Stockholm action plan for climate and energy 2010–2020

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A report from the Environment and Health Department
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The Stockholm action plan for climate and energy 2010–2020 has been partly financed by the EU project COMBAT under the Central Baltic Interreg IV A Programme 2007–2013.

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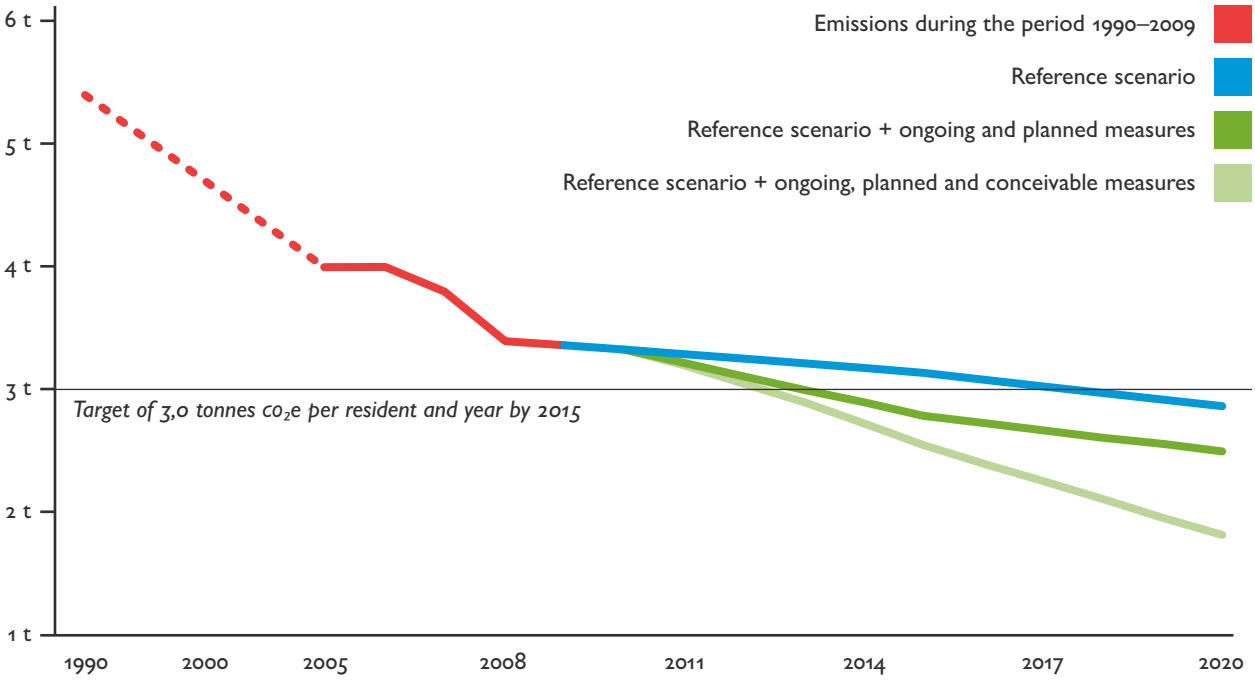
co_2e per resident and year



Graph 1. Different scenarios for greenhouse gas emissions in the City of Stockholm per capita between the years 1990 and 2020. (The reason for the rapid decrease between 2007 and 2008 is a heavily reduced emission factor for electricity (–123,000 tonnes) which in the reference scenario is assumed to remain unchanged after 2008)

Year	Total emission thousand tonnes co_2e*	Decrease thousand tonnes co_2e	Emission per person in Stockholm
1990	3668		5.4
2000	3509		4.7
2005	3109		4.0
2009	2775		3.4
2015 according to reference scenario	2590	185	3.1
2015 ongoing and planned measures	2303	287	2.8
2015 conceivable measures	2109	481	2.5
2020 according to reference scenario	2435	155**	2.9
2020 conceivable measures	1548	561***	1.8

Table 1. Emission of greenhouse gases, 1990–2020. (ERR · 1)

* Carbon dioxide equivalents (co_2e) are the aggregated greenhouse gas effects of various gases expressed in terms of an equivalent amount of carbon dioxide.

** Decrease compared with emissions in 2015 according to the reference scenario (blue line in Graph 1)

*** Decrease compared with emissions in 2015 if all conceivable measures are implemented (light-green line in Graph 1).

1 Summary

In the City of Stockholm, the emissions of greenhouse gases from traffic, electricity and heating are estimated to decrease by over 24 per cent between 1990 and 2009. It is the City's target to reduce greenhouse gas emissions to 3.0 tonnes per capita by the year 2015. The potential for achieving this target is good.

According to the estimates in the reference scenario, i.e. the measures taking place in the development of society, greenhouse gas emissions will decrease to 3.1 tonnes per capita, or almost 2,600,000 tonnes in total, by 2015. The estimates assume a continued trend towards a more efficient vehicle fleet, energy-efficiency improvements as a result of technological development and an increased use of district heating.

A number of ongoing or planned measures in addition to the reference scenario will result in a further decrease of almost 0.35 tonnes per resident, or to 287,000 tonnes in total by the year 2015. These measures do not include district heating, since this is included in the reference scenario. (ERR · II)

In addition to the measures identified in the reference scenario, or which are in progress or planned, the report also proposes a catalogue of conceivable measures. If all the conceivable measures presented in this report were to be fully implemented, greenhouse gas emissions would decrease by a further 194,000 tonnes before 2015, or by 0.23 tonnes per resident. However, this is unlikely to happen, among other things because the City of Stockholm does not have full right of disposition over all the proposed measures.

The measures include Fortum making a 50 per cent conversion from coal to renewable fuels in the company's coal-fired combined heat and power plant at Värtan. This would serve to decrease the emissions of greenhouse gases by 235,000 tonnes per year, or 0.3 tonnes per resident and year. Fortum considers that it will be possible to achieve this decrease by 2015. (ERR · III)

Finally, there is a considerable theoretical potential for reducing greenhouse gas emissions if all building properties in Stockholm were to undergo energy-efficiency improvement to the same extent as is being carried out on municipal property holdings. The same applies to the acquisition of clean vehicles, in which context the City of Stockholm has decided to purchase only clean vehicles. These theoretical potentials are described in the plan, although not to the same extent as measures in which consideration has been given to cost efficiency and the City of Stockholm's right of disposition. (ERR · IV)

To summarise, this means that the City of Stockholm should achieve its target by 2015, provided that ambitious efforts continue to be made.

2 Introduction

In Stockholm, the emissions of greenhouse gases are estimated to have decreased by over 24 per cent between 1990 and 2009. During the same period, the population of Stockholm has increased by 22 per cent. Bearing in mind both the decrease in emissions and the increase in population, the reduction in greenhouse gas emissions is estimated to be 38 per cent per resident between 1990 and 2009.

The City of Stockholm's long-term goal is to be fossil fuel-free by 2050. The City Council has adopted the interim target of greenhouse gas emissions not exceeding 3.0 tonnes per capita by 2015. The purpose of this action plan is therefore to demonstrate how the City can reduce greenhouse gas emissions by the year 2015 from transport, electricity, heating and district cooling within the City boundaries.

The action plan also includes estimates on how much the City can reduce greenhouse gas emissions by the year 2020. In February 2009, the Mayor of Stockholm signed the Covenant of Mayors. Through this covenant, cities in Europe undertake to try reducing greenhouse gas emissions by more than the level decided by the EU, or in other words to reduce greenhouse gas emissions by over 20 per cent between 1990 and 2020. An account of the work is to be submitted by the City to the EU in the sustainable action plan (SEAP), i.e. this plan. Follow-up reports on the plan will then be submitted to the EU every second year.

