

## 12. Energy performance

Present details of the original and/or most recent Action Plan, including any relevant disadvantages or constraints resulting from historical and/or geographical factors, which may have influenced this indicator area negatively.

### **Overall goals and objectives in the most recent action plan; The Copenhagen Climate Plan**

In August 2009, a unanimous city council passed an ambitious climate strategy, the Copenhagen Climate Plan. Though the City of Copenhagen had been working on reducing green house gas emissions for many years, the new plan raised the level of ambition significantly.

The objective of the plan is to reduce greenhouse gas emissions from Copenhagen by 20 percent (in relation 2005) by 2015. The plan specifies 50 initiatives to achieve this objective.

More than 75 % of the reductions in the plan are to be realized through changes in the energy production and 10% are to come from energy savings.

The plan also set the goal that Copenhagen is to be a carbon-neutral city by 2025.

### **Energy consumption & performance of municipal buildings**

In 2010, the total electricity consumption in municipal buildings was 100 GWh. The total heating consumption was 320 GWh.

The city has set the goal that the CO<sub>2</sub>-emission from consumption in municipal building should be reduced by 20% by 2015 compared to 2005. Both energy savings and more renewable energy can contribute to this goal.

<b>Average annual energy consumption in municipal buildings in 2010</b>	<b>kWh/sq.m.</b>
Electricity	39
Heat	125

### **The goals for renewable energy share of all energy**

#### **District heating**

Copenhagen wants reduce its CO<sub>2</sub> emissions by 20% by 2015. 75 % of the reductions will come from initiatives in relation to the city's energy system. The main tool will be to increase the share of renewable energy in the City's district heating. This will primarily be done by switching fuel from coal to biomass at the major combined heat and power plants in the City. Thus by 2015, the district heating system will primarily be based on renewables (oil and natural gas used in peak demand situations will still constitute share of the fuel consumption, and some amount of plastic waste will still be incinerated). **The conversion from coal to biomass was initiated in 2010 and will be completed at all major CHP plants in the City by 2015.**

In relation to heat production the Copenhagen Climate Plan also encompassed the construction of a geothermal facility and implementation of an additional flue gas condensation unit.

#### **Electricity**

By 2025 Copenhagen wants to be carbon-neutral. By our definition the city will be

carbon-neutral when the heat and electricity production is carbon neutral, and the city, on a net annual basis, has a surplus production of renewable electricity that displaces fossil-based energy production elsewhere. The displacement of fossil-based energy production must be large enough to compensate for any remaining emissions from traffic, wastewater management, and industrial processes, etc.

The main tool the city will use to establish a renewable electricity production, which, on a net annual basis, is larger than the consumption, is to erect wind turbines, both onshore and offshore. The city's utility company will start to put up wind turbines as soon as possible but the lion's share of the planned capacity will be established between 2015 and 2025, if possible in a linear fashion. However, as onshore wind turbines and offshore wind farms are subject to approval from various authorities, the exact schedule of the implementation rate is difficult to predict.

### **The long term strategy for the mix of renewables vs. non-renewable**

#### **District heating**

The city plan to phase out coal on its combined heat at power plants during the next 4-5 years, primarily by switching fuel from coal to biomass. Towards 2025, the City plans to separate and recycle a larger share of the plastic waste instead of incinerating at combined heat and power plants. At the same time scale the City also wants to replace as much as possible of the oil and gas, used in peak demand situations, with biomass.

Geothermal heat and solar panels are also planned to play role in the district heating.

The renewable share of the district heat production is already is close to 50 percent and will be increased significantly towards 2015. By 2025 the district heating is expected to be almost entirely based on renewables.

#### **Electricity**

Over the 14 years period between now and 2025 the city will establish a production of renewable electricity that is as large, or larger, than the electricity consumption on a net annual basis. The main renewable technology will be wind turbines but waste and biomass incineration at the city's CHP plants is also important. Photo voltaic cells are also planned to play a role.

Thus, on a net annual, basis the City of Copenhagen will have a renewable energy production that is larger than the city's energy consumption by 2025.

