



Stockholms
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Summary

Roadmap for a fossil fuel-free Stockholm 2050

Foreword

The twin challenges of reducing emissions of greenhouse gases to a level that meets the UN's two-degree Celsius limit and ending society's dependence on fossil fuels are probably the most important and most difficult obstacles that humanity has to overcome in the century ahead. What is already obvious is that, if achieving these aims is to be possible, stakeholders at every level – from global to national and all the way down to local and grassroots level – must play their part and all pull together. With individual nations and the international community seemingly bogged down in the same old rut, playing a waiting game, it is left to the cities to shoulder responsibility by addressing a global problem through their own local efforts.

As the capital of Sweden and the nation's engine for growth, Stockholm has an opportunity to take the lead in this work by demonstrating that it is possible to phase out fossil fuels and reduce emission levels while still sustaining growth and meeting the challenge of a rise in population.

The conclusion reached in the City's roadmap is that we are, indeed, facing a major challenge that ought not to be underestimated, but also that it is fully feasible to achieve the goal we have set ourselves. Success, however, will be predicated on resolve and hard work. As not all the mechanisms and policy instruments needed to achieve the goal are within the purview of the city authorities, a significant number of decisions are also required at government and county council level, as well as from other stakeholders.

For the first time ever there is now a concrete description and a plan for how Stockholm can achieve its long-term goal of becoming fossil fuel-free by 2050. This marks the start of yet another important chapter in the City's commitment to acknowledge its share of local responsibility for the global challenge of climate change. It is hoped that this will also serve as a source of inspiration for other cities that will follow our lead in our endeavours to build a greener and more beautiful world.

Stockholm, 24 March 2014



Per Ankersjö
Vice Mayor of Urban Environment,
City of Stockholm

Roadmap for a fossil fuel-free Stockholm 2050

The roadmap was approved by the Municipal Assembly of the City of Stockholm on 24 March 2014. The roadmap was approved by the Environment and Public Health Committee on 12 March 2013 and has since been referred for broad consultation both within and beyond the offices of local government. This process has generated a large number of points of view, many of which have been incorporated into this final report.

Global climate goals

According to the UN Framework Convention on Climate Change, climate change is manageable as long as the average global surface temperature does not rise by more than two degrees above the pre-industrial level. This permits concentrations of greenhouse gases to stabilise at a level that ensures that human impact on the planet's climate system will not have catastrophic consequences.

To restrict global warming to within the two-degree range, total greenhouse gas emissions worldwide need to start falling by 2020. If the trend is not reversed until some later date, the scope of subsequent greenhouse gas emissions will need to be more extensive and the pace quicker.

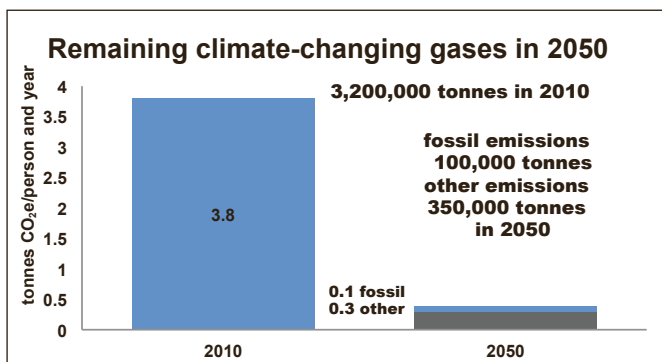
The two-degree target corresponds to total greenhouse gas emissions of no more than 1.5 tonnes per capita worldwide. The Stockholm Roadmap focuses exclusively on greenhouse gas emissions from the City's own energy use and from transport in the city, and on how these can be reduced.

Stockholm's target for 2050

The City of Stockholm's goal is to ensure that Stockholm is fossil fuel-free by 2050. The roadmap describes how fossil fuels can be replaced by other sources of energy and how the overall need for fuel can be reduced through the introduction and implementation of energy efficiency measures.

The roadmap assumes that by 2050 the population of Stockholm will have risen to 1.2 million, an increase of 40 percent compared with the figure for 2012.

