programmes like the area of sustainable growth. This programme carries out interdisciplinary research within new technologies and markets and how social relations and values are transformed into sustainable solutions.

UCN's research activities originate either in four primary subject areas of health, education/social studies, technology and business or in four cross-disciplinary research programmes. As a result, UCN offer a unique combination of competencies, and the tradition for cross-disciplinary collaboration across the different subject areas enables UCN to contribute with a multifaceted, practice-related angle on the societal challenges that is solved.

### Industrial Digital Transformation

Within the area of Industrial Digital Transformation the ambition is to strengthen the digitalisation of production companies with a special focus towards the small and medium-sized segment.

Within the area of Industrial Digital Transformation, UCN has defined three supporting research themes:

- Digitization of production systems
- Intelligent and sustainable product design
- Design of industrial learning and upskilling

The focus is on energy consumption and sustainability in the use of automation for green production. In addition, the programme is concerned with research in virtual prototypes, machine vision for quality control, learning factories as well as electrical drives, frequency converters and energy optimization of motors.

### Sustainable building and innovation within construction

UCN aims to equip students attending the construction engineering programmes with increased knowledge and awareness on sustainability. Research and perspectives regarding circular economy in the construction industry is introduced as well as the current barriers in the market.

### Power-to-x

UCN has created a power-to-x platform in collaboration with international institutions and public partners. The platform has a focus on the development of the different power-to-x-technologies, but is mainly concerned with the practical use, implementation and extraction.

As a part of this, the students are educated within the field of power-to-x and the concept is processed and discussed in relation to their semester projects.

## Lab facilities at University College of Northern Denmark

- Several motor control test benches
- Gas-lab
- Collaborative robots, 3D-printers and large scale laser cutter
- House-hold installation lab
- PLCs from leading manufacturers
- Machine vision systems
- Drones, VR and AR technology

## A region that experiences the highest growth rates in Denmark

A recent analysis based on the latest figures from Denmark's Statistics shows that the region of North Denmark experiences the highest growth rates when it comes to so-called green jobs in Denmark.

In addition, the figures show that the companies in the region of North Denmark are also the ones that experience the highest growth rates in turnover when looking at the years 2015-2019.

In a 2020 report from Dansk Energi, a forecast for the total number of green jobs in Denmark by 2030 is made. A stunning number of 290,000 new jobs are expected. In 2019, the share of green jobs in the region of North Denmark amounts to 12 pct. As a result, 35,000 of the new green jobs can be forecasted to be created in this region.



**9,255 green jobs**  
**19 % increase**

**3.9 bn EUR**  
**green turnover**  
**37 % increase**



## Wind Energy

Wind power is one of the most deployed and utilized forms of renewable energy in Denmark and 46 pct. of the total production of electricity derive from wind turbines in 2020. Wind energy, therefore, plays an important role regarding the flow and organization of the Danish energy system and infrastructure.

Denmark began erecting wind turbines in 1970 and is today considered to be world leading in the development and production of wind turbines and wind energy. In North Denmark, you will find a prosperous ecosystem of wind power technology, manufacturers and windy conditions.

The ecosystem in Denmark consists of more than 200 different companies, institutions, suppliers and sub-suppliers - all from blade manufacturers and makers of wind turbine foundations to test environments and energy consultants.

### Siemens Gamesa Renewable Energy

One of the key players in the region is Siemens Gamesa Renewable Energy and the blade factory situated at the Port of Aalborg. The factory employs 1,500 people and develops some of the world's largest wind turbine blades.

In september 2021, Siemens Gamesa Renewable Energy announced that they have produced the world's first reusable offshore wind turbine blades, named RecyclableBlade, in Aalborg. The development marks a milestone for the global wind energy sector.

Later in November 2021, the factory in Aalborg dispatched their new 108-metre-long giant blades for the world's largest wind turbine to Testcenter Østerild.

**The world's first reusable offshore wind turbine blades have recently been made in Aalborg.**

### Blade Test Centre (Blaest)

The most experienced blade test center in the world, Blaest is also residing at the Port of Aalborg. Blaest is the world's largest independent blade testing laboratory. Blaest has mastered static and fatigue testing of blades as well as modal analysis and as an independent company the centre is testing blades from leading manufacturers from all around the world.

