

Green Urban Denmark

Low Carbon & New Energy Cities in Denmark

Copenhagen
Aarhus
Sonderborg

MINISTRY OF
HOUSING, URBAN
AND RURAL AFFAIRS



DANISH
ENERGY
AGENCY

Foreword: Cities and Regions - Key Players in realizing Green Urbanization

Denmark has a long tradition of active energy policy, initiated by the first oil crisis in 1973. Over the years, numerous actions have been taken on the basis of a broad consensus in the Danish Parliament - both in order to reduce the energy consumption and in order to increase the share of renewable energy.

Cities, in particular, play an important part as role models for sustainable green urban development. More than half of the world's population now lives in cities that are responsible for 75% of global CO₂ emissions.

In this booklet three Danish cities at the forefront of implementing sustainable urban solutions present their approach to green urbanization and new energy solutions: The two largest cities in Denmark, the City of Copenhagen and the City of Aarhus, have both set ambitious goals to become CO₂ neutral by 2025 and 2030 respectively. Last, but not least, the southern city of Sønderborg, through its Project Zero has a goal of making Sønderborg CO₂-neutral by 2029 and develop a green growth area in a region with a competitive commercial sector.

The results of an active Danish climate and energy policy to drive the green transition since the 1970s have been significant: The Danish experience demonstrates that through persistent and active energy policy focused on enhanced energy efficiency in buildings, in district heating systems, and in industry coupled with an ambitious use of renewables, it is possible to sustain high economic

growth and at the same time reduce fossil-fuel dependency. Since 1980, the post-industrial Danish economy has grown considerably while energy consumption has remained more or less constant and CO₂ emissions have been reduced.

In terms of production, Denmark is one of the most efficient users of energy compared with the other EU Member States and OECD countries. For the Kyoto period 2008-12, Denmark has committed itself to an ambitious greenhouse gas reduction target of 21% - this target has been met. For the year 2020, the Danish Government has set a target of reducing greenhouse gas emissions by 40% compared to 1990.

Now, the cornerstones for the Danish energy future have also been laid. The Danish Government has set the long-term goal to abandon fossil fuels by 2050. We are already on the right track: renewables now cover more than 40% of the Danish electricity consumption. Through expanded offshore wind production and use of biomass, it is expected that renewables will cover almost 70% of Danish electricity production in 2020.

China too has taken important steps towards a green transition of its economy setting new and binding goals for a gradual de-carbonization of the Chinese economy. The modernization of the entire Chinese society during these years is without historic precedent and presents enormous challenges e.g. in the field of promoting a green urbanization.



As in Denmark a lot of the work towards realizing the green transition rests on the shoulders of policy makers at the regional and local level in China.

This is not only a major challenge but also opens up numerous possibilities for international cooperation in the decades ahead at all levels of government including the knowledge sharing of our achievements in pushing towards new frontiers in terms of green solutions in our cities.

We all share a responsibility for our own and coming generations to secure a better climate, a greener growth path and a more secure energy system. It is our hope that this booklet will serve as a source of inspiration for decision makers in China at all levels of government as well as in the private sector aiming to reduce dependency of fossil fuels and combat climate change.



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For more on the Danish Energy Agency please visit:

<http://www.ens.dk/en/policy/danish-chinese-cooperation-climate-energy-buildings>

For more on the Ministry of Housing, Urban and Rural Affairs please visit: <http://www.mbbi.dk/english>

Front page photo: 8House by Bjarke Ingels Group located in Copenhagen.

Back page photo: The Iceberg residential complex by CEBRA located in Aarhus

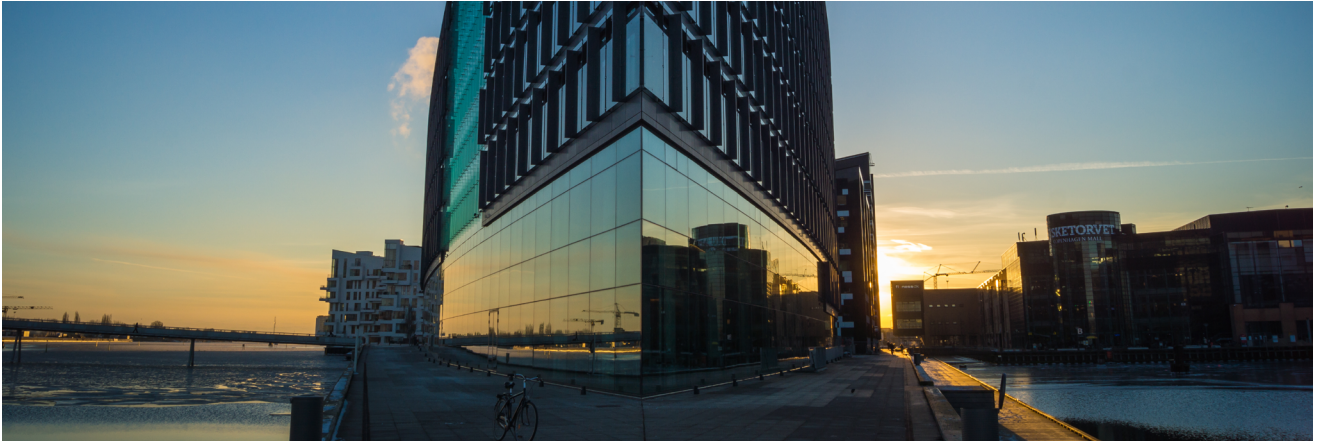


An aerial, top-down view of a modern dormitory building. The building's structure is a complex grid of concrete beams and glass railings. The railings are made of a white metal frame with glass panels. The floor is a light-colored concrete. The walls are also concrete, and the doors are painted in various bright colors: red, orange, yellow, and purple. The overall design is clean, industrial, and functional. The text "Green Urban Denmark" is overlaid on the image in a black, sans-serif font, with the word "Urban" in a green color.

Green Urban Denmark

Grundfos Dormitory student housing by CEBRA, the dormitory works on implementation of advanced energy technological solutions aiming to reduce the behaviour related consumption of energy to a minimum.

1. The Danish Case: Achieving a 100% Green Energy Nation by 2050 - the key role of cities, regions and municipalities



Danish Energy Policy aims at 100% Renewables in Energy and Transport by 2050

Denmark has already largely achieved the decoupling of economic growth and growth in greenhouse gas emissions. By striving towards a green energy transition since the late 1970s taking advantage of continuous improvements in energy efficiency, expansion of district heating networks, increased supply from Combined Heat and Power and the deployment of ever greater shares of renewable energy in our energy system, Denmark has managed to both reduce and green the nation's energy consumption while the economy has grown by almost 80% over the course of the last 30 years.

The next step is to realize the long-term vision of making Denmark's energy supply in the energy and transport sectors 100% fuelled by renewable energy sources by 2050. Achieving this goal requires not only long-term national policy to set the general direction and policy framework but also the active and creative cooperation at the regional and

local levels from cities and citizens to implement policy and find and test the new concrete green solutions.

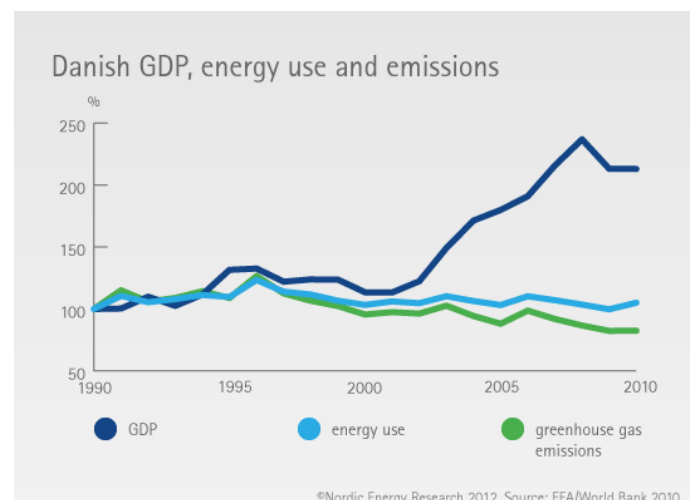


Figure 1: Danish GDP, energy use and emissions. Source: EEA/World Bank 2010

An ambitious Energy Agreement for 2020 – a Key Stepping Stone towards 2050

In March 2012, a new energy policy agreement was negotiated and supported by a large majority among the Danish political parties in the Danish parliament. The agree-

ment contains a wide range of key goals and specific initiatives that will bring Denmark a good step closer to the target of 100% renewable energy in the energy and transport sectors by 2050.

The agreement covers the period 2012 – 2020. By 2020, the agreement aims at the following key results:

- To achieve more than 35% renewable energy in final energy consumption
- To have app. 50% of electricity consumption supplied by wind power
- A 7.6% reduction in gross energy consumption compared to 2010
- A 34% reduction in greenhouse gas emissions compared to 1990.

Danish cities, municipalities and regions lead the way

Denmark's long-term commitment to creating a green sustainable society is historically grounded in an early green vision which is closely linked to our decentralized governance system. Denmark's decentralized governance system was, and still is, a vital factor in our green transition. Danish municipalities hold a lot of independent governance.