It has been calculated that this expanding population will generate a need for 5,000 new homes a year – a total of 190,000 new homes by 2050. The need for premises for shops, offices, schools, hospitals, etc. is expected to increase to keep pace with the rise in the number of residents; so, too, is the demand for travel and goods transportation in the city. This means that the city can expect its total energy needs to increase by 40 percent.



Estimated greenhouse gas emissions expressed in tonnes per inhabitant in Stockholm in 2010 and 2050.



Photo: Fredrik Persson

Roadmap for a fossil fuel-free city by 2050

The Stockholm Roadmap illustrates the potential for ensuring that the energy used within the geographical boundary of Stockholm is fossil fuel-free by 2050. In addition, it indicates how large the remaining methane gas and nitrous oxide emissions will be, together with LCA emissions.

The roadmap also shows how energy use can be reduced in the city, so that energy needs for transport, heating and electricity consumption can be met from renewable sources.

The calculations in the roadmap take full account of all energy use and all emissions of greenhouse gases within the geographical boundary of Stockholm Municipality for:

- Heating and cooling premises.
- All types of road transport.
- Railways and shipping.
- Flights to/from Bromma Airport up to 915 metres (3,000 feet).
- Other gas and electricity used by homes and businesses, for example for the production of goods and services.

The calculations do not include greenhouse gas emissions from:

- Travel undertaken by Stockholm residents outside the city boundary.
- The production of foodstuffs or other goods consumed by/ services utilised by Stockholm residents, that are produced outside the city boundary.
- Freons in cooling media and construction waste.
- Nitrous oxide used for medical purposes.
- Short-lived climate compounds, with the exception of methane and nitrous oxide generated during the combustion of fuels.

Fossil fuels today

The fossil fuels currently used in Stockholm are:

- Coal in the Värtan combined heat and power plant (CHP 6) for the production of district heating and electricity.
- Oil for heating boilers in buildings, for heating plants producing district heating, for industry and for shipping.
- Natural gas for heating boilers in buildings, cooking stoves and vehicles.
- Petroleum for road vehicles.
- Diesel for road vehicles, construction machinery and shipping.
- Aviation fuel.
- Fossil-fuel based plastic that constitutes one of the fractions in the waste supplied to heating plants for the production of district heating.

Fossil fuels in 2050

The roadmap shows how the use of fossil fuels can be more or less eradicated by 2050; total emissions of greenhouse gases are estimated to decline from 3,200,000 tonnes of CO₂e in 2010 to 450,000 tonnes in 2050. The calculations show that greenhouse gas emissions per capita will fall from 3.8 tonnes per year to 0.4 tonnes per year in 2050.

It is estimated that approximately a quarter of the greenhouse gas emissions that remain in 2050 will come from the use of fossil fuels, chiefly in the form of plastic derived from fossil fuels that is combusted in the production of district heating. The remaining three quarters will comprise various supplements for life cycle assessments and direct emissions of methane and nitrous oxide.

Timetable

As climate changes are a consequence of the aggregate emissions of greenhouse gases in the atmosphere, the recommendation is made in the Stockholm Roadmap to reach a decision on and implement measures at the earliest possible opportunity.

This is especially important in the case of measures that it is expected will take a long time to implement, such as the expansion of public rail transportation and **the imposition of environmental protection zones where access is limited to vehicles that run on biofuels or electricity.**

It is also important that priority is given to measures that need to be worked on continuously throughout the entire period, and that ambitions with regard to these are set high from the outset. Examples of such measures are the shift to fossil fuel-free district heating, energy efficiency measures in buildings, improved bus services and measures to facilitate pedestrian and cycle traffic.

Abbreviations and explanations

CO₂e – Carbon dioxide equivalents. The sum of the effect of these greenhouse gases: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) weighted by their respective global warming potentials (GWP₁₀₀).

LCA – Lifecycle analysis. The impact from production and distribution of, for example, a fuel and, where applicable, the disposal of fuel waste.

REFUSE-DERIVED FUEL (RDF) or SOLID RECOVERED FUEL (SRF) – Waste from offices, business and industry that cannot be recycled.