In order to be able to report progress in accordance with the Covenant of Mayors, apart from ways in which the City can achieve its own target, this plan therefore also specifies how much the City can reduce its emissions of greenhouse gases by the year 2020. The figures for 2020 are based on estimated data, which introduces an element of uncertainty regarding what sort of impact the measures can have by 2020. Stockholm achieved the Covenant of Mayors' target at the end of 2003.

In this plan, the measures to achieve reduced emissions of greenhouse gases are divided into planned and ongoing measures, and conceivable measures.

Ongoing and planned measures comprise those measures that are already in progress or have been decided within the City. They sum up those measures that are most important for emission reduction.

Conceivable measures are a selection of those measures that are most cost-efficient, the City has the greatest right of disposition over, and which may need to be implemented in order for the City to be able to achieve the target of 3.0 tonnes of CO_2e per resident and year by 2015. But above all, the conceivable measures aim at studying how the City can continue with its climate efforts once the 3.0 target has been achieved.

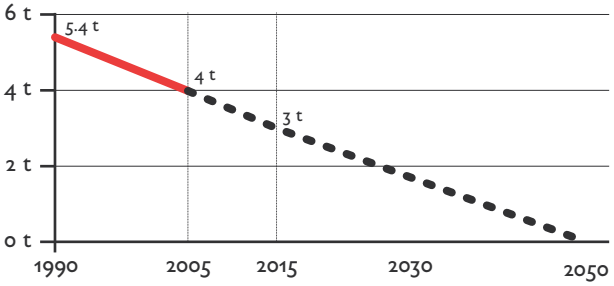
3 City of Stockholm climate efforts, 1990–2009

The City of Stockholm has a long and unbroken tradition of ambitious environmental efforts. During recent decades, the City has undertaken various initiatives and driven development to reduce climate impact. The City of Stockholm is now working together with its residents, industry and commerce, and authorities to achieve its established climate targets. It is endeavouring to reduce emissions from both its own organisation (referred to in this plan as the City of Stockholm) as well as from other operations within the City's geographical boundaries (the municipality).

One of the success factors for Stockholm's climate efforts is the City's systematic process for achieving concensus in advance of political decisions. Emissions are established and analyses made to determine which of the measures are cost-efficient and which of them can be implemented over the next few years. Emission targets are then proposed on the basis of this data. Since climate targets are decided by the City Council, they have an impact throughout the entire organisation. The targets are then followed up.

The City's long-term goal is to continue cutting back on greenhouse gas emissions at the same rate as up to now. This will result in a fossil fuel-free Stockholm by the year 2050. To achieve this target, a new emission target has been adopted in the City budget for 2009. Emissions shall be reduced to 3.0 tonnes of greenhouse gases (CO_2e — Carbon dioxide equivalents — the effects of different greenhouse gases expressed as an equivalent quantity of carbon dioxide) by the year 2015, which means a decrease of 44 per cent per resident calculated from the level in 1990. Pending this decision, an analysis has been made of the most cost-efficient measures for reducing emissions by 2015.

CO_2e emissions per resident and year (tonnes)



Graph 2. The City's climate targets. Emissions have not decreased linearly, and are not expected to.

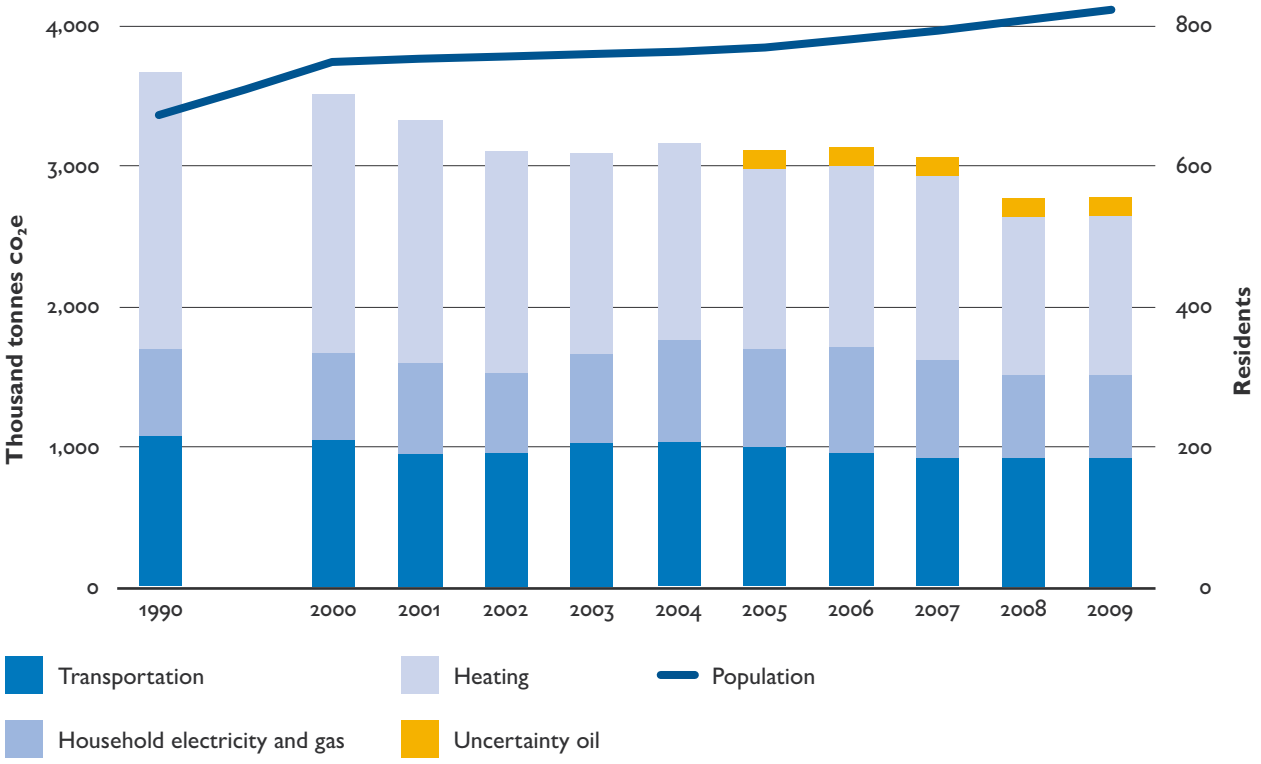
3.1 Greenhouse gas emissions, 1990–2005

The City of Stockholm has been working on action plans to combat greenhouse gas emissions since the mid-1990s.

The target of the Environmental Plan for Stockholm (1995–2000) was, by the year 2000, not to exceed the level recorded in 1990 for greenhouse gas emissions from electricity, heating and transportation. In 1990, the emission level was 5.4 tonnes per Stockholmer and year. The target was exceeded; at the end of 2000 the emission level was approximately 4.5 tonnes per Stockholmer and year.

The City Council decided in 1998 that the emissions should be cut by 20 per cent between 1990 and 2005. This target was revised in the second action plan, which was adopted by the City Council in 2003, to specify that greenhouse gas emissions should be reduced to 4.0 tonnes per resident by the year 2005. This was achieved in 2005 when emissions were reduced to 4 tonnes per Stockholmer and year.

Emissions in Stockholm were reduced by a total of 655,000 tonnes of greenhouse gases between 1990 and 2005, which is a decrease of 18 per cent. Calculated per person and with a population increase of 14 per cent, emissions decreased from 5.4 to 4 tonnes of greenhouse gases per resident, or by just over 25 per cent per resident.



Graph 3. Reduction in the emissions of greenhouse gases over the period 2000–2009 divided by sector, and the population trend throughout the same period. The figures for 2008 and 2009 are preliminary. "Uncertainty oil" is a statistical error that has been adjusted and reported separately.