### **Integration and performance of renewable energy technology in municipal buildings and homes**

In 2009 the city council adopted a strategy of installing 1000 square meters of photovoltaics on municipal buildings every year.

### **Development of compatible and integrated district systems and the facilitation of more sophisticated city-wide control**

After the energy crisis in the 1970s, a comprehensive heat-planning program was launched in Denmark, involving both municipalities and energy companies in an intense planning process. The 1979 Heat Supply Act enabled municipalities to designate certain areas for district heating and made it mandatory for households to connect to district heating. It was a successful initiative, leading to significant energy savings and a reduction in overall dependence on imported oil.

Today Copenhagen's district heating system provides 98% of the city with clean, reliable and affordable heating. This heating supply system uses heat from regional waste and sewage sludge incineration plants and combined heat and power plants (CHPs), distributing heat through a pipe system to customers in the city.

The district heating in The City of Copenhagen system is connected with other district heating systems in the entire Greater Copenhagen Area. Production and transmission is coordinated through a sophisticated market between energy production companies and heat distribution companies.

Further expansion of district heating system in the Greater Copenhagen Area, and replacement of old tubes with new ones with better insulation, is currently being planned.

Details of those targets achieved or not, to date (within the last 5 – 10 years). Provide a review of how both situations occurred and lessons learned.

### Increasing the share of renewables

Copenhagen wants reduce its CO2 emissions 20% by 2015, compared to 2005. This goal has not been reached yet but the implementation is well on its way.

The main tool to reduce the emissions 20 % by 2015 is conversion of the city's combined heat and power plants from coal to biomass. The first step in the transition from coal to biomass was taken in 2010 where unit 1 at *Amagerværket* (Amager Power Plant) was converted to biomass (coal is still used as backup fuel but the plant is subject to a requirement of a minimum percentage of biomass-based CHP production). This initiative has been the main cause of a 20 % reduction in the CO2 emissions per MWh heat from the district heating system, which was realized between 2009 and 2010.

Year	2009	2010
Grams of CO2 per kWh consumption of district heating	143	122

Thus, the transition towards a renewables-based district heating is well on its way.

#### *Fuel sources for district heating, Copenhagen 2010*

Source	GWh	Pct
Wood pellets	477	11%
Straw	217	5%
Waste (renewable share)	1693	39%
Waste (fossil share – plastic)	434	10%
Coal	998	23%
Oil and diesel	260	6%
Natural gas	304	7%
<b>Total</b>	<b>4340</b>	<b>100</b>

Increasing the share of renewables in the electricity production is expected to contribute somewhat to reducing the emission 20 % by 2015 and is crucial in relation to becoming CO<sub>2</sub> neutral by 2025.

In 2010, renewables-based electricity production in Copenhagen was equal to 24% of the power consumption in the city. This share will grow in the coming years as the City Council has issued a loan guarantee of DKK 5.5 billion (EUR 738 million) to the city's utility company in order to enable significant investments in renewable energy, primarily wind turbines. Thus, the transition towards a renewable based electricity production is well on its way.

*Renewable electricity production in Copenhagen, 2010*

Energy source	Production (MWh/year)	Percentage of total power consumption
Photovoltaic	750	0.03%
Wind turbines	97,637	4%
Waste (only the biomass share)	109,215	4%
Biomass incineration at CHPs	395,995	16%
<b>Total</b>	<b>603,598</b>	<b>24%</b>

**Improving the energy performance of municipal buildings**

The city of Copenhagen has a goal of reducing the CO<sub>2</sub> emission from the municipality's operations by 20 % before 2015. This goal has not been reached yet but the implementation is well on its way.

The City of Copenhagen has initiated an effort to retrofit its buildings. An amount of DKK 280 million (EUR 38 million) has been allocated for the years 2008 – 2014 for this purpose. Initiatives will be carried out on more than 100 buildings. So far the effort has resulted in a 5-7 percent reduction in the average climate-adjusted energy consumption reduction in these.