As an example, utility companies are often owned by the municipalities and the local governance levels are to a large extent responsible for the detailed implementation of national policies through regional and municipal plans for urban and industrial development, district heat planning, location of power plants etc. The local governance level also plays a key role in enforcement e.g. of Danish building codes. In that respect it is worth mentioning that the country's first urban planning legislation dates all the way back to 1925.

Another key feature in the Danish decentralized governance model is the long tradition of involving many different stakeholders in the decision and planning process regarding urban development. The Urban Renewal Act (2005) is a good example. Municipalities can apply for state funds for urban renewal projects in worn down neighbourhoods and modern urban areas with social challenges.

A precondition for being granted funds is that local stakeholders, i.e. citizens, companies and organizations, are involved in the planning and implementation of the projects. By including these private and civic competences early on a sense of shared responsibility and ownership can be instilled which ensures a continuous development that exceeds the project period.

The Smart City Network

The Danish Ministry of Housing, Urban and Rural Affairs has established a Smart City Network together with the University of Aarhus. The network links a wide range of national and municipal stakeholders with scientific institutions in the common pursuit of developing solutions and best practices. In the network's vision, the Danish decentralized governance system is considered key for triggering the potential in data and Information and Communication Technology into liveable smart cities via the following pillars:

- Political leadership, holistic organization and civic engagement
- Welfare technology and social innovation
- Early citizen engagement at macro level
- Business innovation
- Community-planning and co-creation
- Sustainable communities through real-time information and resource sharing
- Accessible data streams



By applying this holistic approach to Smart City governance, Denmark can deliver powerful solutions in a global context.

The digital infrastructure of Danish society will become even more developed in the years to come, as the government in cooperation with the regions and municipalities are working strategically on the digitalization of Danish society. As an example, the Good Basic Data policy aims at giving everyone access to geo data, address data, real property data etc.

This will not only improve further digital communication between the citizens, private companies and public authorities, it will also strengthen communication between the many databases, company systems and smart devices which contain valuable information about Danish society.

Equally important, Danish citizens are ready to become active players in the smart transition. Among the most frequent users of the internet, smart phones and social networks in the entire EU, the Danish citizens are the foundation of a well-connected smart society. The digitization and growing interconnectedness across urban communities is essential in realizing the next step in energy efficient urbanization and the development of distributed green power generation in advanced Smart Grid solutions where cities gradually become energy engines in themselves.

The Danish National Energy Policy Approach

The Danish approach to achieve the green energy transition may be described in one word: Holistic. There is broad political agreement that the green transition should be as cost effective as possible. Therefore, no

stone in the energy system widely conceived can be left unturned. Using scenarios of the entire energy system as a guiding policy instrument all sectors of the economy and all policy instruments are analysed to find the optimum combination of policies and sector contributions as is politically feasible in view of the multitude of considerations including the global marketplace, social considerations, and agreements forged at international and the level of the European Union.

Key policy instruments used to achieve steady improvements in energy efficiency and the deployment of renewable energy in the Danish case has been planning, outright regulation and financial incentives.

Regulation in the building sector: Building codes and decentralized green urban building zones

In Denmark as in most OECD-countries up to 40% of the total energy consumption is consumed in buildings. To save energy in buildings there has been energy requirements for new Danish buildings since 1961. The energy performance of new buildings is regulated in the Danish building code. The energy performance covers energy for heating, cooling, ventilation, domestic hot water and lighting.

The energy requirements have been tightened several times since 1961. Today, the heat demand of new buildings is only about 25% of what it was before 1977.

Before the first oil crisis in 1973, nearly all Danish energy consumption in general and in buildings in particular was based on oil. This implied that due to the cold Danish climate and long heating season when the oil price increased dramatically in late 1973, heating of buildings became prohibitively expensive.

To ensure that new buildings would have high levels of energy efficiency the energy requirements for new buildings were tightened in 1977 and in 1978 government subsidies for energy improvements to existing buildings were introduced to kick-start energy retrofitting. These subsidies were phased-out in 1984.

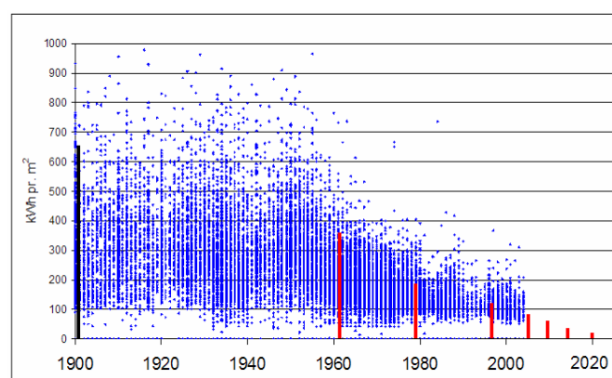
The most recent building code has a mandatory 2011 energy usage for new buildings but it also stipulates future stricter requirements for new buildings that will enter into law as of 2015 and from 2020. By 2020 the energy performance of new buildings will quite strict: New buildings must be “nearly zero” buildings and their energy needs covered primarily by renewable energy sources or district heating.

The Energy Agreement of 2012 also contains a number of initiatives aimed at reducing the energy consumption of existing buildings, including government subsidies for investments in energy conservation, an energy savings package for rented housing, and a new strategy for energy retrofitting of existing buildings.

Municipalities in Denmark also have legal tools to promote green urbanization within the framework of the building codes. For instance, municipalities are free to outline special “green building zones” where the stricter but voluntary future building codes must apply. This has proved an efficient instrument which has allowed some neighbourhoods to become veritable “green urban labs”.

These measures in the Danish building code have resulted in decreasing net heat demand for space heating, measured per square meter of heated floor area. Figure 2 shows the

development in net heat demand for space heating per square meter of heated area.



Kilde: SBI 2004 og Erhvervs- og Byggestyrelsen 2008

Figure 2. Danish energy usage (blue) and Danish national building codes (red). The red lines show the maximum allowed energy demand per year and m^2 heated floor space in a new $150 m^2$ residential building. The limit is on the total amount of supplied energy for heating, ventilation, cooling and domestic hot water. Source: Danish Building Research Institute (2004), the Danish Business Authority and the Danish Building and Property Agency (2008).

Municipal District Heat Planning

Before 1979 there was no law regulating heat supply in Denmark. The first heat planning law was passed in 1979 and contained regulations on the form and contents of heat planning and became the beginning of a wave of national heat plans. The new law required local municipalities to prepare reports on their heat requirements, the heating methods used at the time and the amounts of energy consumed.

They were also asked to assess potentials for district heating. This data was then used by the regions to prepare regional heat supply plans based on drafts drawn up by the municipalities. The final plans were required to show in which areas various forms of heat supply should have priority and where future

heat supply installations should be located. Based on this, local authorities then created their own municipal heat plans.

This heat planning process led to an extensive development of both natural gas and district heating networks. From 1972 to 1990, the share of natural gas for heating grew from 0% to more than 10%, and the share of district heating grew from 20% to app. 40%. Since 1990 the share of district heating has grown further to app. 55%. Due to this success the Heat Supply Act is no longer highly relevant although still in force.

However, as this booklet shows, many Danish municipalities desiring to go beyond national requirements to go “green” have revitalized the heat planning concept into a new policy instrument of long-term strategic initiatives and choices at local level. Cooperation between local authorities, energy utilities, and other stakeholders is vital. A budget for such voluntary energy planning activities has been set aside in the new Energy Agreement.

High Energy Taxes and Subsidy Schemes for Renewable Energy

Energy taxes and subsidy schemes for renewable energy are other important policy instrument used in the Danish context. The purpose of putting taxes on fossil energy use is to stimulate energy savings and CO₂ reductions by making renewable energy more competitive. Energy taxes on electricity and oil were first introduced in 1977. Since then, the energy taxes have been increased several times and taxes are now also relevant to coal and natural gas.

In 1992, the energy taxes were supplemented by specific CO₂ taxes which punish fossil

fuels with high carbon contents. The exact influence of the energy taxes on Danish energy consumption is hard to measure with accuracy. But there is little doubt that the taxes have had a big influence on reducing energy consumption.

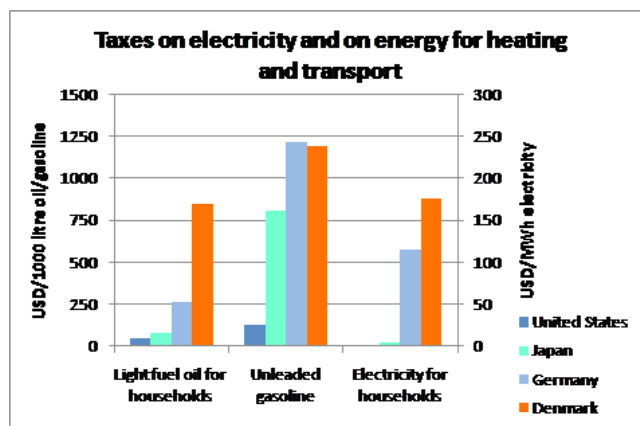


Figure 3. Source: “Energy Prices and Taxes. Quarterly Statistics. First quarter 2012”, International Energy Agency 2012.