3.2 Greenhouse gas emissions and energy use in Stockholm, 2006–2009

The emission of greenhouse gases in Stockholm continued to decrease over the period 2006 to 2009. Some of the factors that indicate this are energy use in buildings, trends in car sales, taxes, emission factors, etc.

Within the heating sector, an increasing number of properties are being connected to the district heating system with a corresponding phasing-out of oil and city gas, which is leading to a decrease in net emissions. Emissions from electricity production (Nordpool) are expected to continue to be low throughout the entire period. The use of renewable fuels is increasing, as too is the percentage of vehicles powered by renewable fuels.

The population of Stockholm is increasing at a rate of just over one per cent per year, a factor which has, among other things, prompted an increase in housing construction. New residential buildings are more energy-efficient than existing buildings, and are to a large extent heated by district heating. At the same time, energy-efficiency improvements in the existing building stock are leading to energy emission reductions that correspond roughly to the increase in emissions resulting from increased building development. Another impact of the population increase is that traffic is assumed to increase by one per cent per

Anticipated trend in emissions over the period 2006–2009 per sector

- The emissions from heating are expected to decrease by 10.3 per cent, largely owing to the conversion from city gas and oil to district heating.
- Emissions from electricity are expected to decrease by 16.3 per cent – despite electricity use increasing somewhat – because only a limited amount of electricity used in Sweden is generated by fossil fuel.
- Emissions from the transport sector are estimated to decrease by 7.4 per cent. The increase in clean vehicles and improvements in construction plant and other machinery are important factors in this context.

year. However, the growing use of renewable fuels is leading to a largely unchanged emission level from the transport sector.

The estimates of energy use and greenhouse gas emissions for the period in question are of a preliminary nature. The final statistics are subject to a time lag of eighteen months. This means that estimates up to and including 2007 have a statistical basis, but that the estimates for 2008 and 2009 are based on preliminary statistics and assumptions.

Since 2005, it is calculated that the emissions of greenhouse gases have decreased from 3,109,000 tonnes to approximately 2,775,000 tonnes in 2009, or by 10.7 per cent. On average, this is a decrease of 2.6 per cent per year. Emissions in 2009 are estimated to be 3.4 tonnes per resident in Stockholm.

The majority of the statistics that serve as a basis for the emission estimates have a time lag of approximately eighteen months, which is why the figures for 2008 and 2009 have had to be estimated.

Since 2005, statistics have also been marred by uncertainties regarding use of oil in Stockholm. According to statistics received from Statistics Sweden (SCB), the use of, above all, heavy oils is on the increase in Stockholm. There are no indications to support this. Quite the contrary in fact – the use of oil is being phased out within both heating and transportation. Consequently, the City has decided in its estimates to let the use of oil to remain at the same level as in 2004. The City's climate target was based on the incorrect statistics with increased oil supplies. The error from 2004 will be allowed to remain so that the City can continue to work for the same percentage reduction without having to adjust the target downwards. The error is reported as uncertainty in the oil statistics.

3.3 Measures that have led to substantial reductions in emissions

Those measures which together account for the greatest share of greenhouse gas emission reductions in Stockholm are:

District heating and heat pumps

In an increasing number of properties, oil and gas-fired boilers are being replaced by district heating and heat pumps. This is the single largest reason for the decrease in emissions in Stockholm. Today, district heating is being produced with almost 80 per cent renewable energy sources or energy from waste or residual waste heat. The district heating system covers over 80 per cent of Stockholm's total heating needs.

Energy-efficiency improvement in buildings

Energy-efficiency improvement in buildings is another important measure that is being implemented to reduce energy use. The most cost-efficient measures involve improving building automation systems for ventilation and heating. Other important measures include the insulation of windows and conversions to more efficient lighting systems. There has been no follow-up to determine how large the savings have been.

Production of district cooling

The production and distribution of district cooling allows less efficient cooling units to be phased out. For the production of district cooling, use is made of cold water from lakes and the sea. In addition, the process utilises the cooling effect that is generated in heat pumps that extract energy from lakes or wastewater. No follow-up has been made of this measure.

Clean vehicles and renewable fuels

Since the mid-1990s, the City has been working to increase the proportion of clean vehicles on the market and the use of renewable fuels to power them. Just over 35 per cent of all new vehicles sold in the region are clean vehicles. This gives a further annual reduction in greenhouse gas emissions of approximately 10, 000 tonnes.

Congestion tax

To deal with congestion and traffic disturbances, a congestion charge was implemented in Stockholm in 2007. Since then, traffic to and from the city centre has declined by an average of almost 20 per cent in one year. Greenhouse gas emissions in Stockholm have decreased by just over one per cent as a result of congestion tax. Congestion tax have contributed to an increase in the number of clean vehicles in Stockholm from 3 per cent in January 2006 to 15 per cent in 2009, since clean vehicles registered before 2009 are exempt from congestion tax until the year 2012. Despite the substantial increase in the number of clean vehicles, there has been no increase in the volume of traffic to and from the city.

Investments in public transport

Investments in public transport have a considerable impact. Public transport has a market share to and from the city centre of 75 per cent during the rush hour periods. Over the entire day, an average of 66 per cent of all passenger transport is by public transport. Only 5.3 per cent of all greenhouse gas emissions within the transport sector come from public transport. Investments in biofuels to power buses have led to further reductions in emissions.

Measures to promote use of the cycle

The use of cycles in Stockholm has doubled over the past ten years. This is due mostly to investments in cycle paths and cycle lanes.

Communication projects

The City of Stockholm is conducting a number of communication projects within the climate area focused on Stockholmers and the business community. The purpose is to increase the level of awareness about what can be done to reduce greenhouse gas emissions and overall energy use.

3.4 Principles applied in estimates

The estimates of greenhouse gas emissions cover fossil-based carbon dioxide (CO_2), fossil-based methane (CH_4) and nitrous oxide (N_2O) from energy use for heating, electricity and transportation in Stockholm. Since methane and nitrous oxide have a stronger greenhouse effect than carbon dioxide, the emissions are converted into greenhouse gas equivalents (CO_2e). The emissions are estimated on the total life cycle of the energy source and include emissions of the above greenhouse gases generated during production and distribution.

The geographical limits of the estimates are Stockholm's municipal boundaries. This means that emissions from journeys made by Stockholmers by road, rail, air and ferry outside the municipal boundaries are not included. Furthermore, emissions from goods and food products that Stockholmers consume, but which are manufactured and produced outside the city, are not included either. On the other hand, the figures do include, for example, all road works carried out within the municipal boundaries irrespective of by whom.

Emissions of greenhouse gases from sources other than combustion, for instance freons in refrigerants and construction waste or nitrous oxide within the health care sector, are not included in the goals for the action plan, and are thus reported separately.

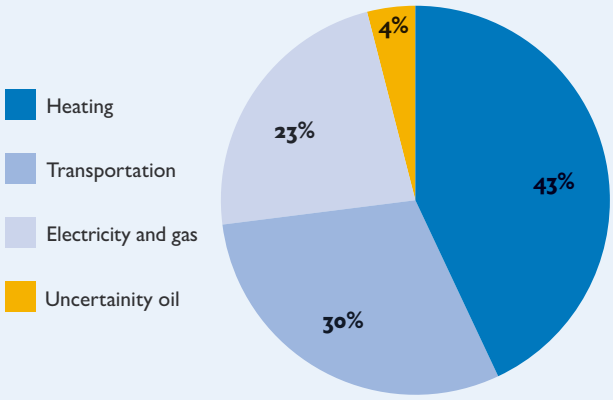
The City's estimates of greenhouse gas emissions are based primarily on statistics from Statistics Sweden for heating and electricity use and from the City's Environment and Health Administration for road transport.

