

D I Energy

DENMARK

LEADING ENERGY RESEARCH
& INNOVATION HUB



”Denmark is ranked in the top 5 of OECD country scientific publication and citation counts within the energy and environment fields.”

”Denmark achieves a genuine energy cluster cooperation between companies, commercial organizations, universities and governmental authorities.”

”Companies invest 600 million Euro a year in energy research, which represents 12 percent of all private research investment.”

📍 Find out more about Danish research programmes at **Energiforskning.dk**

INTRODUCTION

Half of Denmark’s total power consumption is to be provided by wind generation by 2020 and the Government’s vision is that all Denmark’s energy supply – electricity, heat, industry and transport – is to be covered by renewable energy by 2050. No other country in the world has set such a demanding technological challenge.

Achieving this goal will require a committed, continuous focus on energy research and innovation and international collaboration.

The Government and the private sector are bringing forward green energy technology to the marketplace, underlined by public funding of energy research, development and demonstration projects at more than 1 billion Danish crowns annually. The Government’s energy research programmes are currently supporting more than 550 Danish energy research and development projects.

I would like, with this booklet, to invite international companies, academia and authorities to tap into our Danish energy know-how, exchange ideas, solutions and new technologies with us and help shape the future of clean energy.



Martin Lidegaard, Minister of Climate, Energy and Building

WIND POWER AND OFFSHORE INDUSTRY

Denmark's position as a leader in the global wind industry is founded on more than 100 years of research in electric wind power. More than 30 percent of Denmark's electricity consumption is provided by wind power, which is to rise to 50 percent by 2020. Danish companies supply 1/4 of the world's wind turbines and components and 90 percent of the world's off-shore wind turbines. This concentration of companies and R&D operations across the wind power value chain is unparalleled anywhere else in the world. The wind industry works closely with academia and the fast growing Danish offshore industry.

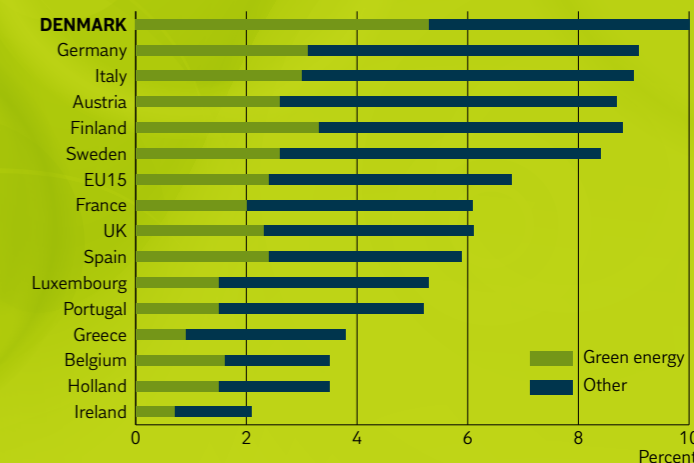


Robin Rigg Wind Farm, Scotland.
Photo by Vestas

FEATURED FACTS

- ⊕ **Megavind** is Denmark's national (public-private) partnership for wind energy, and acts as a catalyst and initiator of an enhanced strategic agenda for research, development, and demonstration (RD&D).
- ⊕ **Offshoreenergy.dk** is the official national competence and innovation centre for the Danish offshore industry. Focus areas are oil & gas, offshore wind, the offshore maritime area and wave energy.
- ⊕ **Lindoe Offshore Renewables Center (LORC)** is a leading centre for knowledge, innovation, testing, and demonstration of green offshore technology.
- ⊕ **DTU Wind Energy** is a world class RD&D environment covering all areas of wind energy, such as the testing of turbines of up to 250 meters at The National Test Centre for Large Wind Turbines at Oesterild.
- ⊕ The Danish wind industry consists of more than 350 companies and employs 28,000 people.