Denmark is blessed with ample wind resources and wind turbines have been supported over the past three decades in numerous ways, including through direct state subsidies, feed-in tariffs and today's feed-in premiums, orders to the electricity utilities to build a specific number of wind turbines tenders for off-shore wind farms and orders to municipalities to allocate suitable areas for new onshore wind turbines.

Today app. 30% of Danish electricity consumption is produced by wind turbines and this share is set to increase to 50% in 2020. A liberalized interconnected Nordic Power market as well as combined heat and power have been essential in integrating vast amounts of fluctuating wind power into the Danish power grid while maintaining a high level of reliable performance.



Cities at the forefront

As described above the Danish green transition is partly driven by national policy but to a major extent also by visionary local authorities and citizens. Several Danish regions and municipalities have adopted their own ambitious climate and energy targets. Three of the most advanced and ambitious cities and municipalities in sustainable urbanization in Denmark include Copenhagen, Aarhus, and Sonderborg.

Copenhagen

The Danish capital Copenhagen with 550.000 inhabitants seeks to become the first carbon neutral capital in the world by 2025. The CPH 2025 Climate Plan was adopted by the City Council in August 2012. The city will be carbon neutral when Copenhagen’s carbon net emissions equals zero. That is when Copenhagen has reduced carbon emissions to a minimum and compensated for the remainder of emissions with external initiatives.

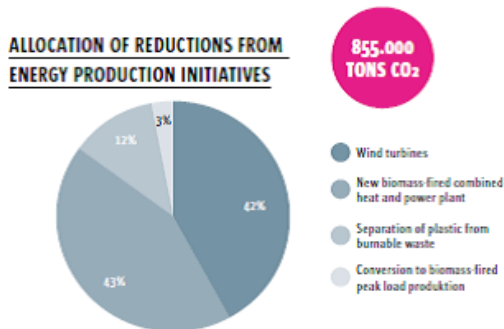


Figure 4: Allocation of reductions from energy reduction initiatives in Copenhagen.

Extensive retrofitting of buildings, reorganisation of the energy supply and a radical change in transport patterns are some of many initiatives which Copenhagen seeks to

implement. On transport the Copenhagen Climate Plan aims at testing new alternatives to private cars. An example is funding of either public transport or loan schemes for city bicycles both for shorter period of time and longer – as is done in other European cities such as London, Paris, and Brussels. Likewise Copenhagen is testing schemes for small shared electric vehicles. With its climate action plan in hand, the Danish capital aims to combine economic growth, urban development and a high quality of life with a reduction in carbon emissions of about 1.2 million tons.

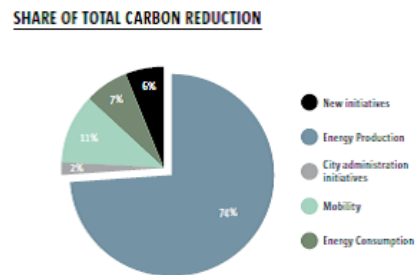


Figure 5: Share of total carbon reduction for Copenhagen

The Copenhagen Climate Plan has been developed in close cooperation with businesses, the citizens of Copenhagen, NGOs and research institutions. Chapter 2 of this booklet describes the Copenhagen efforts in greater detail.

Aarhus

Aarhus is a dynamic city on the Jutland peninsula in Denmark. 324.000 people live in Aarhus Municipality and 1.2 million people live in the greater Aarhus Area. Aarhus is the second largest city in Denmark and the largest city in the mainland region of Jutland. Aarhus is characterized by knowledge hubs,

innovation centers, investments in city architecture, new technological solutions as well as a goal of becoming CO₂ neutral by 2030 adopted by the City Council. Aarhus Municipality facilitates and establishes innovative partnerships with key businesses and knowledge institutions within energy efficiency and cleantech technologies.

Through the partnerships innovative projects are implemented. One of the key focuses of Aarhus an efficient district heating system. The goal is to introduce a carbon neutral district heating system by way of already existing production facilities – transiting away from coal towards biomass including the construction of new biomass heat capacity. The innovation projects will benefit green growth in the Aarhus region. In chapter 3 of this booklet the Aarhus efforts are described in greater detail.

Sonderborg

Sonderborg (27.000 inhabitants) is a middle-size Danish town placed in the southern part of Jutland peninsula bordering Germany. Sonderborg has launched its “ProjectZero”. This project aims to make Sonderborg a carbon neutral city by 2029. The project is a public-private partnership and was established to be an inspirational driver for Sonderborg’s transformation into a carbon neutral community by 2029, based on improved energy efficiency, and a replacement of fossil energy sources into renewable ones.

A core aspect of ProjectZero is aimed at the public - providing environmental and climate change awareness campaigns on all levels. Another main aspect of the project is the specific focus on encouraging energy renovation of private homes.

Local companies also play a key role. For example Danish global company Danfoss with global headquarters located in Sonderborg has established district heating projects in the city.

Also, manure and straw from farming will be converted into green energy and green fertilizer in large biogas plants. The ground below Sonderborg contains substantial thermal heat which will be used for CO₂-neutral district heating. Between 2007 and 2012 CO₂-emissions from Sonderborg were reduced by 22% and in 2010 ProjectZero received the European Union award for the best “European Sustainable Energy Community” project. Chapter 4 of this booklet goes into greater detail on Sonderborgs transition.

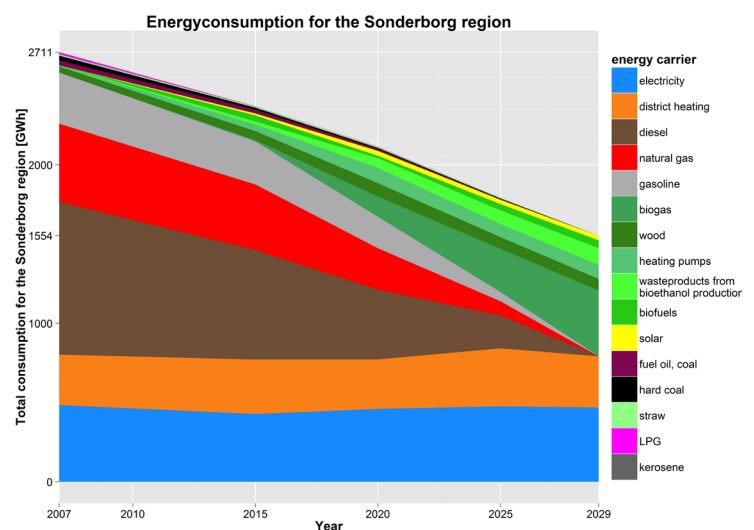
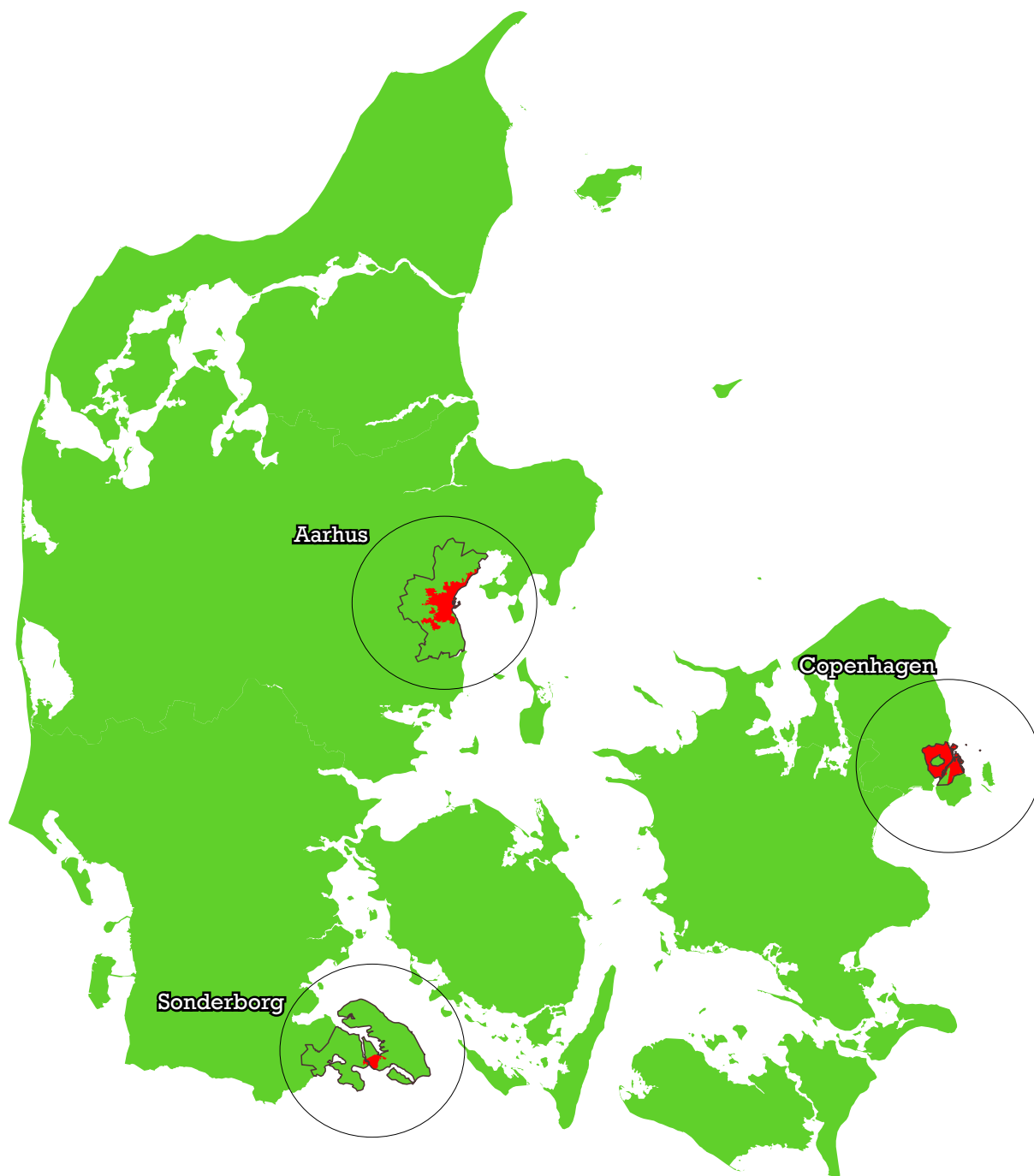