Emissions from district heating are calculated mainly on the emissions from Fortum's production in Stockholm. The emissions from electricity use are calculated on the basis of emissions from production in Nordpool. In those cases where there are long-term agreements for electricity that fulfil the requirements for environmental certification, due consideration is given to this fact.

The emissions from district heating are adjusted by an average value based on the year of measuring and the actual values of the previous four years. In the same way, the emission factors for electricity are adjusted in order to balance the variations in hydropower generation over different years. The energy use for heating purposes during a normal year is adjusted on the basis of changes in the weather.

Stockholm total emissions calculated on a sector basis

- **Heating**
  Oil, city gas, district heating, industry (production and heating), electricity for heating, wood fuels (chips, pellets, lignin, etc.) and waste
- **Electricity**
  Electricity and gas use (apart from that used for heating and transport)
- **Transportation**
  Road transport, shipping, electricity for rail transport, air transport (during take-off and landing up to a height of 915 m, according to the Swedish Civil Aviation Authority, Luftfartsverket's, directive) and machinery



Graph 4. Share of emissions by sector in Stockholm, 2007. The City's climate targets are based on inaccurate statistics with increasing oil supplies. The error is reported as "Uncertainty oil" so that the target does not have to be revised.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STOCKHOLMS ELEKTRICITETSVERK

4 Expected development, 2010–2015

In order to be able to assess development over the following five years, the City of Stockholm has conducted two surveys.

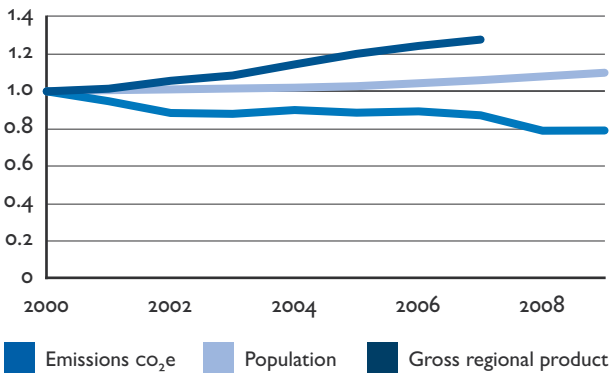
One of the surveys is a reference scenario with forecasts and an analysis of the most significant international and national development factors that are beyond the City's control and which have an impact on the City's emissions of greenhouse gases. Examples of such factors are anticipated population trends, price trends, electricity production and other factors that influence energy use and emissions. The analysis provides an indication of how the factors influence development both individually and jointly.

One example is the development of energy-efficiency improvement measures in the existing building stock. In the reference scenario, it is assumed that the energy-efficiency improvements will result in approximately 1 per cent lower energy use between the years 2010 and 2015. Stockholm municipality building companies have decided to improve energy efficiency by on average 18 per cent over the same period. The effects of the more far-reaching 18 per cent decision are presented in the survey for planned or ongoing measures.

4.1 Impact of surrounding factors

The population growth in Stockholm has during recent years been considerably larger than was originally predicted. According to the City's vision, "Vision 2030", the population is expected to be in the region of 826,000 by the year 2015. By the end of September 2009 the population had already reached 825,100. The estimates in this report assume a population of 825,000 at the end of 2009 and thereafter a development in line with Vision 2030. This means that the population level has been underestimated in the reference scenario, and consequently that the decrease in emissions per resident may be expected to be higher than calculated. The increase in population is a result of high birth rates, the fact that families with children are remaining within the municipality and that there is a high influx of people moving into the area.

The increase in emissions as a consequence of population increase is included in the estimates for emissions from heating and transportation. Increases in emissions are for the same reason expected to be lower than calculated.



Graph 5. Historical picture of the development of greenhouse gas emissions, population and gross regional product in Stockholm 2000–2009.

The growth in population between 2006 and 2009 is 6.1 per cent. Over the same period, greenhouse gas emissions into the atmosphere are expected to decrease by 10.7 per cent in Stockholm, despite the increase in population.

Electricity use is expected to increase as a result of the increasing population. At the same time, electricity use is decreasing since new electrical equipment is more efficient than older units and traditional light bulbs are gradually being phased out. Altogether, greenhouse gas emissions from electricity use are estimated to increase by 14,000 tonnes per year.

Greenhouse gas emissions from electricity production vary, however, depending on how much electricity can be produced without fossil fuel, from primarily hydropower. In order to reduce the variations in statistics, the emission value for electricity is calculated on the basis of the past five years' actual values. This means that a measure which leads to a reduction in emissions from electricity use is distributed over a period of five years in the statistics.

Factor	Development	Change in emissions, 2010–2015
Population	Increasing according to scenario in Stockholm Vision 2030: 2015 by approx. 826,000 residents. *	Included in the development of other factors.
Oil price	Oil price assessed by Swedish Energy Authority and IEA to be about USD 90–100 per barrel in 2015	The uncertainty and fluctuations mean that no impact from the oil price is assumed.
Electricity price	Relatively unchanged prior to 2015	Difficult to predict.
Nordic electricity mix	Five-year average for 2004–2008 (85.4 g/kWh) applied for the entire period.	No change.
Climate and energy taxes	Certain changes during the term of office. Development thereafter uncertain.	Difficult to predict.

Table 2. Impact of surrounding factors on emissions according to the reference scenario up to 2015.

* 826,000 could be an underestimate by approximately 25,000 residents. If the population estimate is adjusted to 850,000 residents by 2015 the emissions are reduced by totally 0.1 tonnes CO_2e per resident.

4.2 Transport sector – development plus ongoing and planned measures in the City

Altogether, greenhouse gas emissions in the transport sector are expected to increase by 14,000 tonnes by 2015 compared with the year 2009. The growth is a result of increased passenger transport mileage, but is at the same time compensated by an increase in the number of clean vehicles.

The anticipated development according to the reference scenario is that the greenhouse gas emissions from road traffic, air transport and shipping will increases as a consequence of a growing demand for transport. The increase in demand is the result of an anticipated growth in population. Road transport mileage is expected to increase by 1 per cent per year. The emissions of greenhouse gases from air transport and shipping are also expected to increase somewhat, but constitute in total less than 3 per cent of the emissions within Stockholm.

Factor	Development	Change in emissions, 2010–2015	Change in emissions *	Change in energy use, GWh
Transport mileage, road traffic	Transport mileage is growing at a rate of 1 per cent per year for all types of vehicle.	Emissions increase as a consequence of increased transport mileage.	+ 54	+220
Shipping development	Passenger transport is expected to increase at the same time as freight transport is expected to decrease.	Emissions increase according to trends with increasing transport mileage.	+ 4	increasing, *data not available*
Air transport development	Air transport mileage increases, but is reduced somewhat as a result of emission trading.	Emissions increase from the totally increasing transport mileage.	+ 1	increasing, *data not available*
Private car fleet development	New vehicles are more efficient and more frequently clean vehicles.	Emissions decrease as a consequence of efficiency improvements in the vehicle fleet.	– 43	+20
Electric vehicles	Electric cars are expected to be introduced slowly and have only a minor impact until 2015.	Insignificant decrease in emissions prior to 2015 as a result of electric cars replacing conventional cars.		

Table 3. Changes in emissions from the transport sector according to the reference scenario.

* Thousand tonnes

The trend in the car fleet is towards cars that use less fuel and more renewable fuels, which is expected to lead to a decrease in emissions of 43,000 tonnes of greenhouse gases. In total, the proportion of clean vehicles in Stockholm will increase from 8 per cent in 2008 to 22 per cent in 2015.