To keep up with their costumers such as Siemens Gamesa and Vestas, Blaest has expanded their facilities several times to keep up with their customers' never-ending race to develop larger turbine blades which can be tested at Blaest's facilities in full scale.

### Testcenter Østerild

The national test facility for wind technology is located in Østerild, near Thisted. The facility is situated at the best wind zone in Europe - far away from any residential area and close to the shore with powerful windy conditions.

The wind turbines tested here are often offshore wind turbines as the test facility is situated only seven kilometers from the sea. When fully expanded, the test facility will produce electricity to cover 60.000-70.000 households.

### Additional companies in the wind energy sector

To mention but a few:

- > Bladt Industries A/S
- > Eurowind Energy A/S
- > Liftra ApS

## Power-to-x

Power-to-x has been defined as an obvious solution for green sector coupling with fuel for the transport industry, heat for the district heating network and energy storage.

In North Denmark, several companies and Aalborg University are developing solutions for Power-to-x. The Port of Aalborg hosts an industrial cluster for Power-to-x solutions.

### Methanol and Fuel Cells

Methanol and fuel cells have the potential to contribute significantly to overcoming classic wind power challenges by utilizing excess wind power production for Power-to-x.

This sustainable energy can be used to produce methanol known as “liquid electricity” which is easy to store and transport to a relevant location where it can be used as a sustainable fuel in the transport sector.

Especially in the heavy duty automotive and shipping traffic, the methanol fuel offers a much needed green alternative to combustion engines and diesel generators.

### Blue World Technologies

The company Blue World Technologies is a manufacturer of methanol fuel cell components and systems for the automotive and heavy-duty transportation sectors and stationary as well as APU applications around the world. The fuel cells act as a green alternative to combustion engines and diesel generators.

### European Energy

The company REintegrate, now European Energy, has developed a new decentralized production technology that offers green e-methanol identical to fossil methanol from renewable energy sources and CO<sub>2</sub> from bio-waste.

E-methanol provides the transport sector and chemical industry a convenient transition to environmentally friendly fuels and chemicals.

### Hydrogen Valley

Another possible X in Power-to-x is hydrogen. Different Power-to-x-partners has joined forces and created a hub of expertise within the development, storage and utilization of hydrogen. The hub is called, Hydrogen Valley and is home to some of the most prominent suppliers and sub-suppliers of technology and solutions for the hydrogen and Power-to-x market.

### HyBalance

Within the hydrogen hub you will find one of Europe’s first facilities to produce proton-exchange membrane (PEM) water electrolysis on an industrial scale, the Hybalance plant in Hobro.

The HyBalance plant produces 20 kg of hydrogen per hour and at the end of 2020, the plant had produced and delivered 120 tonnes of hydrogen since its commissioning in 2018.

The plant has also demonstrated its ability to accommodate the intermittency of renewable energy production thus contributing to stabilizing the Danish electricity grid.

**Within methanol fuel cells, North Denmark is making immense progress.**

**Pioneering companies in the region are right now changing the transport and automotive sector as we know it.**

### Ballard Power Systems Europe

Headquartered in Hobro, Ballard Power Systems is one of the leading players in the commercial application of fuel cell solutions, and Ballard is focused on applications in which hydrogen fuel cells have a clear advantage.

In Hobro, Ballard has their Marine Center of Excellence where some of their fuel cell modules are designed and built. The Center is dedicated to the engineering, manufacturing and service of heavy-duty fuel cell modules specifically for the marine industry. It has an annual production capacity of more than 40 MW of fuel cell modules.

### Large-scale Hydrogen Storage

The area around Hobro embraces unique opportunities for large-scale hydrogen storage as it is one of the few geological areas in Europe with depleted salt caverns. Salt caverns have been identified as a feasible and flexible solution for large-scale hydrogen storage.

The recently launched project Green Hydrogen Hub Denmark is investigating the possibilities for building one of the world's largest hydrogen-producing facilities.

**Hobro is one of the very few areas in Europe where salt caverns are available.**

## Carbon Capture Utilisation and Storage (CCUS)

North Denmark is home to a great deal of innovative stakeholders pushing the green agenda in the region. It is well positioned for the next step within CCUS as it is home to institutions and companies that have the potential to facilitate all the different stages in the CCUS value chain.