Figure 6: Energy consumption for the Sonderborg region.



Map of Denmark:



Green Urban Denmark Copenhagen



Foreword:

A sustainable world starts with sustainable cities. In Copenhagen, we keep this in mind as we strive to combine sustainable solutions with focus on growth and quality of life to make Copenhagen an even more liveable city. More than half of the world's population lives in cities, and Copenhagen is growing, just like cities all over the world, also facing challenges such as carbon emissions, traffic congestion and waste accumulation.

In Copenhagen, we have addressed our challenges with both adaptation and mitigation initiatives, in recognition of the added benefits such as less air pollution, better health and optimized recycling on the way to our vision: A zero waste city.

Reducing carbon emissions is just a small part of being a sustainable city. It is also about growing our economy and, ultimately, improving the quality of life for our residents.

A sustainable city is also a liveable city where people can live and breathe, work and recreate. Green mobility with our combinati-

on of the best cycling conditions in the world and efficient and integrated public transportation make way for green growth and quality of life. Investing in sustainability also has financial benefits.

Cleaning the water in our harbour improved the marine environment, and it also benefited business, tourism and real estate prices. An integrated public transportation system fuelled with alternative environmentally friendly fuels, not only reduces traffic congestion, it also saves us billions of euros and keeps the city efficient and competitive.

This publication profiles some of our best sustainable solutions. In the spirit of sharing, Copenhagen reaches out to cities worldwide with our solutions, but we are also on the lookout for new ideas to improve Copenhagen and hope to be inspired by the lessons learnt by others.

If you are interested in learning more about Copenhagen and our sustainable solutions, please do not hesitate to contact us.



*Mr. FRANK JENSEN
Lord Mayor of Copenhagen*



*Mr. MORTEN KABELL
Mayor of the Technical and
Environmental Administration*



2. Copenhagen: Keeping the city warm efficiently



Carbon neutral by 2025

Copenhagen assumes its share of the responsibility for climate change with the CPH 2025 Climate Plan. We want to show that it is possible to combine growth, development and increased quality of life with the reduction of CO₂ emissions. It is all about finding solutions that are smarter, greener, healthier and more profitable. And by 2025 we will be able to call ourselves the world's first carbon neutral capital.

The CPH 2025 Climate Plan is a holistic plan as well as a collection of specific goals and initiatives within four areas – energy consumption, energy production, green mobility and the City Administration. Work in the four areas must be set in motion immediately for Copenhagen to become the world's first carbon neutral capital.

The CPH 2025 Climate Plan describes how our ambitions for carbon neutrality should be used as leverage for a better quality of life, innovation, job creation and investment, and how the goal of carbon neutrality can be achieved by 2025 through close cooperation between government businesses, knowledge institutions and Copenhageners

A sustainable solution

With the Climate Plan, the Danish capital combines growth, development and a higher quality of life with a reduction in carbon emissions of around 1.2 million tonnes. The plan creates environmental benefits such as clean air, less noise and better quality of life.

Climate goals

Climate actions have been operating in Copenhagen since 2009 when the Copenhagen Climate Plan up to 2015 was adopted. The initiatives which have been launched since then have contributed to substantial CO₂ reductions. The goal of a 20% reduction by 2015 was already achieved by 2011 when CO₂ emissions were reduced by 21% compared to 2005. Today, Copenhagen emits 1.9 million tonnes of CO₂ annually.

By 2025, this will have fallen to 1.2 million tonnes due solely to a number of planned initiatives, e.g. switching from coal to biomass in combined heat and power plants in the Capital Region together with changes in the existing legislation on energy and transport.

In order to become carbon neutral by 2025, the city must use less energy than it does today and at the same time switch energy production to green sources.

Green laboratory

Copenhagen is ready to make the city available as a green laboratory and, with the CPH 2025 Climate Plan, is prepared to meet the climate challenge and take the steps towards a carbon neutral Copenhagen by 2025. Our ambition is to make Copenhagen an international centre for cleantech companies.

With a carbon neutral Copenhagen, Danish companies will have a unified platform to demonstrate green Danish technologies. This will not be the case just for embryonic projects and demonstration facilities on a smaller scale, but in a full-scale metropolis where technologies are in symbiosis with solutions, showing their strength both separately and together at the same time.

Improved quality of life

Copenhagen is now internationally recognised and designated as one of the world's best cities to live in, winning the prize of European Green Capital 2014.

Work done to become the world's first carbon neutral city is not only a gain for the climate and environment. The initiatives will have positive effects on Copenhageners' lives generally as well as on an everyday basis. The Climate Plan will create solutions that promote green growth and enhance the quality of life for the individual citizen without additional expense to those citizens.

Principles in the preparation of the CPH 2025 Climate Plan to keep Costs down:

- The transformation takes place gradually over a long time period.
- Sound financial initiatives are set in motion as soon as possible.
- The shift to green transport, which is relatively expensive, starts with development projects in most cases.
- As well as reducing carbon emissions, initiatives should also, if possible, create green growth and enhance the quality of life.



Adapting to the future climate

Global climate changes will set their marks on Copenhagen over the next 100 years: Dry summers with intensive rainfall, wetter winters, higher temperatures and rising water levels. To safeguard Copenhagen and prepare the city for the changing climate, the city of Copenhagen has produced a climate adaptation plan. With long-term investments and timely planning, we will have the required edge to ensure that the city is prepared for violent rainstorms and heat waves.

Initially changes come gradually but will then happen faster and faster. The most dramatic changes will occur after 2050. In preparation for the future, we are collaborating across different sectors to develop smart solutions which do not only prepare the city for the climate changes, but also make the city a better place to live with its green islands and blue canals in the middle of the city.

The blue and green areas in the city have several functions:

- Reduce stormwater flows by absorbing and detaining rainwater.
- Moderate and balance temperature changes.
- Reduce the city's energy consumption for cooling buildings by creation of shade and air circulation.
- Increase biodiversity.
- Reduce noise and pollution.
- Create possibilities of recreation.

Concept for screening of flood risk

It is not possible, neither technically nor financially, to secure Copenhagen completely against climate-related incidents. Nevertheless, an extended series of measures can be implemented which will either prevent the incident, reduce its extent or reduce the city's vulnerability to it.

The trick is to pick the right ones. That is why a unique concept for screening of flood risk has been developed.

A unique concept

The concept combines information on the topography, the sea level rise, the storm surge, the rainfall/runoff distribution and knowledge of the economic values of property etc. in

the area. The idea uses flood risk defined as vulnerability (economic value) times the probability of flooding in a given area. The flood risk was first assessed by screening methods followed by prioritised detailed dynamic modelling of floods and economic consequences over the next 100 years.

Flood and risk maps

All information is gathered in a GIS in which the spatial extent and depth of the flooding can be viewed together with area maps showing economic values of properties, infrastructure etc. The flood risk maps will identify areas which are most important or most beneficial to protect, and these areas should be given highest priority for the most cost-efficient climate change adaptation. Climate adaptation measures are planned to be such as recreational areas, businesses, beaches, landscape and infrastructure.

Contingency plans

The flood and flood risk maps give a solid background for contingency plans and disaster risk management, and can be used during emergency actions to prioritise activities and forecast where flooding will occur if the event continues. A series of contingency plans and adaptation activities have been screened in this manner, and the most effective in economic terms have been identified.

Keeping the city warm efficiently

District heating is one of the most carbon efficient and flexible ways to produce and supply energy locally, cutting out much of the waste associated with centralised power generation. By integrating renewable energy such as biomass, surplus wind energy, geothermal energy and biomass to replace fossil fuels in the system, further reductions of emissions have been achieved.