The city planning is also very important. The strategic direction of the City's physical planning is to develop the City inwards in good public transport locations. This strategy has been applied since comprehensive plan ÖP 99 was adopted almost ten years ago. City development must meet the requirements of a fast-growing population, and at the same time favour a modern transport system and sustainable travel. The City is now taking a further step in this direction with the proposal for a new plan which the City Council will decide on during 2010. Strategies are proposed for utilising the existing infrastructure efficiently and for supporting important investments in new public transport, not least in the form of new lateral connections and meeting points. The planning must also provide good conditions for pedestrian and cycle traffic. Proposed investments in attractive meeting points, or travel centres, and linking together the different parts of the City will provide a wider range of workplaces and service in the outer city areas.

4.2.1 Transportation – ongoing and planned measures

In addition to expected development, the vehicle fleet will also be affected by local decisions. One example is the decision made by the City of Stockholm that the City's own vehicle fleet should consist of 100 per cent clean vehicles by 2010. The leading taxi firms as well as certain delivery firms in Stockholm have decided to only purchase clean vehicles. In the planning of the new city district Royal Seaport, measures were introduced to favour public transport, which are expected to reduce emissions compared with the development assumed in the reference scenario. In all, these decisions are expected to result in a further greenhouse gas reduction of 11,000 tonnes per year between the years 2010 and 2015.

Spårväg City, a tram line to serve the city area, is being built between Lindhagen and Ropsten, and is planned to be completed in 2013. Although the tram line will improve public transport, it is not expected to result in a significant decrease in greenhouse gases.

Other measures that are not covered by the reference scenario are the major ongoing railway investments that are planned in Stockholm. Some of these will have a substantial impact on emissions within the City of Stockholm boundaries. This applies in particular to the new City Line, which is planned to be operational by 2017. This and other railway investments such as Tvärspårvägen Solna — a rapid light-rail transit system that is being routed from Alvik-Ulvsunda-Solna, and Tvärspårväg Ost/Saltsjöbanan — are expected to reduce greenhouse gas emissions by a total of 18,300 tonnes by the year 2020.

Furthermore, a number of major investments are being made to generate biogas. In all, new biogas production is being planned that is expected to lead to reduced emissions equivalent to 37,800 tonnes in the City area. In order to avoid duplicating the figures, however, this potential saving is not included in the final total since the emission reduction has already been included in the decrease that will be achieved when biogas is used in the transport sector.

		Change in emissions in thousand tonnes of CO_2e in 2015 compared with 2010
City of Stockholm	100% clean vehicles for business travel in the city	−2.2
Taxi and delivery firms	Only clean vehicles for new purchases	−7.6
Private building projects	General public transport measures, car pools, fewer residential parking areas for Royal Seaport (Norra Djurgårdsstaden)	−1.2
		Total −11.0

Table 4. Ongoing and planned measures within the transport sector.

4.3 The building sector – development plus ongoing and planned measures

The reference scenario indicates that the development of new residential and non-residential buildings leads to increased electricity use in the City and thus to an increase in greenhouse gas emissions. General energy-efficiency improvements in the existing building stock are expected to result in a reduction of 1 per cent in greenhouse gas emissions between 2010 and 2015. In addition, a conversion to more energy-efficient lighting is also expected to lead to emission reductions. Altogether, greenhouse gas emissions are expected to decrease by 8,000 tonnes in 2015 compared with the year 2009.

4.3.1 Buildings – ongoing and planned measures

The City has allocated SEK 10 billion up to 2015 in order to implement upgrading and energy-efficiency improvements in the municipally-owned property stock. The investments are expected to reduce greenhouse gas emissions by on average 18 per cent, or just over 27,500 tonnes, between the years 2010 and 2015.

A number of private property owners who were interviewed are conducting energy-efficiency improvements that are more far-reaching than the general efficiency improvement measures that are described in the reference scenario. The measures are estimated to lead to emission reductions of 6,000 tonnes in 2015. New residential buildings that are being constructed in the new city district Royal Seaport will be more energy efficient than the levels prescribed in building standards. The measures mean that emissions in 2015 are estimated to be 800 tonnes lower than the assumed

Factor	Development	Change in emissions, 2010–2015	Change in emissions *	Change in energy use GWh
Electricity use in residential and non-residential buildings	Existing household electricity and service electricity remain unchanged per resident.	Electricity use in the household and service sectors increases as a result of a growing population.	+16	+260
Lighting	EU directive on phasing out light bulbs introduced.	Emissions from household electricity use for lighting decrease.	−6	−70
Energy-efficiency improvements in existing heating	Heating efficiency improved by 2–3 per mille per year.	Emissions decrease as a result of efficiency improvement measures	−18	−90

Table 5. Surrounding factors in the reference scenario within the impact of the building sector on carbon dioxide emissions over the period 2010–2015.

* Thousand tonnes

		Change in emissions in thousand tonnes CO_2e in 2015 compared with 2010	Change in energy use, GWh
City of Stockholm	Energy-efficiency improvement programme for buildings	−27.5	−220
Private building developers	Energy-efficient construction, Royal Seaport *	−0.8	
Private building owners, various	Energy-efficiency improvements and low-energy buildings	−6.0	−40
		Total −34.3	

Table 6. Ongoing and planned measures within the building sector

* The new developments in Norra Djurgårdsstaden will lead to an increase in emissions. The housing units will be more energy-efficient than the building standards prescribe. Therefore, the reduction in emissions compared to the increase assumed in the reference scenario is counted as a measure.

development in the reference scenario. In all, the measures being taken within the building sector are expected to lead to 34,300 tonnes in emission reductions.

4.4 Energy production – development and ongoing plus planned measures

According to the reference scenario, the emissions from energy production are estimated to decrease by 151,000 tonnes of greenhouse gases because the district heating mix (composition of the fuels that are used to produce district heat) will be improved from 120 g CO_2e/kWh to 101 g CO_2e/kWh over the period 2010 to 2015. This depends above all on various measures that Fortum plans to take in connection with district heating production and the district heating network.

In addition, Tälje Energi is building a new biofuel-fired combined heat and power plant at Igelsta in Södertälje, which is expected to be operational by 2010. Tälje Energi's district heating network is linked to Fortum's network in Stockholm, and thus helps to increase the biofuel mix in Stockholm's district heating production system.

The above measures are a step in the ongoing construction of combined heat and power production facilities by energy companies. Several of the measures mean that the emissions will increase but that the average district heating mix in Stockholm is improved. All the measures are presented in the reference scenario. Apart from the fact that the district heating mix is improved during the period, emissions from district heating will be influenced by the fact that a number

Fortum's planned measures in the district heating grid

- **Flue gas condensation** in Combined Heat and Power Plant 6 in Värtan during 2010.
- **Construction of a new combined heat and power plant** in Brista, Sigtuna, fired with waste over the period 2010–2013. (The district heating network in Märsta linked together with the district heating network in Stockholm).
- **Conversion of Combined Heat and Power Plant 2** in Värtan from oil-fired boilers (one oil-fired boiler and one bio-oil-fired boiler to a pellets-fired CHP plant. Planned to be operational by 2014).
- **Upgrading of a pellets-fired combined heat and power plant** in Hässelby for increased electricity production and fuel flexibility. Planned to be operational by 2014.

Factor	Development	Change in emissions, 2010–2015	Change in emissions *	Change in energy use GWh
District heating	New city areas developed and connected	District heating increases	+17	+170
District heating	More buildings connected	District heating increases	+18	+180
Gas leakage	Transition from naphtha to natural gas and a decrease in the size of the city gas network	Gas leakage increases because natural gas is a stronger greenhouse gas than the previous gas.	+11	*Not calculated energy use*
Oil and electricity for heating	Oil-fired and electric heating converted to natural gas	Oil and electricity use decreases	−38	±0
City gas use	Fortum replaces naphtha with natural gas in city gas.	Emissions decrease as a result of conversion to natural gas.	−50	±0
District heating mix	District heating mix gives considerably lower emissions.	District heating mix has a lower fossil-based share.	−151	±0

Table 7. Changes in emissions in energy production according to reference scenario.