The share of energy technology out of total danish exports, 2012



The share of Danish exports of energy technology are 10 percent of the total exports. This is the highest share among all the EU countries. 53 percent of the Danish energy technology is green. No other EU-countries are above 50 pct. Source: Eurostat

SMART GRID

The Danish smart grid sector has, through continuous innovation and growth, established a strong international reputation for Danish intelligent energy technology and know-how.

Denmark is home to the most advanced electricity grid in Europe. The national grid's more than 60 smart grid companies provide state-of-the-art advice and products within energy management systems, power transmission, power distribution and power electronics.

22 percent of all intelligent power grid projects in the EU are carried out in Denmark, at the Danish Island of Bornholm's full scale smart grid test site. The island's smart grid, which provides power to 28,000 inhabitants, is an essential part of the EU EcoGrid project.

- ③ Leading Danish research institutions, including Aalborg University and The Technical University of Denmark (DTU PowerlabDK) provide excellent opportunities for R&D collaboration.
- ③ **Smart City Kalundborg** is a full scale test site and open data platform for service providers, developers and researchers etc. within smart grid.
- ③ A full mapping of the Danish smart grid sector is available at: CphCleantech.com/publications
- ③ The project eu-ecogrid.net on Bornholm includes 2000 homes with Smart Appliances for demand response
- ③ Denmark is part of the Nordpoolspot.com, one of the most liquid electricity markets of the world
- ③ Denmark also frontiers flexible system integration of various energy sources, e.g. Centre for Smart Energy Solutions

FEATURED FACTS

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- ③ Danish combined heat and power plants have fuel efficiencies of up to 90 percent
- ③ Denmark is experiencing strong growth in the export of district heating and cooling technologies
- ③ **4DH** (4dh.dk) is an international research center for the development of 4th Generation District Heating Technologies and Systems (4GDH)
- ③ **The District Energy Partnership** under the Danish Energy Industries Federation, works to inspire authorities in other countries to develop legislation, ownership structures, and business models that will allow district heating to contribute to national and local green goals. districtenergypartnership.com
- ③ **The Danish Energy Agency** provides facts on heat supply in Denmark

DISTRICT HEATING AND COOLING

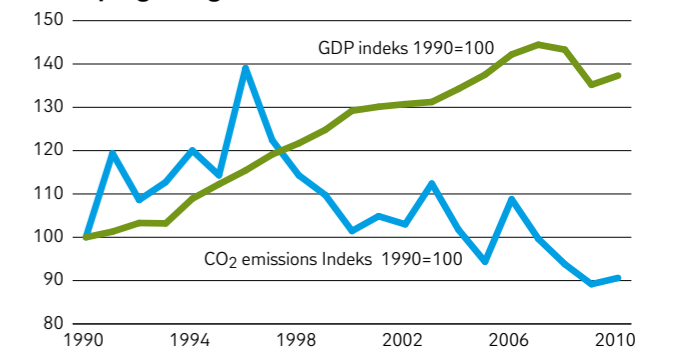
Denmark has one of the highest levels of district heating use. Today, 63 percent of Danish homes are connected to clean and efficient district heating systems. Heat is derived from many different sources including waste incineration, combined heat and power production, surplus heat from industrial processes and a variety of renewable sources such as geothermal energy, solar, waste and biomass.

More than 98 percent of homes in the City of Copenhagen are connected to district heating.

Absorption cooling from power plants and free cooling from cold sea-water is also used to provide cooling.

Denmark's district heating and cooling expertise has become highly sought after around the world.

Decoupling GDP growth from emissions of CO₂



District Heating in Denmark are one of the main contributors to the decreasing emissions of CO₂. Source: Statistics Denmark

GREEN MOBILITY

Electric Vehicles

Denmark is the first country in the world to establish a nationwide vehicle charging infrastructure, which furthermore includes quick charge and common charging stations. Denmark has a wide range of EV test and demonstration sites and 76 EV projects are currently running in Denmark. EVs are backed by favourable framework conditions and large public funding of EV market activities, testing and demonstration.