The district heating system was first established in the mid 1920s and was more intensively developed in the 1970s as a way to protect citizens and the economy from the dramatic rise in fossil fuel prices.

This was a time when the city faced over dependency on increasingly scarce and expensive fossil fuels, air quality concerns caused by coal and oil burning within a city environment, and low efficiency in energy distribution in the existing district heating network. The solution was to reduce reliance on fossil fuels by maximising energy generated from waste, biomass and other fuel sources.

Solution – decarbonising the district heating:

- Technologies such as Combined Heat and Power (CHP) to capture and re-use heat energy that is otherwise lost in the electricity generation process.
- The district heating network distributes heat energy efficiently around the city.
- The integration of renewable fuels such as biomass further reduces the carbon intensity of the network.

Benefits:

- District heating costs around 45% less than oil by individual oil boiler.
- Reduced CO₂ emissions.
- Creation of new jobs.
- The most cost-effective way to heat buildings, taking into account environmental costs.
- Almost no negative impact on air quality.

Solution in detail

Development of a district heating system that uses heat generated from waste-to-energy plants; along with CHP technology, initially fuelled by coal, natural gas and oil.

Step by step expansion of the network

District heating does not necessarily require an overhaul of existing energy systems. It can be implemented over a suitable period of time. A steam network was originally established to supply hospitals and industry, and once a steam pipe was established, offices, daycare centres and private homes nearby were also connected. This network is now replaced by water-based district heating which is more energy efficient and can be stored in thermal storages.

Regional co-operation in Greater Copenhagen:

The entire integrated district heating system spanning more than 20 municipalities in the region is developed and operated through regional co-operation and partnerships.



Decarbonising the heating system

Strategy

The short-term goal of the city is to convert all remaining coal-fired CHP to biomass. As a long-term strategy the City of Copenhagen is now using geothermal energy in the district heating network.

Renewable energy supply

The use of CHP units allows highly efficient use of the energy in the fuels (up to 94%), and results in lower carbon dioxide emissions. Biogas is being made an operational part of the town gas grid by extracting gas from sludge produced in wastewater treatment processes.

Biomass is planned to replace coal and provide 100% renewable energy from the CHP plant-one plant has already been converted to 100% biomass.

The sustainable benefits

Economic:

With high fuel efficiencies of up to 94% by simultaneously generating heat and power, the power plants need much less fuel per kWh generated. In comparison, conventional power plants have an efficiency of around 40%.

For society in general, district heating is the most cost-effective heat supply taking into account environmental costs of CO₂ and other emissions.

Environmental:

The District Heating system achieves lower carbon dioxide emissions than the individual gas boilers (40% lower) and oil boilers (50% lower) it replaces.

District heating can utilise and store the available heat from CHP plants and thereby reduce the primary energy consumption by 70% compared to individual boilers.

Conversion to biomass-fuelled district heating is further decarbonising the energy supply.

Social:

Jobs were created in developing the grid infrastructure required for the district heating system. Municipal and consumer ownership of the district heating grid infrastructure and the Danish Heat Supply Act ensure that all economic benefits of district heating are returned to the consumers.

Joining the district heating system and sharing the fixed infrastructure costs reduces the heat price to the benefit of all consumers.



Keeping cool under CO₂ pressure

The increased demand for air conditioning and cooling has led to higher electricity consumption in many cities. In our effort to provide low carbon cooling, we have built the first two district cooling networks. They are based on free cooling from seawater abstraction, along with running surplus heat from the district heating network through absorption cooling and traditional compression chillers. The project is expected to save 30,000 tonnes of carbon dioxide per year. Peak summer temperatures in Copenhagen can reach 35°C and are expected to rise by 2–3% by 2050 – with average daily temperatures also rising. Consequently, the demand for traditional air conditioning is increasing.

Dependency on electricity-based cooling appliances can create unsustainable electricity demand and overreliance on fossil fuels. Traditional air conditioning systems are expensive, noisy and take up a lot of space. Additionally there is currently excess heat within the district heating system during summer months when demand is low. The solution was to develop a 'District Cooling' system to complement the highly successful District Heating system.

Solution – District cooling network:

District Cooling is the centralised production and distribution of chilled water – partly cooled with cold seawater. It is distributed via underground insulated pipelines to commercial and industrial buildings to cool the indoor air.

Benefits:

- Reduced CO₂ emission.
- Urban heat island effect is reduced.
- Zero noise, unlike conventional cooling methods.
- Reduced expenditure on energy imports.

Solution in detail:

District Cooling is the centralised production and distribution of chilled water, partly cooled with cold seawater. It is distributed via underground insulated pipelines to commercial and industrial buildings to cool the indoor air. The plant is designed around three different methods of cooling making it very flexible and highly energy-efficient, depending on the temperature of the seawater.

Utilise existing resources

Seawater from Copenhagen Harbour is one resource during periods when the seawater is sufficiently cold. Surplus heat from the district heating network during periods of low heat demand is another resource.

Creation of multiple connections to a network

District Cooling works on the same principles as district heating. Chilled water is produced centrally and carried to the end users through a system of pipes. Network can be built adjoining district heating pipework, or can be laid where no existing network is in place.

Integration of different principles of coolingFree cooling:

Seawater temperature is below 5.5°C and cooling demand low (less than 2400 kW). All cooling demands are covered by free cooling heat exchangers.

Combined operation:

Seawater temperature is between 5.5°C and 11.5°C. Heat exchangers are used for pre-cooling of the water, before it is fully cooled by chillers to the desired temperature.

Chiller cooling:

Seawater temperature is above 11.5°C. The seawater is too warm to be used for free cooling so absorption and compression chillers provide all cooling. Free cooling heat exchangers are bypassed completely.

The sustainable benefitsEconomic:

- Reduction in expenditure on energy imports.
- Cooling contracts with different organisations and institutions can be replicated, allowing easy transferability.
- Frees up commercial, retail and parking spaces as conventional cooling systems and fan coils on roofs are replaced by underground infrastructure.

Environmental:

- Carbon dioxide reduction of 70%, compared to traditional cooling. The annual sulphur dioxide and nitrogen oxide savings are 62% and 69% respectively.
- Potential to negate or, at least reduce, the urban heat island effect.
- Demand for electricity is reduced because electrically operated chillers are replaced by free cooling and heat-operated chillers via district cooling.
- Excessive heat, noise and chemicals from compressor chillers are avoided in individual buildings.

Social:

- Zero noise to the customer, as opposed to conventional cooling methods.
- Removes many of the health risks associated with cooling towers, e.g. legionnaire's disease.
- Increased energy security from a centralised supply with improved resilience built in.
- Rooftop terraces instead of traditional cooling systems.
- Does not damage the architectural impression of a beautiful city.

For more information go to:

www.cphcleantech.com/cph-adaptation

Green Urban Denmark Aarhus



Foreword:

Aarhus is one of the most ambitious municipalities in sustainable urbanization in Denmark, and is one of the Danish cities at the forefront of implementing sustainable solutions.

Aarhus has a beautiful location, close to forests, beaches and water. Both citizens and visitors enjoy the convenience of having nature within easy reach and the fresh air flowing free in their lungs. Preservation and further development of the blue and green city is a key target for the City Council.

The City Council provides guidelines for how to create green growth in the city, reducing dependency on fossil fuels as well as carbon dioxide emissions. The City Council has a goal that Aarhus will be carbon neutral by 2030.

Aarhus is already a very energy efficient city, primarily because of an energy system based largely on combined heat and power utilization.

Aarhus is continuously undergoing a dynamic development that requires strong municipal focus on planning as well as involving many different stakeholders in the process of developing solutions.

A number of the most important Danish businesses within energy technologies and energy research are situated in the Aarhus area. With the municipality as facilitator and the businesses and knowledge institutions as key actors, innovative partnerships are established. Through these partnerships projects are initiated that will help increase green growth in Aarhus and achieve the goal of carbon neutrality.

Politicians and businesses are also benefiting from one another across borders, and in Aarhus there is a long tradition for cooperating internationally. The Chinese city Harbin and Aarhus have cooperated for 30 years. In recent years, the successful cooperation has focused on energy efficiency, green growth and clean technologies.



*Mr. JACOB BUNDSGAARD
Mayor of Aarhus*



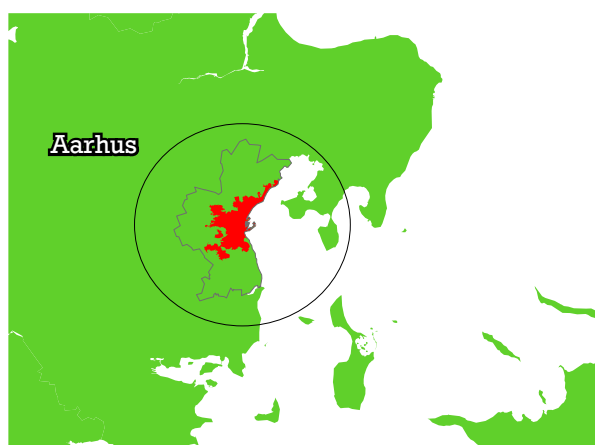
*Mr. KRISTIAN WÜRTZ
Vice-Mayor, Technical and Environmental
Administration*

3. Aarhus: A District Heating Pioneer moving towards Carbon Neutrality by 2030



Introduction

Aarhus is the second largest city in Denmark with app. 325.000 inhabitants. Our city is located on the mainland peninsula of Jutland on the western part of Denmark and located on the Danish coast at the Kattegat sea, where the Baltic Sea meets the North Sea. As university town and a hub for many businesses Aarhus is developing fast.