* Thousand tonnes

of households will convert their heating supply systems to district heating (increasing emissions by 18,000 tonnes of CO_2e) and that new properties will be built which are directly connected to district heating (increasing emissions by 25,000 tonnes of CO_2e).

In all, the emissions from district heating will decrease by 116,000 tonnes. At the same time, emissions from oil-fired and electric heating — which are being replaced by district heat — will decrease by 38,000 tonnes.

The production of city gas from naphtha (crude petroleum) will be phased out and replaced by natural gas in the Stockholm gas network during 2010, which will reduce emissions by 50,000 tonnes. This measure is also presented in the reference scenario.

The leakage of gas from the city gas network which is caused by old gas lines in the streets corresponded to an emission of 40,000 tonnes of greenhouse gases in 2008. Emissions are expected to increase by 11,000 tonnes because natural gas contains more methane, which is a stronger greenhouse gas than the naphtha-based gas.

4.4.1 Energy production — ongoing and planned measures

Fortum Värme has plans for a staged conversion from coal to biofuel in their combined heat and power plant in Värtan with the aim of achieving at least a 50 per cent admix of biofuel by 2015[3]. An entire transition to renewable fuels is not considered being economically viable by Fortum at the present, partly because lignin supplies are uncertain. Halving the use of coal would mean that the emissions allocated to district heating production are reduced by 235,000 tonnes, i.e. emissions from district heating production after they have been allocated between electricity generation and district heating production. (ERR · V)

During 2010 and 2011, a series of measures will be introduced that are partially financed by the national support for climate investments, KLIMP, which could be applied for up to 2007. A number of different areas such as Gamla Stan, Essingen and Hässelby will be connected to the district heating system. Altogether, these emission reductions amount to 6,700 tonnes.

	Change in emissions in thousand tonnes CO_2e in 2015 compared with 2010	Change in energy use, GWh
Fortum – Renewable fuels instead of coal	– 235*	± 0
Fortum – District heating expansion	– 6,7	– 4,3

Table 8. Ongoing and planned measures within energy production.

* The statement is not exact, but a calculation based on Fortum's objective to reach 50 per cent renewable fuels by 2015.

4.5 Gas emissions

Stockholm Water Company is implementing measures to reduce methane emissions from Henriksdal Water Treatment Plant by 3,800 tonnes by 2011. The County Council anaesthetic and labour wards within the municipality are making efforts to reduce the emission of nitrous oxide (laughing gas) corresponding to 1,500 tonnes by 2011.

Greenhouse gas emissions generated by the leakage of gas from treatment plants and hospitals have so far not been included in the estimates of emissions in the municipality. In order to compare emission reductions over time, these emissions will not be included in the list of overall emissions, but will be reported separately.

4.6 Summary of the reference scenario, ongoing and planned measures, 2010–2015

Altogether, an emission reduction of 185,000 tonnes is assumed in the reference scenario, which is equivalent to an emission of 0.3 tonnes per person in 2015.

The sum total of the ongoing and planned measures taken by the City and other actors corresponds to an emission reduction of 287,000 tonnes, which is equivalent to 0.35 tonnes of greenhouse gases per year and resident by the year 2015.

Known planned measures between 2015 and 2020 are estimated to amount to 21,400 tonnes, corresponding to 0.03 tonnes of greenhouse gases per year and person. It concerns, above all, the expansion of rail traffic. Fortum also has planned measures, which include a new wood chip-fired combined heat and power plant in Värtan and increased waste incineration at Högdalen. These measures are included in the reference scenario because, although they lead to increased emissions, they will nevertheless contribute towards lower emissions per energy unit (kWh) generated.

Major ongoing and planned measures undertaken by the City, 2010–2015	
100% clean vehicles for business travel in the City	– 2.2
Energy-efficiency improvement programme for buildings	– 27.5
Total	**– 29.7**

Other major ongoing and planned measures. 2010–2015	
Taxi and delivery firms — Only clean vehicles purchased	– 7.6
Private builders — Car pools, fewer residential carparks in the Royal Seaport	– 1.2
Private builders — Energy-efficiency improvements	– 0.8
Private building owners, various — Energy-efficiency improvements and low-energy buildings	– 6.0
Fortum — District heating expansion	– 6.7
Fortum — Renewable fuels instead of coal	– 235
Total	**– 257.3**

Other major ongoing and planned measures, 2016–2020	
SL — Rapid Light Rail System Solna (Alvik-Ulvsunda-Solna), start of operation 2015	– 3.9
SL — City Line, start of operation 2017	– 10.8
Stockholm County Council, SL — Rapid Light Rail System Ost/Saltsjöbanan, preliminary start of operation 2018	– 3.6
Private building developers — Energy-efficiency improvements in the Royal Seaport	– 0.9
Private building owners, various — Energy-efficiency improvements and low-energy buildings	– 2.2
Total	**– 21.4**

5 Conceivable measures

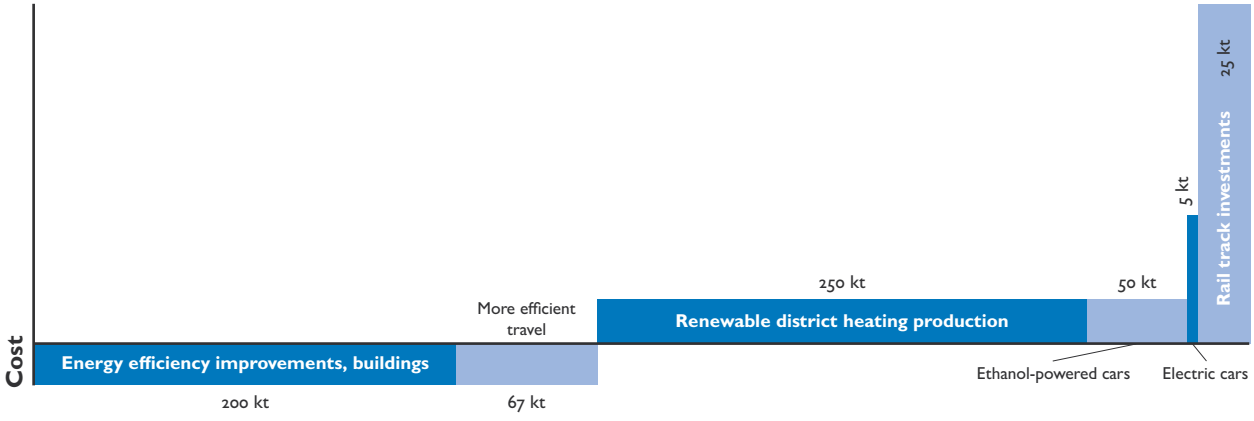
Provided that development is in line with the reference scenario and that all ongoing and planned measures are implemented, the emission level will be 2.8 tonnes per resident in the year 2015. This means that the target of 3.0 tonnes in 2015 will be achieved with a margin.

In the work involved in drawing up this catalogue of conceivable measures, a gross list of fifty measures has been produced in cooperation between the City's administrative departments and companies, experts and enterprises in the City. The measures have then been ranked in terms of cost efficiency, reduction potential and degree of municipal right of disposition. Those measures that have had insufficient potential, a low level of cost efficiency or a low degree of municipal right of disposition have been discounted. A further criterion has been that the measures should produce a result by as early as 2015. In order to realise several of the measures, co-operation is needed between many different actors — municipal, state and private. The complexity of such projects means that they are both time consuming and difficult to implement.

The cost of the measures and their reduction potential up to the year 2015 are illustrated below. Those measures that are economically viable are energy-efficiency improvements in building properties and transportation efficiency improvements. The measure that is most expensive per reduced tonne of greenhouse gases is new rail tracks for public transport. Other aspects of social benefit, such as improved accessibility for public transport, are not weighed into the assessments.