Sustainable biofuels

Danish research is also at the forefront of sustainable biofuel development, which includes a number of competitive biofuel production technologies for both bioethanol and biodiesel, including full scale demonstration and production plants. Denmark has built a number of strong clusters around biotechnology.



FEATURED FACTS

- ➔ **NEVIC** is a leading European test facility for EV charging and interoperability solutions.
- ➔ **CLEVER** is the leading Danish electric mobility operator (EMO)
- ➔ **DAKAbiodiesel** is a 2G biodiesel plant producing 55 million litres of 2G biodiesel annually
- ➔ **Inbicon** is a 2G bioethanol plant with a proven production concept. Operated by DONG Energy.
- ➔ **Maabjerg Energy Concept** is a Danish consortium building a large scale 2G bioethanol plant and a waste treatment plant in Maabjerg, Denmark. It will produce annually 73 million litres of bioethanol, about 99 million m³ of biogas (of which 47 million m³ will be upgraded to natural gas) and district heating for 20,000 households.
- ➔ **Cluster Biofuels Denmark** is a biotechnology cluster initiative promoting bio-refinery projects.
- ➔ **DI Bioenergy** is the voice of the Danish bioindustry and promotes Denmark's position throughout the value chain, from sustainable use of biomass to bio-based products. bioenergy.di.dk

HYDROGEN AND FUEL CELLS

In the last 20 years, Denmark has become one of the most important centres of hydrogen and fuel cell research and development. Denmark has proven to be a crucial player in the implementation of these technologies via system integration and demonstration projects. Efficient cooperation between researchers, the industry and state funded programs is ensured by The Danish Partnership for Hydrogen and Fuel Cells, which also forms a platform for international cooperation between Denmark and other countries.

- ③ **Haldor Topsoe** is a world leading Danish company within fuel cells and heterogeneous catalysis.
- ③ **Dantherm Power** has developed a Micro Combined Heat and Power unit that can easily meet a family's consumption of power and heat or be used for various industrial purposes.
- ③ **The Danish Partnership for Hydrogen and Fuel Cells** can be contacted on: hydrogennet.dk
- ③ **Dansk Mikrokraftvarme:** A full scale project where hydrogen from an electrolysis plant, powered by wind, is sent via pipelines to fuel cells in each home in the Village of Vestenskov, producing green electricity and heating for the families.
- ③ **Infrastructure for Hydrogen:** In 2013 a new hydrogen fueling station produced by H2 Logic A/S opened in Copenhagen and 15 fuel cell electric vehicles from Hyundai were delivered to Copenhagen. More than 10 hydrogen refueling stations are planned to be installed in Denmark in 2015. The driving range of these cars is more than 550 km and refueling takes 3 minutes.

FEATURED FACTS

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- ③ **The Avedøre Power Station 2** is the world's largest biomass fired boiler. It will be 100 per cent wood pellet fired. It has a capacity of 585 MW electricity and 570 MW heat.
- ③ Several Danish power plants co-fire straw (10–15 percent) with coal.
- ③ A gasifier from Pyroneer uses straw in thermal gasification, there by reducing coal usage at Asnaes Power Station
- ③ **Amager Bakke Waste-to-Energy Plant** is a state of the art waste treatment plant in Copenhagen that will set new standards for environmental performance, energy production and waste treatment.
- ③ **REnescience** is a pilot project that uses enzymes to separate city waste and produce biofuels.
- ③ A full mapping of the Danish waste sector is available at: CphCleantech.com/publications
- ③ **Danish Waste Association** represents 21 of the 26 Danish Waste-to-Energy installations

BIOENERGY AND WASTE

Denmark has been using biomass to produce energy for many years. Biomass accounts for more than 10 percent of total energy consumption, and agricultural residue, straw, wood chip and city waste account for 70 percent of the biomass used in Denmark. Denmark is an industry hub and testing ground for modern energy technologies based on biomass, biofuels, and biogas.