It is expected that within 15 years the city will have increased its citizens by 25%. At the same time, Aarhus has decided to become carbon neutral by 2030–20 years

ahead of the national goal. The agenda of energy efficiency is therefore of great importance in order to reducing dependency on fossil fuels and in order to decoupling carbon emissions from economic growth.

Ambitious plans to be put into effect over the next years will reduce carbon emissions from 2009 to 2020 by 35% and pave the way for a carbon neutral city of Aarhus by 2030. Highly efficient district heating and combined heat power solutions are among the main tools to achieve this goal.

Climate and Energy Planning in Aarhus: Challenges and Solutions

The district heating system in Aarhus covers 95% of the city's heat demand. And in common with other Danish cities and towns, the district heating system in Aarhus has a very high level of energy efficiency. One main reason is use of surplus heat from electricity production to produce heat.



Energy efficiency is prioritized from highest level with the City Council emphasizing the importance of an efficient city based on green growth

Energy efficiency is a key consideration in the municipal climate and energy planning in Aarhus and projects are implemented involving a number of stakeholders

Aarhus Municipality is working from a cooperation model, where the municipality takes on a facilitator role. Through cooperation with businesses, universities, and other knowledge institutions in Aarhus, as well as other parts of Denmark, the projects are implemented with the aim of promoting green growth. The cooperation model with stakeholders is thought of as innovative partnerships and it frames the way of thinking and interaction between business, universities, knowledge institutions, and the municipality. The model is also used internationally and is for example strengthening the city friendship program between Aarhus and Harbin in China.

The focus on energy efficiency and innovative partnerships has increased green growth in Aarhus as well as the number of energy efficient projects implemented in recent years. And new ones will be established in the coming years. The projects are part of the solution that will ensure Aarhus the necessary level of energy efficiency in the future. Some of the most important projects are described below.

The Danish Government has a goal of achieving a 100% renewable energy based electricity and heat system by 2050. To achieve this goal, a milestone of 50% wind coverage in the electricity consumption (not including electricity for heat pumps and ele-

tric vehicles) should be achieved by 2020. Towards 2030 this percentage will be further increased. In line with this, Aarhus also has a strong focus on solutions for integrating wind power into the district heating system.

Solutions in Aarhus

Projects are initiated with the purpose of increasing Aarhus' energy efficiency in line with the municipal energy and climate planning. Below are described a few of the important projects that at the time of writing are already implemented or about to be implemented in Aarhus.

Municipal institutions, private businesses, universities and knowledge institutions in Aarhus and other parts of Denmark are participating in the projects. The various types of organizations have different incentives for participating in the cooperation, for example earnings and testing of solutions. The different incentives have proven to be a strong tool for commissioning the projects, with a common goal of increasing energy efficiency and green growth and at the same time improving the quality of life for citizens.

Solutions:

- All production of district heating up to 2015 will be converted from coal to non-fossil fuels
- New biomass-fired combined heat and power plant
- Wind and solar power is phased into the heating system in the years to come
- Intelligent district heating meters
- Integration of wind via use of the district heating system



Climate Change Heat Plan - Biomass as the Primary Fuel for District Heating

Aarhus Heat Supply Company has put forward an ambitious plan to pave the way for green heat. The plan contains initiatives where major investments will introduce renewable energy and increase energy efficiency still further in the already efficient heat supply.

The plan also paves the way for more wind energy in the district heating grid.

As a first step, all production of district heating up to 2015 will be converted from coal to non-fossil fuels such as straw, wood pellets, wood chips, and waste.

This will be achieved by converting the Studstrup combined heat and power (CHP) plant north of Aarhus from burning coal to burning wood pellets and by building a new biomass-fired combined heat and power plant. Aarhus Heat Supply Company will build the new biofuel plant alongside the city's existing waste-fired plant. The plant is designed with high efficiency, including heat recovery of fluegas, for efficient utility of the fuel.

The primary fuel will be straw from local suppliers, but up to 50% of the fuel may come from wood chips, in situations with insufficient straw supply. The plant is expected to be ready for the autumn/winter of 2016-2017 and will provide more than 20% of the heat requirement in Aarhus.

According to the heat plan, long-term sustainable energy such as wind and solar power will be phased into the heating system by 2030 to reduce dependence on scarce bio fuels. Working together with leading businesses and education centers, there are

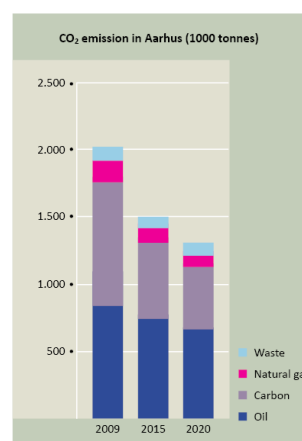


Figure 7: Carbon emissions in Aarhus. Source: Aarhus municipality

excellent opportunities for developing heat stores, bypass systems for CHPs, and components that are able to create greater flexibility for the system.

Part of the plan also calls for launching a number of development projects to make the system more energy efficient. This includes utilizing the surplus heat from certain local businesses in the heating grid and setting up partnerships with a number of small heat generators.

Deployment of intelligent district heating meters

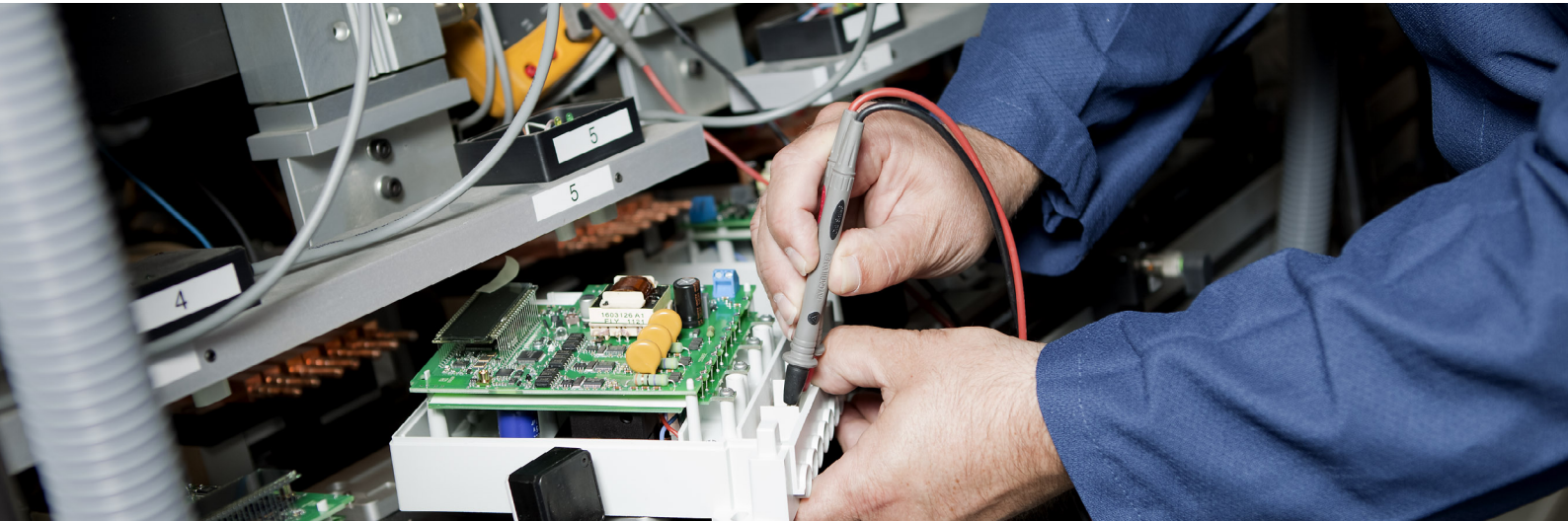
A new smart metering system in Aarhus is designed to reduce heat consumption, to increase reliability of the grid and to reduce the administrative costs of the energy supplier, Aarhus Heat Supply Company. Households in Aarhus will benefit from one of the world's biggest and most advanced systems for remote metering of heat consumption.

Intelligent metering

The core of the system is data transmission via intelligent meters installed at the customers' homes as the Aarhus Heat Supply Company replaces its more than 53,000 meters by new remote meters. The meters will report heat consumption automatically once every 24 hours and replace the existing manual meter reading. The data system will thus provide consumers with the opportunity to continuously follow their heat consumption on the internet and prospectively also on their mobile phones.