INDIRECT EMISSIONS – Emissions caused by an activity but not directly related to that activity in time or space.



Photos: Johan Penten

Kyrksjölöten's nature reserve in Stockholm.

Buildings

Energy production

Energy is used to heat properties, for tap water and for air conditioning. Basically, this is in the form of district heating, electricity for heating and oil for heating boilers. The fossil fuels used for heating are coal, fossil oil, plastic waste, RDF/SRF and natural gas.

District heating

Coal is used as a fuel for the production of heat and electricity in the Värtan CHP plant (CHP 6). Much of the electricity is used by Fortum Värme to operate the heat pumps at the Värtan plant. Fortum Värme is currently working to gradually replace coal with biofuels.

There are, however, technical complications relating to this changeover, so it remains uncertain just how large a proportion of coal can be replaced by biofuels. The roadmap presumes that Värtan CHP 6 will have been decommissioned by 2050 and that coal will therefore have been totally eliminated as a fuel.

Waste and RDF/SRF are currently being used as fuel for district heating and there are plans to increase their share of the total energy mix. However, this fuel contains significant amounts of fossil-based plastics. If the city is to become fossil fuel-free, these plastic fractions must be separated from the waste.

While it will probably be possible to manufacture more plastics in the future using biobased raw materials, the roadmap presumes that there will still be some fossil plastics in 2050. To ensure good resource management, plastic that has served its useful life ought to be used as fuel, even though this conflicts with the goal of a fossil-free city.

Fortum Värme intends to offset its emissions of greenhouse gases through compensatory measures for the small quantity of fossil fuel used for district heating.

From fossil oil to renewable energy

Fossil oil for heating is used only to a limited degree in the city. Fossil oil needs to be totally phased out and replaced by 2050.

Some 600 multi-occupancy dwellings and a few thousand private homes are still heated by oil-fired boilers. During the past 20 years much of the fossil oil previously used has gradually been phased out and the roadmap presumes that this trend will continue.

The district-heating system has oil-fired boilers that are used in the coldest weather and emergency back-up power plants for hospitals, server farms, etc. It is already technically possible to replace fossil oil with biodiesel in these reserve power plants.

Gas for heating

A limited amount of gas from the city's gas grid is used as energy for heating boilers. It is, of course, possible to replace gas with biogas, but this does require a significant expansion of biogas production.

Preconditions for fossil fuel-free heating:

- CHP 6 converted totally to biofuels or decommissioned.
- Oil-fired boilers, local heating plants and buildings are heated with biogas or some other form of heating.
- Reserve/emergency power plants to run on bio oil or similar.
- Natural gas in the city gas grid to be replaced by biogas.



Photo: Svarpunkt AB

Buildings

Energy consumption in buildings

Demand for biofuels will increase worldwide as the change-over from fossil fuels takes place. This will lead to a risk of biofuel shortages and high prices. For this reason, energy consumption needs to be low; this may be essential in order to achieve the goal of a fossil fuel-free city.

New construction

The roadmap presumes that energy consumption in newly built properties will be less than half the level prescribed by current Swedish building regulations. Following a decision made by Stockholm City Council in December 2011 stricter new requirements relating to energy use have been introduced for new construction on land earmarked for development. Technological advances over the coming years may well see a further tightening of these requirements.

Existing properties

There is huge potential to reduce energy use in existing properties in the city. However, in the case of the many buildings in the city that are worthy of protection, the potential for energy efficiency measures is limited. The roadmap is predicated on the assumption that the city's existing building stock can reasonably be made 30 percent more energy efficient.

Preconditions for energy-efficient buildings:

- The City can prescribe high standards for energy-efficient buildings on land earmarked for development.
- Financial instruments are available for financing energy efficiency measures in existing buildings.

Electricity and gas

Electricity and gas are used for household electricity and operational electricity, and include all electricity apart from that used for heating and transportation.