**Maximising and prioritising the use of renewable energy technology in municipal buildings and homes.**

The city has not yet succeeded in implementing its strategy to instal 1,000 square meters of photovoltaic cells on municipal buildings every year. Some photovoltaic cells have been installed on municipal buildings every year but the annual installed area falls short of the ambitions. However, the falling prices of photovoltaics is making it easier to reach the goal in the future.

**Measures to improve the City's overall energy demand performance**

10 percent of the reductions in the CO<sub>2</sub> emissions are to be achieved through energy savings. This goal has not been realized yet but a number of initiatives have been taken to reduce the overall energy consumption in the city:

- In relation to new buildings in urban development areas in Copenhagen, the City Council has decided that these must comply with very tight energy standards (tighter than the already fairly tight Danish building code).
- The City is cooperating with Danish energy companies, which have an energy-saving obligation (this model for realizing energy savings, which also encompasses a market for energy savings, has recently been adopted as a

general EU model).

- Energy savings is promoted through the to use urban regeneration funds to energy- renovate buildings of low energy standards
- All streetlights on public roads will be replaced with energy efficient solutions

### **Lessons learned**

Historically Copenhagen has an impressive track record in relation to energy performance as a result of the city's district heating system. The co-production of heat and electricity, made possible by the district heating, generally more than doubles the share of the energy in the fuel that is utilised, compared to standalone heat and electricity production. Hence, expansion of the district heating has created substantial reductions in the gross energy consumption. This in turn has resulted in less pollution and lower prices of heat and electricity. Thus, we have shown that solving a coordination problem among large number energy consumers can result in both environmental and economic benefits.

We have also found that using waste in the heat and power production is economically viable and reduces greenhouse gas emissions.

Another lesson we have learned is that aesthetics is important, in relation securing public support for renewable energy infrastructure. Many places plans to erect wind turbines are met with local resistance as they are thought to spoil the view. In Copenhagen, however, most people find the wind farm at Middelgrunden (close to shore) is beautiful because of the soft curve, the wind turbines draws in the landscape.

Plans to meet or revise key targets for the future and proposed approach to achieve these.

### **The 2025 Copenhagen Climate Action Plan**

In addition to the Copenhagen Climate Plan, which will make Copenhagen reach a 20 percent carbon reduction by 2015, the City is currently developing a wide-ranging action plan, the 2025 Copenhagen Climate Action Plan, which will lead the City towards carbon neutrality by 2025. A first draft of the Plan is currently being qualified through a stakeholder process and is expected to be adopted in 2012.

One of the central themes in the 2025 Copenhagen Climate Action Plan, which is still at a preliminary stage, is green energy production.

Therefore, the preliminary 2025 Climate Action Plan encompasses an ambition to erect more than hundred wind turbines (onshore and offshore) with a total capacity of approximately 360 MW.

Also included in the plan is increased separation of plastic waste, full replacement of coal with biomass in the city's combined heat and power plants (CHPs), establishment of one or two geothermal plants, installing 30,000 m<sup>2</sup> photovoltaic cells on municipal buildings, and making it easier for citizens to instal photovoltaic cells.

### **Partnerships – North Harbour Energy Partnership**

An important part of the City's green growth strategy is to engage businesses and citizens in innovative partnerships. An example of this approach is the North Harbour Energy Partnership.

The North Harbour Energy Partnership is between the City of Copenhagen, City &

Port Development, DONG Energy, Copenhagen Energy and the Ministry of Climate and Energy.

The partnership comprises nine specific projects which will all help ensure that the North Harbour becomes an urban area with innovative green energy solutions.

These will be solutions which enhance and develop the initiatives which have to be taken at all events in connection with urban development in the North Harbour, in close interplay with a wide range of enterprises.

The partnership focuses on innovative solutions which also have:

- A significant CO2 impact
- Significant growth potential
- High cost effectiveness
- Considerable market maturity in both the short and long terms
- High branding value

The specific projects in the North Harbour Energy Partnership are:

- Smart Energy
- Intelligent housing
- Street lighting
- Onshore power supply
- Electric cars
- Low-temperature district heating
- District cooling
- Heat storage
- Geothermics