Facts: intelligent meters

- 53,000 meters to be installed before 2017.
- A comprehensive solution based on well-proven standard components and wireless technology.
- Heat consumers have the possibility to follow their heat consumption via the internet.
- Reduced water loss up to 20%.



Kamstrup A/S has developed intelligent meters that allows customers the opportunity to continuously follow their heat consumption on the internet and possible via an app for mobile units.

As mentioned, the system will be one of the biggest and most advanced of its kind when fully installed in 2017. The first 13,300 meters are supplied by the local company, Kamstrup, one of the world leaders within energy metering, whilst EMT Nordic and Saseco developed the IT systems for data collection. Intego handles the physical installation of meters.

The goal is to raise the energy awareness of heat consumers and encourage a change of habits and behaviour. Furthermore, a reduced water loss of up to 20% is expected in the distribution system, as the data collection system also detects and reports water leaks. The administrative costs from incorrect or missing readings can also be avoided. Danish district heating solutions are already in international demand because of the accumulated experience of companies in designing, building and operating systems for heat and power production. The district

heating system in Aarhus, which also counts the smart meters, gives the city - and the rest of the world - a model for energy optimization to the benefit of residents, businesses and the environment.

Integration of wind via district heating

To meet the Danish long-term goal of fossil fuel independence, the deployment of wind energy, which is an abundant renewable energy source in Denmark, will probably be one of the key means for achieving this goal. The strategy in Aarhus is a short-term deployment of bio fuels and a long-term strategy of integrating large amounts of wind and solar energy into the energy system. In fact, the Heat Plan focuses on the benefits of interaction between wind and heat production, which is in line with the role that wind turbines are to play in future energy planning.

Aarhus' greatest strength in relation to the integration of wind energy is seen to be the extensive district heating system in the municipality. This means that there are very good opportunities for using the already existing district heating system for creating flexibility in the system which may help absorb large shares of renewable energy into the grid while maintaining system stability. Large-scale heat pumps and electric boilers in addition to by-pass solutions at the CHP plants could be a good concrete solutions together with heat storages.

Aarhus has already several heat storages in combination with the existing thermal plants. And the possibility for more thermal storage capacity will be assessed in relation to cost-effectiveness of the other forms of flexibility in the district heating system.

System integration of wind power by the use of the DH/CHP system in North-East China

Besides Aarhus' own considerations of integrating wind energy in the district heating system by the means as described above, Aarhus also participates in such projects in China. The project titled "System integration of wind power by use of the DH/CHP system in North-East China" is partly funded by the Sino-Danish Renewable Energy Program (RED) and has been defined within the context of the Harbin-Aarhus city friendship program.

The purpose of the project is to analyse the energy system in Harbin in order to detect, investigate, and present possible institutional solutions and concepts/technologies for integrating wind power into the DH/CHP system. The project is initiated based on the expectation of a boom in wind power expansion in China in the coming years. The project illustrates the possibilities and consequences of using different measures, coordinated dispatch as well as technical means (heat storages, electric boilers and heat pumps), for efficient integration of wind power into the system.

The project results were presented to Danish and Chinese politicians and officials in Harbin in January 2014, where among others the Danish Minister for Climate, Energy, and Building was present as well as the Deputy Director General of China's National Energy Administration. Also, a number of Danish parliamentarians took part in the meeting in their capacity as members of the Danish Parliament Committee for Climate, Energy and Building.



Go Green with Aarhus Web Portal



Figure 7: Visit the web portal by entering www.gogreenwithaarhus.dk in your web browser.

In Aarhus, a new web portal "Go Green with Aarhus" informs relevant partners and the citizens on the important initiatives that are already implemented or will be launched in the near future. The portal centers on the themes of "the green and blue city", "the energy-efficient city" and "innovative partnerships". The ideas behind a number of demonstration projects are undertaken in close collaboration with some of the country's leading businesses, universities and suppliers. The aim of "Go Green with Aarhus" is to create an international showcase, to pave the way for green growth in Aarhus.

Aarhus and Harbin

Harbin and Aarhus Municipality have cooperated for 30 years in the context of the Harbin-Aarhus city friendship program. The cooperation was established in 1984, and politicians from all administrative levels in Harbin and Aarhus have visited each other several times each year. Also the Chinese and Danish businesses are visiting each other regularly and benefit from the city friendship program through concrete project cooperation. New projects and business-to-business relations have been successfully established as a consequence of a tailor-made focus on the relevance of external cooperation.

The scope of Harbin-Aarhus cooperation on energy efficiency is based on the Chinese politicians' interest in efficient Danish solutions in the district energy systems. Therefore, one of the focus points in the cooperation is energy efficiency in district heating systems and on inspiring technical and financial solutions for China's policy making which may improve the cost-effectiveness of district heating systems in Harbin. This also includes a focus on integration of wind power into the district heating system.

Combining the Chinese national 2050 vision within research and practical demonstration experiences from the current Sino-Danish projects in Northern China may lead to the development of generic concepts that could be replicated widely in district heating areas. Strengthened Sino-Danish cooperation in new joint market-driven projects in this area may inspire China's green district heat transition in the coming years.

For more information please visit:

<http://www.gogreenwithaarhus.dk/en.aspx>

Green **Urban** Denmark Sonderborg



Foreword:

The City Council of Sonderborg has a strong commitment to the vision of ProjectZero. The efforts of the vision are anchored in a public-private secretariat, which together with the Municipality and the stakeholders of the region drives the implementation. The City Council commits itself wholeheartedly to sustainability in its own administration, in developing education on all levels – from Kindergarten to PhD – and in our business policy.

Doing business with China is not new to Sonderborg. Strong historic relations tie our city to China – big ships built in Sonderborg during earlier centuries brought goods from Europa to China and vice versa.

Nowadays we still have strong ties and good relations to China. Several companies in Sonderborg have branches in China – I would like to mention the company of Danfoss, which has more than 4000 employees in China, and Asia Base, which was founded by Peter Rasmussen, who originates from Sonderborg.

For many years Chinese youth have been valuable students to the international University of Southern Denmark in Sonderborg.

People and culture are also in focus every year, when we celebrate Chinese New Year – in close cooperation with the Chinese Embassy in Denmark and with thousands of people from Sonderborg as open-minded and enthusiastic audience.

Our sistercity-agreement with Baoding city and the EU-China urbanization partnership project with Haiyan County are important corporations, which are embedded in concrete collaborations supporting low and zero carbon transitions. I myself joined the Bright Green Business fact finding tour to a number of Chinese cities in 2012, and I am very inspired by the great Chinese interest in energy, climate and environmental themes. I am convinced that mayors and cities across our continents can learn from each other. ProjectZero in Sonderborg every year receives many Chinese delegations, who would like to learn from us and share best practices with us.

I warmly support more dialogue on how we together learn from best practices and I am happy to share the experiences from ProjectZero with you.

I welcome you to visit Sonderborg.



*Mr. ERIK LAURITZEN
Mayor of Sonderborg*



4. Sonderborg: Including the Citizens in Reaching CO₂-neutrality by 2029



Introduction

Sonderborg Municipality, located in the south of Denmark and the home-town of Danish leading energy efficient technology companies like Danfoss, aim at becoming carbon neutral by 2029.



To achieve the ambitious goals Sonderborg is driving an ambitious stakeholder participation including citizens, corporations, utility companies, schools, universities etc. with the ambition of changing the thinking and mindset of the entire society. Energy efficiency by all means and conversion to renewables are important priorities and the municipality plays an important role as frame-setter and frontrunner for changing society. Benefits to society include, apart from carbon-reductions, also green job creation, capacity build-

ing and potential green growth as part of the transition.

Municipal climate and energy planning in Sonderborg

ProjectZero enables the green transition of Sonderborg. The ProjectZero-vision enables Sonderborg to be a first mover municipality in energy- and climate transition. But the ProjectZero vision and its 2029 goals goes beyond what a Danish municipality normally address and call for a much stronger partnership with committed stakeholders.

Therefore, ProjectZero in 2007 was created as a public-private partnership between industry (the Danfoss-foundation), energy (national DONG Energy company), regional utility companies (SE, Sonderborg Utility company), banks (the Nordea Bank foundation) and the municipality of Sonderborg. The partnership has created the ProjectZero Company, to anchor and assist stakeholders planning activities, drive stakeholder participation, implement solutions and monitor climate and society impact.



The first priority is energy efficiency

ProjectZero enables Sonderborg to achieve its ambitious goals in a prioritized combination of energy efficiency improvements (43%), conversion of energy sources to renewables (57%) and creating a dynamic energy system with flexible pricing ect. 22% carbon reduction has been achieved by 2012 (baseline 2007 comparison) and the next milestone is focused on achieving a 50% carbon reduction by 2020.

Strong stakeholder participation will impact the society “thinking”

Creating a green platform and stakeholder participation was already from ProjectZero’s creation in 2007 an important part of the transition. Engaging all society stakeholders including citizens, corporations, utility companies, schools, universities etc. has been a political vision and competencies has been built across society sectors for stakeholders to participate in the project offering valuable easy-to-join platforms. The strategy is to build competence/capacity across sectors, step by step change the current thinking of society and thereby change society values and preferences.