Use of electricity

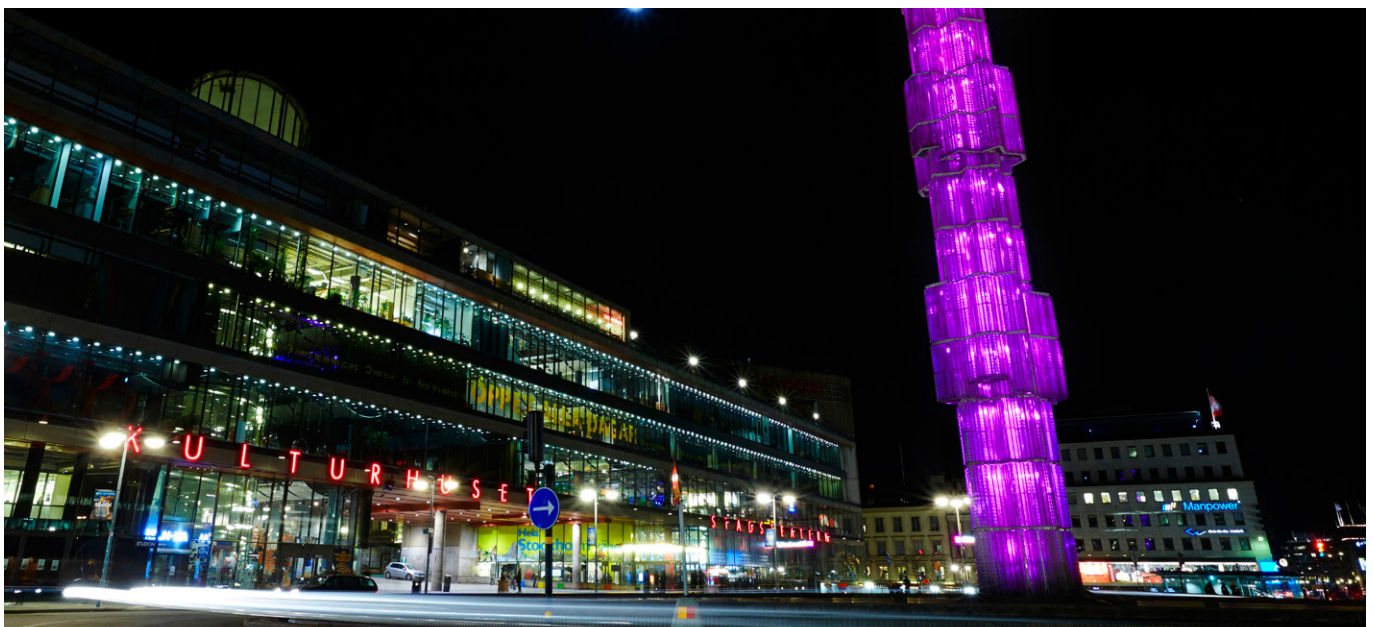
There are no direct emissions of greenhouse gases when electricity is used in Stockholm. For that reason, the goal of creating a fossil fuel-free city has only an indirect impact on the use of electricity. However, there is a considerable amount of uncertainty about how electricity will be produced in the future. The roadmap presumes that by 2050 electricity produced in Sweden and the Nordic countries will be based on renewable sources of energy.

Use of gas

Gas in the city gas grid is used for cooking, various commercial processes (such as the city's crematoriums) and for boilers. Today this gas is a mixture of natural gas and air. The gas can be replaced by biogas.

Preconditions for fossil fuel-free gas:

- Natural gas in the city gas grid is replaced by biogas.



Transport

Fossil fuel-free transport

It is presumed that transport in Stockholm will reflect the projected increase in the population of the city. Based on today's traffic structure, this means an increase of 40 percent compared with figures for 2009, increasing greenhouse gas emissions to 1,380,000 tonnes by 2050 unless measures are taken to counteract this.

Various solutions to reduce emissions have been investigated. The roadmap proposes a combination of restrictions and expansion of public transport, cycling and freight logistics combined with investments in energy-efficient clean cars running on renewable fuels.

Emissions are estimated to fall from 1,380,000 tonnes to about 69,000 tonnes. Emissions would not be totally eliminated because electricity and biofuels are not entirely fossil-free.