The graph shows that there are substantial measures to be implemented in the building and heating sectors that are relatively inexpensive or viable. It should be noted that if district heating is generated entirely carbon dioxide-neutral, the

Potentials and costs for different blocks of measures prior to 2015 (thousand tonnes of CO_2e)



Graph 6. Summary of the theoretical potential for selected conceivable measures to reduce greenhouse gas emissions within municipal boundaries. The breadth and figures indicate the potential for reduction in thousand tonnes carbon dioxide equivalents while the height indicates the technical cost per emission reduction for the measure in question. Fields below the X axis are economically viable. (ERR · VI)

reduction potential for measures within the building sector will decline in terms of CO_2e but not as energy.

The choice of conceivable measures is based on analyses of their emission reduction, cost efficiency and the City's right of disposition.

Cost efficiency	
Economically viable measures	Very high
SEK 0–1 per kg CO_2	High
SEK 1–5 per kg CO_2	Average
SEK 5–10 per kg CO_2	Low
SEK >10 per kg CO_2	Very low

Reduction potential, tonnes of greenhouse gas emissions (CO_2e)	
20,001 or more	Very high
10,001–20,000	High
5,001–10,000	Average
2,001–5,000	Low
500–2,000	Very low

Municipal right of disposition	
Within own budget frame	Very high
Own right of disposition over means of control	High
National ordinances	Average
National laws	Låg
External financiers	Mycket låg
Co-operation with other players	Low
EU law or voluntary project	Very low

5.1 Conceivable measures for more efficient travel

Theoretical potential

There is a substantial remaining efficiency improvement potential for transportation. Between the years 2010 and 2015, it is estimated to amount to a total of 67,000 tonnes of greenhouse gases. Between 2015 and 2020, the potential is estimated to be 36,000 tonnes.

Business travel by car can be replaced by video or telephone meetings, or in other situations by use of the cycle or public transport. Certain measures can be merged so that several journeys can be combined into one, etc. This also serves to reduce congestion and pollution.

Car pools are a solution that offers the potential to reduce routine car travel, and can be used by both companies and private persons. A car pool lowers the fixed costs for access to a car at the same time as the variable costs of using a car increase. This results in reduced car usage to the benefit of more efficient travel planning, travel by cycle and public transport as well as meetings with the aid of video or telephone conferences. If a car pool was available within a few hundred metres of each household, there would be thousands of potential car pool customers in Stockholm.

In a modern, densely built-up city like Stockholm there is ample potential for cycling. New studies show that cycling is also an alternative for travels of over 10 km in length.

Potential for more efficient travel and transportation measures, 2010–2020	Total potential thousand tonnes
Transport sector's total emission of CO_2e in 2015 according to reference scenario	937
Carbon dioxide reduction from planned and ongoing measures by the year 2015	–1.2
Further potential 2010–2015	–67
Further potential 2015–2020 (ERR · VII)	–36

5.1.1 More car-pool cars — parking

This measure is based on the City studying how a close network of parking places in the City could be made available to car-pool companies. All Stockholmers will be given the opportunity to join a car pool with a car parked near their house or flat. The biggest obstacle currently facing car pool companies is access to parking areas. A car-pool vehicle that is shared by a large number of households must have permanent parking facilities.

The advantages of this measure are that the members of a car pool on average reduce their car travel in favour of using a cycle, public transport and a more efficient form of car travel. In addition, there is a decrease in the total number of cars since more families, approximately six, can share one car. More car pools would therefore reduce the need for parking places in Stockholm at the same time as congestion and emissions would decrease. The estimates for 2015 are based on 1,500 new car-pool vehicles in 2015.

Consequences of more car-pool cars — parking	
Carbon dioxide reduction 2010–2015	6,400 tonnes
Carbon dioxide reduction 2016–2020	6,400 tonnes
Municipality's costs	Survey and administration
Cost efficiency	High
Municipality's right of disposition	High (own right of disposition over means of control)

5.1.2 Alternative to car travel — marketing

The purpose of this measure is to show motorists the potential offered by public transport and cycling. The measure includes travel schedules for schools, campaigns to raise the level of public awareness, efforts to increase remote or distance working, a greater use of telephone conferences and the marketing of public transport. Marketing efforts will be focused directly on car owners in areas with good public transport and/or good opportunities for cycling. Altogether, these measures would according to studies reduce transport mileage by 4.9 per cent. In the short term, the figure is assumed to be 2.4 per cent. The measures have full effect in combination with financial incentives and infrastructure investments.

Consequences of alternatives to car travel — marketing	
Carbon dioxide reduction 2010–2015	6,900 tonnes
Carbon dioxide reduction 2016–2020	6,900 tonnes
Municipality's costs	SEK 25 million
Cost efficiency	Average
Municipality's right of disposition	Very high (within own budget frame)

5.1.3 More bus lanes and cycle zones

The purpose of this measure is to facilitate the situation for those people who choose to travel by bus or cycle by increasing the level of accessibility and safety. The measure involves creating more bus lanes and cycle zones, which could mean that the number of streetside parking spaces will need to be reduced. If all existing multi-storey carparks were only to be used for parking, there would be a significant increase in the number of parking places available in Stockholm. Some of the space made available could be used for cycle parking and for special electric car pool parking. The measure should be combined with an information campaign run by the City on how the various investments within the framework of the action plan are coordinated and the City's goals in connection with the work. The estimates are based on one per cent of the traffic mileage being transferred to cycle transport, half a per cent to rail transport and half a per cent to clean car-pool cars.

Consequences of more bus lanes and cycle zones	
Carbon dioxide reduction 2010–2015	12,800 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	The costs comprise the remarking of streets, planning and information investments, and are in the range of SEK 100 million.
Cost efficiency	Low
Municipality's right of disposition	Very high (within own budget frame)

5.1.4 More efficient travel choice — parking

Raising parking fees in Stockholm increases the incentive for households and companies to choose to travel by public transport, to cycle or to join a car pool instead of using their own car. This suggestion serves to complement the previous measure, which means that the space available in streets is insufficient for current street parking levels. The estimates are based on one per cent of all current car travel converting to public transport by the year 2015. The measure should be combined with information activities to promote more efficient travel.

Consequences of more efficient travel choice — parking	
Carbon dioxide reduction 2010–2015	6,400 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	The measure increases the revenue from parking fees.
Cost efficiency	Very high
Municipality's right of disposition	Very high (within own budget frame)

5.1.5 Increased bus traffic

This measure means that bus traffic is significantly increased on those routes and at those times when many motorists are on the roads. In co-operation with Stockholm Transport, SL, a survey should be conducted to determine which routes the new bus services should follow. For the greatest impact, direct bus services are introduced from outer areas to a number of bus-stops in the city. For these bus services, higher fares could be introduced for trips in rush-hour traffic. The bus services could on the one hand run in parallel with rail services and on the other offer a higher standard of comfort. The

potential for the entire measure is estimated on the basis of bus transport increasing its market share by two percentage points. The measure could be combined with the two measures *Increased travel by public transport — marketing* and *More bus lanes and cycle zones*.

Consequences of extended bus traffic	
Carbon dioxide reduction 2010–2015	12,000 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	SL meets the costs for vehicles and transport mileage. The City incurs costs for more bus lanes, but these costs are reported under measures for more bus lanes and cycle zones.
Cost efficiency	High
Municipality's right of disposition	Low (external financing and co-operation with other players)

5.1.6 Rail traffic investments

Investment in new rail traffic infrastructure is not a cost-efficient way of reducing carbon dioxide emissions. On the other hand, new rail traffic tracks offer many other benefits to the society. For an expanding Stockholm that is sustainable in the long term, an extended system of rail traffic is important. Extended rail traffic is also an important factor for increasing the efficiency of public transport.