North Denmark has several heavy sources of CO<sub>2</sub> emission and one of them is the cement factory Aalborg Portland. With Aalborg Portland as a test subject, the region has an opportunity to develop, test and demonstrate large-scale solutions for carbon capture. The total potential for carbon capture from the factory is estimated at 2,3 million tonnes CO<sub>2</sub> per year.

One of the region's competitive advantages within the field of carbon capture, utilization and storage is the storage possibilities. One of them can be found in the subsoil outside Hanstholm. This area is tested for the potential of CO<sub>2</sub> storage which can be a game changer within the green transition as captured CO<sub>2</sub> can be pumped far below the seabed instead of reaching the atmosphere.

### Carbon capture (CC) at the local CHP plant in Thisted

At the waste incineration plant in Thisted, carbon capture has been tested successfully. In a project with the combined heat and power plant, Thisted Heat Supply and two innovative companies, the capture technology was tested on 1 pct. of the chimney smoke, and the parties were able to successfully capture the CO<sub>2</sub>. This may be the first step towards a full-scale power-to-x plant where the captured CO<sub>2</sub> can be utilized for different defined purposes.

## District Heating and Cooling Technologies

In Denmark more than 1.8 million households are supplied by district heating which constitute 65 pct. of all Danish households. 61 pct. of all district heating is based on green energy.

The district heating system is made up by a transmission system and therefore all kinds of heat production can be connected to the system.

North Denmark is home to many different technologies and systems related to district heating. Across the region, you will find several large electrically powered heat pumps, electric boilers, geothermal energy plants, solar heating systems, biomass systems, energy utilization of waste and use of surplus heat.

### Utilization of surplus heat

In Aalborg, surplus heat constitutes a large part of the district heating energy mix. In fact, 28 pct. of the energy made by Aalborg Utilities are in fact obtained through surplus heat from the production of Aalborg Portland.

Besides the huge contribution of Aalborg Portland, surplus heat is delivered by other companies, biogas plants and grocery stores. Utilizing the surplus heat saves many tons of CO<sub>2</sub> and surplus heat is considered to be 100 pct. renewable energy.



**In Aalborg, surplus heat constitutes a large part of the district heating energy mix.**

**In fact, 28% derive from one company.**

The cement factory Aalborg Portland delivers surplus heat to Aalborg Utilities.

### Geothermal energy in Thisted

In 1984, Thisted got the first geothermal energy plant in Denmark. The warm water is extracted below 1.3 kilometers depth by submersible pumps. The plant produces what is equivalent to an annual thermal consumption of 2,000 households.

Thisted Heat Supply is managing the daily operation at the plant including the operation of the two absorption heat pumps which transfer the heat from the geothermic water to the district heating network. The extraction of geothermal energy is considered a secure, cheap and climate-friendly concept. Based on present operational plants, this green technology has been proven and can be put into play immediately.

At the plant in Thisted, 200 cubic meters of water are being pumped per hour and the facility in Thisted can produce as much as 7 MW. In 2017 Thisted Heat Supply was granted a new 30-year license to use geothermic energy and therefore they plan to arrange for a new drilling in addition to the ones already existing. This will increase the capacity by 50 pct.



**Brønderslev is home to the world's first combined heat and power plant that converts energy to both electricity and district heating.**

The CSP plant in Brønderslev consists of 40 rows of 125m U-shaped parabolic trough mirrors.

### **Biomass and Solar Heating Plant**

Brønderslev Utilities is home to the world's first combined heat and power plant that combines concentrated solar heating (CSP) and wood chips and via an ORC facility (Organic Rankine Cycle) converts the energy to both electricity and district heating. By combining different technologies, the energy utilization is so efficient, that the plant is setting a record in energy efficiency for this type of plant in Denmark - and perhaps even worldwide.

## **District Cooling**

The Region of North Denmark and Aalborg Utilities have joined forces regarding a total district cooling solution for the new university hospital in Aalborg East (NAU).

The system is designed for a cooling capacity at 7.3 MW which matches the new hospital's current need. The 7.3 MW corresponds to the energy it takes to fast-freeze 1,900 tonnes of ice per day. Several new customers have signed contracts to be connected to the cooling solution. The capacity can be expanded to 11 MW.

The district cooling system uses a nearby lake (32 m deep) as a cold reservoir. Pumps by the lake transport the cold water from the bottom of the lake through heat exchangers and returns it to the surface of the lake. The temperature varies during the year which is why additional coolers help keeping the temperature of the coolant under the promised 12 °C.