Denmark has developed the most efficient waste management system in Europe, waste being first and foremost recycled, remaining fractions being burnt in incinerators to produce district heating and electricity. Only waste that cannot be recycled or incinerated is dumped at landfill sites.

Amager Bakke under construction in Copenhagen, designed by BIG. Illustration by BIG



SOLAR

Danish photovoltaic technology and solar thermal energy systems provide reliable and cost-efficient electricity and heat generation. These systems have been successfully utilized in both commercial and residential buildings. Solar thermal energy is also used at a larger scale, providing 15–18 percent of the heat supplied by more than 30 CHP units. Denmark has an impressive track record within innovative solar district heating development. An number of plants have already been installed and there are plans for a number of new large plants of between 40,000–70,000 m² of solar panels.



FEATURED FACTS

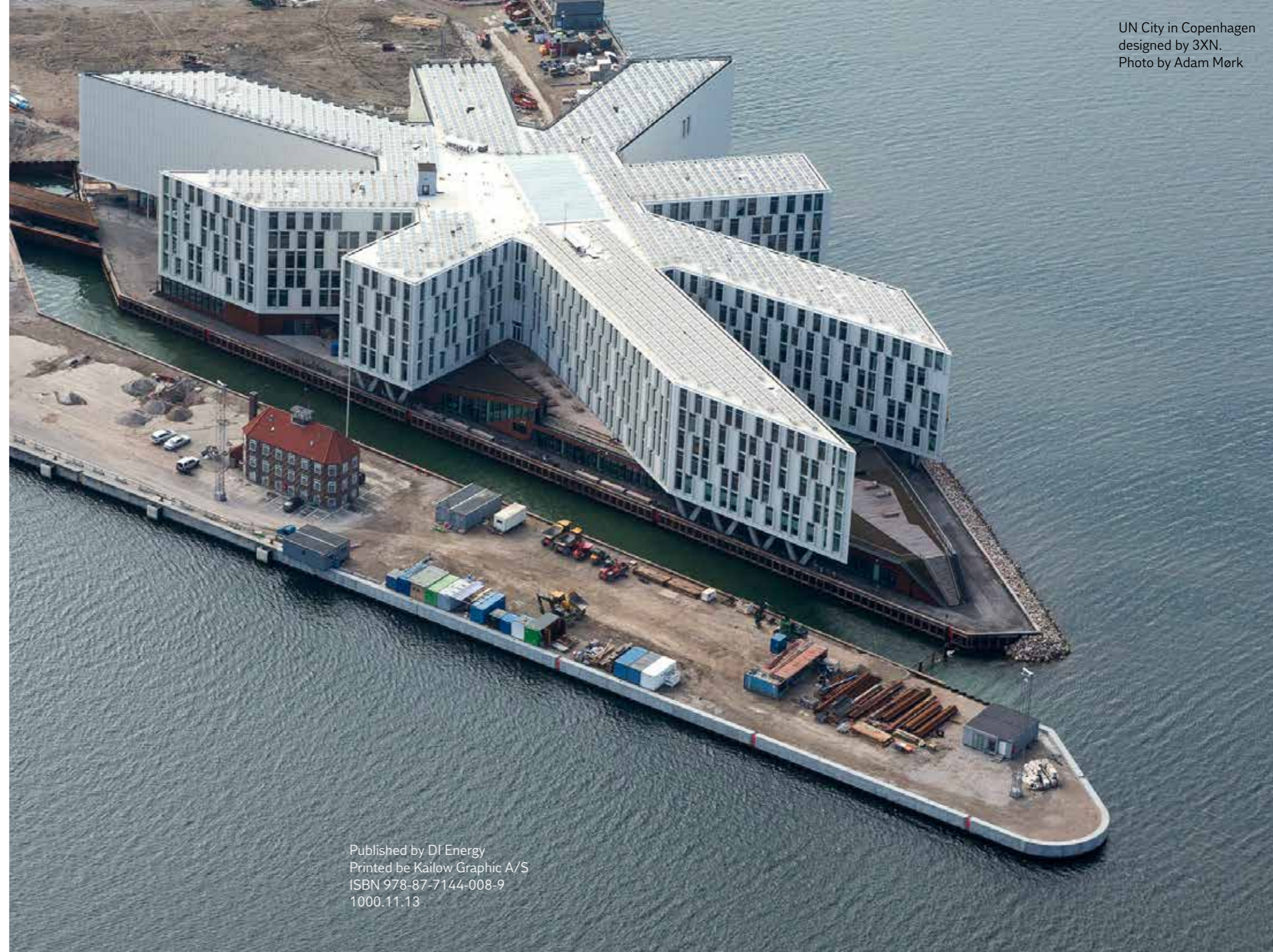
- ④ The world's largest solar panel district heating plant in the Village of Gram in Denmark will be based on 41,000 m² of solar panels that heat water which will be stored in a large reservoir tank for use in winter.
- ④ **DTU Energy Conversion:** The Characterization Laboratory for Organic Photovoltaics (CLOP) offers world class research within organic photovoltaic (OPV) polymers to be used for polymer solar cells.
- ④ **Ramboll** is a leading Danish consultant on solar heating plants and draws upon a strong track record.
- ④ **Danfoss Solar** Inverters produce and export solar inverters with an efficiency rate of 97 percent.
- ④ **The Danish Solar Cell Association** is a professional organization for all Danish solar cell stakeholders