Cross sector and cross municipal planning is required

Cross sector Energy and Climate planning is crucial to an efficient transition as local renewable resources are limited and have to be utilized efficiently. In Sonderborg the urban planning department in cooperation with ProjectZero has reviewed utilization of local resources, created alternative scenario-plans and selected appropriate energy- and climate plans for implementation. Already in 2008 the municipality created its first energy policy strategy. Today energy and climate

considerations are an integral part of the municipal long term planning and every second year reviewed regarding impact and strategy.

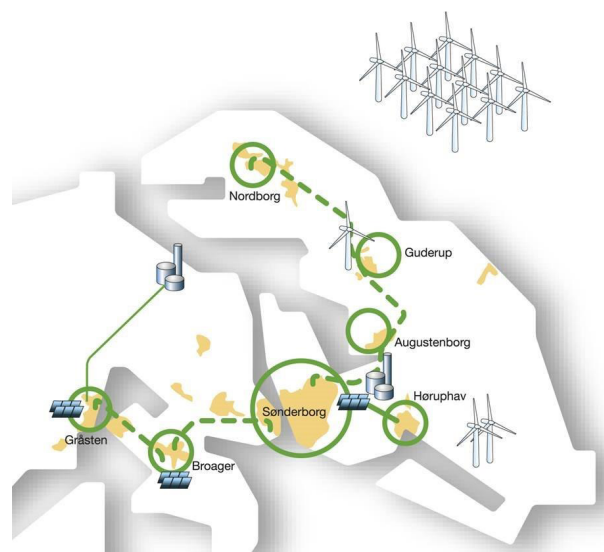


Figure 9 shows the energy system in Sonderborg municipality.

But the planning also crosses municipal borders. This calls for strong regional cooperation among clusters of adjacent municipalities to coordinate their energy- and climate actions, in order to avoid sub-optimization of solutions. Therefore, Sonderborg is also an active partner in the regional strategic energy planning process, initiated by the National Danish Energy Agency (DEA) and led by the administration of Southern Denmark Region and backed up by all 22 participating municipalities.

Detailed ProjectZero plans provide information for Roadmap2020 and Masterplan2029. Learn more about ProjectZero and its ZERO-carbon plans in Chinese and English on www.projectzero.dk.

Fits all technical solutions are available

Most technical solutions are already available in the market place but require policy, participation, education and communication to become widely spread and full scale implemented. The technical solution toolbox includes:

- Insulation, energy efficient windows, controls, pumps, appliances, electronics, lighting and attitude to improve energy efficiency in homes/buildings
- Green district heating systems to secure urban areas with renewable energy from geothermal heat pumps, solar heat, incinerated waste, wind etc.
- Energy efficient vehicles and a rethinking the role of public transportation
- Electric power from wind-turbines, solar panels, biofuels
- Green gas from biofuels
- Smart solutions to improve timely-integration of wind energy

Our progress so far

Citizen participation

Building Denmark's first ZERO+ home in Sonderborg, has had a major impact on changing citizens' perception of a home as a net producer of energy instead of merely an energy consumer. Strong citizen-participation has proven to be crucial in the success of Sonderborg's ProjectZero vision as many initiatives have been developed for different citizen segments to strengthen their participation and the impact of the initiatives. Among the most successful have been the ZEROfamily and the ZEROhome programs.

The ZEROfamily-program focused on learning 100+ families how to save energy in their every day life by awareness and picking

the low hanging fruits (energy saving light bulbs, attention on meters etc.). Average energy saving was 25% and 45% for water indicating that there is a lot to save by just allocation of more (family) attention.



The picture above shows Denmark's first ZERO+ home built in 2008 and located in Sonderborg.

The ZEROhome program provided energy-consulting to interested families measuring interest and impact. Over 2.5 years more than 1,200 homes were visited and more than 61% of the families decided to invest €20.000 (average) in energy retrofit of the building envelope and secure of renewable energy supply from PV, heat pumps, green district heating. The programs learning reflect that (Sonderborg) citizens are interested in active participation but need support and to feel safe and confident when they invest their own money in making their home more energy efficient and climate friendly.

Since 2008 kids and youth in Sonderborg have been introduced to climate and sustainability in during their learning/teaching from Kindergarten to PhD. The program has built green capacity among teachers and pre-schoolteachers and disseminates this knowledge into the teaching plans, where kids learn how to monitor, calculate and save energy at home. The program has been supported by a green teaching plan approved by the city council.



Corporate participation

App. 30% of all energy usage is consumed by companies production processes and shops, heating, lighting etc. To create participation among local industries and companies, ProjectZero has created a special program for enterprises and shops and have now more than 140 commercial participants.

The ZEROcompany program enables enterprises to learn about energy management and how to get started and harvest the first 10% energy savings. Once companies get started the experience show that energy/climate management become integrated in the management philosophies and companies have reduced their carbon emissions by up to 45%. Some companies aim at becoming carbon neutral in their operations and other companies install up to 2 MW PV-plants to cover their own need for renewable energy.

The ZEROshop program help shop-owners identify how to save minimum 10% energy by changing light bulbs, reduce stand-by consumption ect. Long term results are much bigger as some companies have reduced their carbon-emissions by up to 50% by continued focus and measurements.

District heating solutions

Geothermal heat, solar heat, heat from woodchip driven heat pumps, incineration of waste and heat from straw are the new sources for heating the district heating networks of Sonderborg. Natural gas are being phased out and only used during extreme cold winter days. In the future more energy from wind-turbines will be phased into the district heating network as the water system is an excellent “battery” for saving energy. The transition is supported by private and enterprise subscribers of heat and by the city

council being responsible for the local energy and heat planning.

The transition into the areas own renewable sources also secure heat supply and independence of changing prices on fossil fuels.

Power from wind turbines

Harvesting renewable energy from wind using wind-turbines is important for achieving Sonderborg’s ZEROcarbon goals. The ProjectZero master plan implies a major wind-turbine park to be built in a coastal zone near Sonderborg and will generate 120 MW of electricity. The project is in the early planning stage with local utility, private companies and the municipality as key stakeholders.

Wind-turbines are in Sonderborg located onshore. According to the municipal plans more onshore turbines will be built with farmers and local people as investors. On-shore turbines locations shall be developed in close cooperation with the resident living nearby the future onshore sites. Local acceptance of onshore wind turbines through local ownership has proved a crucial experience from Sonderborg.

From Sonderborg to Baoding City and Haiyan County in China

A sister city partnership between Sonderborg and Baoding city was initiated by WWF in 2008 and developed into a formal cooperation agreement during 2009–2011. Today the cities and their world leading technology companies benchmark solutions and knowledge, as Baoding for several years has been a leading Low Carbon City in China. Modern efficient district heating and PV-systems are at the heart of this benchmarking.



A recent partnership between Sonderborg and Haiyan County south of Shanghai was established in 2013 as part of the EU-China Urbanization partnership (EC-link). Across the EU and China, 12 city-partnerships have been selected to demonstrate how energy, climate, culture etc. are important drivers for successful urbanization.

Haiyan County with its 380,000 citizens is strategically located within only a 1-hour drive from Chinese metropolises such as Shanghai, Suzhou, Hangzhou and Ningbo. Based on the EU-China urbanization role model promotion, Haiyan has been appointed as a special demonstration area for sustainable urban development in China. As there are only six such areas appointed in China, there are high expectations for Haiyan to demonstrate new approaches to sustainability.

Haiyan has its main focus on energy efficient buildings, low carbon emission companies and teaching/learning across all ages and sectors. But like Sonderborg, the approach is holistic and includes also an onshore wind turbine farm (under construction), a new (scheduled) offshore wind turbine farm, and high volume solar panels on factory roofs. The ambition is during 2014-15, in cooperation with Danish engineers and solution manufacturers:

- to demonstrate solutions that can reduce energy consumption in buildings by improving energy efficiency.
- to attract Danish and Nordic companies to Haiyan through the use of these company solutions.
- to create a business-case for a “Danish Low-Carbon Street” in the city center of Haiyan.

A Danish lead business consortium is, together with the Haiyan County, administering the developing of specific plans for energy efficient new buildings and retrofitting of existing buildings to state of art Danish building codes mentioned in the introductory chapter of this booklet. A “Green Energy School” concept is being developed supporting the new role of the construction industry in energy efficient construction and retrofitting. EUC Syd (technical college & vocational training school) is together with energy efficient and smart building solutions supporting the Haiyan administration in developing new skills and mindset.

For more information please go to:

<http://ch.brightgreenbusiness.com/>

Facts on Sonderborg:

- Sonderborg has a population of 76.000 citizens. Located in the southern part of Denmark, near the German border.
- The Municipality covers an area of 500 km².
- Education and entrepreneurship goes hand in hand with a liveable city, where culture plays a vital role.
- Farming, food production, energy- and climate technologies, IT-solutions, tourism and experience economy are the dominant industries of Sonderborg.