### **Selected companies within District Heating and Cooling**

- > Aalborg CSP
- > LOGSTOR
- > DESMI
- > DVI Energi
- > EMD International

## Real Life Testing

In Green Hub Denmark the consumers play a vital role to test and demonstrate solutions in a real-life setup.

Himmerland Boligforening is a large housing association, that offers 7000 housings across the region. Himmerland Boligforening often cooperates with the universities. This way the residents are engaged in and contributes to the green transition.

### The low-temperature district heating of the future

One of the district heating solutions of the future will be tested on Fyrkildevej in Aalborg. As part of a 4-year collaboration, Himmerland Boligforening, Aalborg Forsyning and Aalborg University is participating in the project Flexible Energy Denmark. The project is created to investigate how heat management and energy consumption in buildings can affect the supply grid and how the consumption can be adjusted depending on the grid capacity.

The project works towards avoiding unnecessary expansion of the district heating system and to make the production and delivery of district heating cheaper and therefore reduce the price or maintain the heating cost for the consumer.

In the areas that can handle it, the district heating of the future will have a lower temperature than today. This will help the energy system to incorporate renewable energy and surplus energy from the industry, which typically has a lower temperature than district heating uses today. Lower temperatures do not have to be a problem, as the intelligent controls of the future are expected to ensure that homes will receive the agreed comfort, nonetheless.

In addition, temperature sensors will be installed in several homes, so that the flow temperature can be regulated according to wind conditions, sunlight as well as the building's characteristics and actual temperature in the homes.

### A tiny clock in the bath helps reduce water consumption

In collaboration with the company Aguardio, Himmerland Boligforening has launched an experiment to test whether an IoT-unit can help reduce water consumption. The test involves two comparable neighborhoods where one will have an IoT-unit installed in the bath and the other will receive information about water consumption in the mailbox. After one year, the effect is measured.

Basically, the IoT-unit is a clock that starts counting as soon as you open the water in the shower. Through a QR code, the family can track their own consumption at an online platform and thereby gain an increased understanding of the water used in the bath. All data is anonymized and only the residents themselves can see the length of their baths. The thesis is that an increased awareness will lead to a reduction in water consumption.



### Can technology improve indoor climate?

With the user in focus, the MOBISTYLE project intends to create a behavior change based on data insights. By combining data for energy, comfort and health, users are nudged to implement various tips and tricks according to the indoor climate.

MOBISTYLE was tested on Himmerland Boligforening's residents together with Aalborg University.

Several sensors was installed to register the data and provide tips on room upgrades and changes based on the resident's behavior. The comfort in homes can be improved through a better indoor climate, less air pollution and the right temperature.

A more thought through and aware behavior also leads to savings in energy and it can also lead to better mental and physical health in the daily life of the residents.

As part of the MOBISTYLE project an experiment was carried out for approx. 50 homes and was supported by questionnaires, interviews and focus groups. The end product became an app that can be used by residents.

### MOBISTYLE helped residents with:

- > 16% reduction on the energy bill
- > 21% improved indoor climate
- > 5% improved health

### Track your spending hour by hour online

In connection with the replacement of energy meters in 3,000 homes, Himmerland Boligforening and BA Technologies has developed the platform "My Consumption". The platform allows residents to remotely read their meters hour by hour and thereby track their consumption.

In general, some residents experience they consume more than they budget for and therefore have to spend extra money. These unpleasant surprises can be accommodated by the new platform which will contribute to an increased knowledge on how to reduce energy consumption in homes.

In addition, the new meters have a water leakage function, which makes the housing association aware of any leaks or other situations involving extraordinary water consumption. In the first half of the year, this function has already saved the residents up to DKK 1 million.

The residents can measure their own consumption against their neighbors and gain an insight into whether their consumption is higher than the norm.

## Ports

In North Denmark, the ports create the framework for fishing, shipping and the maritime industries. In addition, they are vital business parks and important catalysts in the business community and the business development in the region.

### Port of Aalborg

Aalborg is the largest city in North Denmark, and the port of Aalborg is Denmark's largest industrial inland port with modern multimodal logistics solutions.

Besides the cargo activities, the port focuses increasingly on the expanding business park in the surrounding area with vast expanse of land available and space for growth.

Port of Aalborg intends to grow into one of the largest business parks in Denmark, offering flexible and ideal locations for both commercial and industrial purposes.