ENERGY EFFICIENCY, BUILDINGS AND LIGHTING

Denmark ranks as one of the most energy-efficient countries in the EU and the OECD, not least because many Danish companies have optimised their industrial processes, facilities and equipment. Energy-efficient solutions that can save more than 50 percent energy have furthermore been widely implemented in newly built and refurbished housing, offices and public institutions. Research is also being carried out in several areas such as facades, insulation materials, ventilation systems, heat regulation, refrigeration and intelligent lighting solutions.

FEATURED FACTS

- ③ **Danish Outdoor Lighting Lab (DOLL)** is a Green Lab specialized in energy efficient outdoor lighting solutions based on LED, solar cells, wind turbines and storage in urban space.
- ③ **The UN City** is one of Denmark's most energy efficient buildings with an annual energy consumption of less than 50 kWh per m². The UN City is registered with the LEED® sustainability ratings system.
- ③ A Danish research project has developed LED products that can provide soft light similar to incandescent bulbs.
- ③ **Lean Energy:** leanenergy.dk is a Danish cluster with a focus on energy-efficiency technologies and solutions.



UN City in Copenhagen
designed by 3XN.
Photo by Adam Mørk

ENERGY IN DENMARK

- ➔ No. 1 in the world for wind power, providing more than 30 percent of electricity consumption
- ➔ Excellent collaborative business environment and exemplary public-private partnerships between companies, universities and public administration
- ➔ World class research and test facilities for energy solutions and excellent test market conditions.
- ➔ Since 1980, GDP has grown by 78 percent while adjusted energy consumption has grown by just 7.4 percent
- ➔ Renewable energy accounts for 23.6 percent of final energy consumption
- ➔ Renewable energy accounts for 40.7 percent of total electricity consumption



Vækstforum
Hovedstaden



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Contact us. We will help you gain an overview of who's who in the Danish energy sector and help you network with players across value chains, projects and competencies.

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MORE INFORMATION

State of Green: Overview of all green solutions in Denmark.
stateofgreen.com

DI Energy
energi.di.dk

Energiforskning.dk: Overview of Danish research programmes.
energiforskning.dk

Cleantech Cluster: Overview of cleantech in Copenhagen.
cphcleantech.com

Lean Energy Cluster: working with energy efficient technologies and solutions.
leanenergy.dk

Cleantechfacilitator.com: Overview of test and demonstration facilities in Denmark.
cleantechfacilitator.com