Costs

The costs of this scenario are estimated to be higher than if the introduction of severe restrictions were the only measure taken. However, the costs are significantly lower than if expansion of public transport were the only measure taken. The costs are probably also lower than those incurred by implementing the alternative that consists solely of investing in energy-efficient "clean" vehicles; this is because the vehicle costs decrease if a combination of the alternatives is used.

More efficient travel

Reduced use of cars for private transport

The work of planning new residential areas in Stockholm presents an opportunity to ensure that essential facilities are close at hand even in the suburbs by locating key social functions within walking and cycling distance from people's homes.

Provided that the IT infrastructure continues to develop and expand in all parts of the city, distance working/telecommuting and virtual meetings can reduce the need for travel and replace some of the physical journeys that are common in certain trades and professions today. Local job cafés expand the local service offer and help to reduce the need for travel.

Trips of just 10 kilometres or less currently constitute around 50 percent of all car journeys made by Stockholm residents. In many instances these journeys can be replaced by walking and cycling.

From private to public transport

To encourage more people to travel by bus, rail and tram, the underlying infrastructure for public transport needs to be significantly expanded, while restrictions need to be introduced to reduce the appeal of travelling by car.

The proportion of journeys made using public transport needs to rise from 50 percent to 75 percent, while also managing the challenges posed by the increase in population. This requires doubling today's level of public transport services. To increase the numbers of bus and tram passengers, these forms of transport need to be prioritised by giving them right of way at signals and by dedicating a much larger portion of the road network solely to public transport and keeping it free from private vehicles. These measures will also help to inhibit the growth in other road traffic.



Photos: Lemnart Johansson

Transport

More efficient goods transport

The transportation of goods accounts for approximately 35 percent of greenhouse gas emissions from road traffic in Stockholm. A rise in population will lead to greater needs, not only for goods to be brought into the city, but for the proportionately larger amounts of waste they generate to subsequently be driven away.

Emissions resulting from the distribution of goods can be reduced by 20-25 percent. There is great potential to make goods distribution more efficient, first and foremost by increasing the coordination of deliveries and optimising delivery routes and times.

More efficient vehicles with renewable fuels

It is feasible to reduce the energy used for transport by almost half by 2050. The most important factors for making vehicles more energy-efficient are EU directives on emission norms for new vehicles and the price of fossil fuels. The roadmap presumes that vehicles will run on renewable fuels or electricity by 2050.

Preconditions for more efficient, fossil fuel-free travel:

- Public transport must almost double in capacity and measures must be taken to reduce road traffic.
- Investments in measures to benefit distance working/telecommuting.
- Increased pedestrian and cycle traffic.
- Development of the City's synoptic planning to higher-density development close to public transport.
- A well-developed infrastructure in the city for renewable fuels.

Aviation, shipping and construction machinery

Calculations of greenhouse gas emissions in Stockholm include flights to and from Bromma Airport up to 915 metres (3,000 feet) above ground level, and shipping within the city's geographical boundary.

Air traffic at Bromma

The roadmap presumes that Bromma Airport will still be in operation in 2050. Aviation fuel is a fossil fuel. It is expected that a quarter of aviation fuel will still be fossil-based by 2050.

Shipping

Vessels docking in Stockholm are powered by oil, diesel or natural gas. The calculations used for the roadmap are based on the number of port calls remaining unchanged at today's levels. The number of cruise ships docking within the city's geographical borders is expected to rise. While it should be feasible to run archipelago ferry/boat services and scheduled traffic in the Baltic Sea without having recourse to fossil fuels, it is probably realistic to assume that a large part of other traffic will still use fossil fuels in 2050. Developments in this regard are uncertain and powers of authority over international shipping are limited.

Construction machinery

Diesel is the most widely used fuel for construction machinery and this can already be replaced by biodiesel. By 2050 all construction machinery is expected to run on fossil-free fuels, provided that sufficient quantities of biodiesel are available.



Photo: Lemnert Johansson



Photo: Yaron Li

This is an abridged version of the City of Stockholm's Roadmap for a fossil fuel-free Stockholm 2050

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