The port is already housing a great number of innovative companies addressing the global climate challenges and developing solutions for known as well as new issues and challenges.

Port of Aalborg is world-leading within the wind power sector and has a whole ecosystem of different suppliers, sub-suppliers and test environments within wind power technology. Furthermore, a range of residing companies are shaping the future fuel and energy solutions within methanol fuel cells, solar, Power-to-x, wave energy etc.

The objective of the port is to fortify this position of strength by facilitating collaboration and create synergies through partner projects to support and attract more green business in the future.

### Port of Hanstholm

The Port of Hanstholm is one of the windiest locations in Denmark which makes it an ideal place for wind turbines and testing of wind power technology. Hanstholm is only a short distance from one of the world's largest test centres for wind turbines at Østerild. The port is also ideal for loading and unloading of large wind turbine components.

The windy weather also creates favorable conditions for testing of wave energy and close to the port entrance, you'll find DanWEC (Danish WaveEnergy Center).

**North Denmark houses large business ports in Aalborg, Frederikshavn, Skagen, Hirtshals og Hanstholm.**

### DanWEC

It is a test facility within wave energy working on the prospect of harvesting energy from the sea.

DanWEC aims to support the utilization of wave energy in Denmark, including developing, owning, renting and operating facilities for testing, demonstration and knowledge collection.

## Port of Frederikshavn

The Port of Frederikshavn aims at becoming Northern Europe's leading centre for maritime environmental and recycling operations. The ongoing expansion of the port will make it possible to accommodate even larger ships and offshore installations for scrapping which will further develop the potential for new business.

The Port of Frederikshavn is also a large ferry harbour linking the continental Europe to Scandinavia. The Port has approximately 4,500 ships arriving each year, of which 3,900 are ferries carrying 1.8 million passengers, 350,000 passenger cars.

Besides tourism, ferry traffic and the conventional maritime industries, the Port of Frederikshavn also has a dedicated strategic focus on the environmental challenges and recycling.

Stena Line, the municipality of Frederikshavn and the Port of Frederikshavn have signed a historic agreement in which the parties have committed themselves to the establishment of the first emission free ferry route between Frederikshavn and Gothenburg in Sweden. The route is the first of its kind with two fossil-free Stena Elektra ferries. The ferries will be the world's first fossil-free RoPax vessels of this size and will measure 200 metres with a capacity of approx. 3,000 metres lane length for vehicles and lorries and have a capacity of 1,000 passengers.

## Port of Skagen

The Port of Skagen is a global commercial harbour and the largest fishing port in Denmark. In 2021, the Port of Skagen and the North Danish company PowerCon established the most flexible onshore power supply in Denmark.

The new power supply installation is for larger vessels such as the pelagic fishing vessel and is designed according to the IEC 80005-3 standard.

With the ten new 350A power outlets, it is possible to supply ten different ships with various voltage levels.

When synchronizing up to four outlets, the system can deliver a maximum power of 1,400A. Through pressure-sensitive screens in the onshore power panels, the supply is easily connected and controlled by the customer. When the fishing vessels connect to the power supply instead of using the diesel engines, it will significantly reduce the noise level and improve the air quality in the area.

The initiative is part of the Port's sustainability strategy and goal of reaching climate neutrality by 2030.

## Port of Hirtshals

The Port of Hirtshals is one of Denmark's largest ferry ports with close connections to Norway and the North Atlantic. The port has a unique geographical location combined with an efficient infrastructure and a good logistic system.

The Port of Hirtshals is working on preparing the port for the future with new facilities and green developments. The port is striving to become a centre for production and utilization of renewable energy. The plan is to create a sector coupling between e.g. district heating, green power and liquid biogas (LBG). Many of the companies at the port has a large quantity of surplus heat that are unused and in the near future, this energy will make good use elsewhere.

The port wants to support the development within green fuels like hydrogen or ammonia. To accommodate the larger production and utilization of power, more wind turbines will be erected at the port.

### Recycling M.A.R.S.

At the Port of Frederikshavn, the American company M.A.R.S. has established the first purpose-built shipyard within recycling of ships, offshore platforms and installations.

The decommission is being carried out in an environmentally correct way. For instance, a membrane has been established to prevent seepage getting into the subsurface.

[www.greenhubdenmark.dk](http://www.greenhubdenmark.dk)



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