The estimated maximum potential corresponds to the transfer of 4 per cent of all car travel to rail traffic. This is equivalent to the increased demand for public transport that other measures create. In order to avoid duplicating the figures, this potential should therefore not be added to the effects of the other measures.

Consequences of rail traffic investments	
Carbon dioxide reduction 2010–2015	-
Carbon dioxide reduction 2016–2020	25,000 tonnes
Municipality's costs	High investment costs
Cost efficiency	Very low
Municipality's right of disposition	Low (external financing and co-operation with other players)

5.1.7 More efficient corporate travel

There is considerable potential for increasing the efficiency of corporate travel. Among other things, companies can review their car ownership and convert to cleaner vehicles, use public transport to a greater extent, set up their own car pools with electric or clean vehicles, encourage employees to cycle during working hours, etc. This is an information measure based on helping companies to draw up travel schedules which offers the potential to reduce emissions from car traffic by 1.6 per cent over a ten-year period.

Consequences of more efficient corporate travel	
Carbon dioxide reduction 2010–2015	5,100 tonnes
Carbon dioxide reduction 2016–2020	5,100 tonnes
Municipality's costs	SEK 5 million
Cost efficiency	High
Municipality's right of disposition	Very high (within own budget frame)

5.1.8 Higher level of freight vehicle loading

There is considerable potential in helping the business community to develop more efficient freight transport solutions. According to an international study, at least 25 per cent of all lorry transport could be avoided, which would reduce emissions by 38,000 tonnes. In Stockholm, valuable experience is available from the O-Central, a distribution company which supplies The Old Town with goods, and the distribution centre that was located in Hammarby Sjöstad during the construction stage. Distribution centres should be set up on major traffic routes and at railway stations.

In addition to creating higher lorry-loading levels, the measure would lead to shorter runs as a result of more efficient route optimisation, which reduces both congestion and emissions. The following potentials are based on a reduction in freight traffic of 13 per cent in Stockholm.

Consequences of a higher level of freight vehicle loading	
Carbon dioxide reduction 2010–2015	20,000 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	Private companies run the distribution centres. The city plans and provides land.
Cost efficiency	Very high
Municipality's right of disposition	Low (co-operation with other players)

5.2 Conceivable measures for a more efficient vehicle fleet

Theoretical potential

The potential for reducing emissions from the vehicle fleet with today's technology is approximately 50 per cent if we compare the emissions from an ethanol-powered vehicle with those from a petrol-driven vehicle. With tomorrow's technology, in the form of rechargeable hybrid vehicles, the

reduction potential will increase to 90 per cent, provided the electricity is generated with today's Nordpool. These potentials presuppose that all vehicles in the fleet have been replaced by clean vehicles and electric vehicles. Replacing the vehicle fleet will take a long time since the average vehicle has an eighteen-year service life.

Today's newly-purchased vehicles will affect the average emissions from the vehicle fleet for many years. Scarcely half the number of new vehicles purchased are clean vehicles. In the reference scenario, the number of clean vehicles in the total fleet is assumed to increase from 8 to 22 per cent over the period 2010 to 2015. This is largely a result of different national policy instruments that could vary over time. Over the same period, the target is 100 per cent clean vehicles in the City's own fleet. If all the vehicles used in Stockholm were to be powered by ethanol, emissions would decrease by 300,000 tonnes. This is not realistic for the entire City since other types of vehicles are also permitted.

Between 2010 and 2015, the potential is estimated to be approximately 60,000 tonnes if all new vehicles operated in Stockholm were to be clean. (ERR · VIII) The proportion of clean vehicles would then be approximately 40 per cent. The estimate is based on 10 per cent of all newly purchased vehicles being electric vehicles and 90 per cent being powered by ethanol.

Between 2015 and 2020, the potential is estimated to be 75,000 tonnes of greenhouse gases. The estimates are based on 40 per cent of all new vehicles being electric and 60 per cent being powered by ethanol.

Potential for measures to achieve a more efficient vehicle fleet, 2010-2020	Total potential thousand tonnes
Transport sector's total emissions CO_2e in 2015 according to reference scenario	937.0
Carbon dioxide reduction of planned and ongoing measures by the year 2015	– 9.8
Further potential 2010–2015 (ERR · IX)	– 50.0
Further potential 2015–2020	– 75.0

Measures and policy instruments

The City can introduce incentives to encourage people to buy clean vehicles. Research shows that the most effective way of persuading more people to buy clean vehicles is if they can save a little money often. It means that a low ethanol price and exemption from congestion tax have served as strong incentives in encouraging Stockholmers to buy clean vehicles, whereas free parking for clean vehicles and an environmental premium have not proved to be so important. An account is given below of several conceivable local measures and policy instruments.

5.2.1 More efficient vehicle fleet — increased low blend of biofuel

All petrol and diesel sold in Stockholm has a low blend of biofuel. According to the EU, it is possible to increase the blend of biofuel in all petrol from the current 5 per cent to 10 per cent and in diesel from 5 to 7 per cent. The directive is expected to be implemented in Sweden before 2010. An increased low blend of biofuel is voluntary, and the determining factor for oil companies is expected to be the price and availability of biofuels.

Consequences of more efficient vehicle fleet — increased low blend of biofuel	
Carbon dioxide reduction 2010–2015	26,000 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	Uncertain
Cost efficiency	High
Municipality's right of disposition	Low (co-operation with other players)

5.2.2 More efficient vehicle fleet — climate tax

An alternative to the previous exemption from congestion tax for clean vehicles could be a climate tax, similar to the one that has been introduced in London. It has resulted in a greater incentive for motorists to drive cars with as low a greenhouse gas emission as possible. Climate tax functions so that, unlike a congestion tax, it is levied on a 24-hour basis and the extent of the tax levied varies depending on how high the carbon dioxide emission from the vehicle is. Information on this is already stored in the motor-vehicle register and serves, among other purposes, as a basis for vehicle tax.

A climate tax would mean both a greater incentive for car owners to purchase cars with low carbon dioxide emission levels and would also encourage car owners with access to more than one car to more often choose the one with the lowest carbon dioxide emission levels.

Climate tax can be levied in many different ways. To begin with, it could be charged in the same way as the congestion tax. At a later stage it could be charged on a round-the-clock basis and throughout the entire week. In a third stage, more pay stations could be set up along the most important traffic routes in other parts of the municipality.

An account is given below of a fully developed system with local, differentiated climate tax throughout the entire municipality. The total below consists of a series of different effects such as a change from travelling by car to public transport, increased car pooling and more efficient travel planning. The largest impact is expected to come from the assumed 5 per cent increase in clean vehicles in the vehicle fleet compared to the anticipated development according to the reference scenario, and that the introduction of electric cars is speeded up. This will lead to an increased electric car share

of 2.2 per cent by the year 2015. The potential offered by this measure is largely dependent on when it is decided during the period. For 2020, the potential is even larger since even more new car purchases can be influenced. The effects on travel, however, remain the same.

Consequences of more efficient vehicle fleet — climate tax	
Carbon dioxide reduction 2010–2015	48,500 tonnes
Carbon dioxide reduction 2016–2020	28,300 tonnes
Municipality's costs	The construction of more stations and a system for levying a more differentiated climate tax is somewhere between several hundred million kronor and half a billion kronor. The revenue, however, amounts to several billion kronor.
Cost efficiency	Very high
Municipality's right of disposition	Low (national laws)

When congestion tax were introduced in Stockholm, an exception was made for clean vehicles. Since then, Parliament has decided to change the legislation so that tax exemption for clean vehicles was abolished from 2009. Congestion tax have in this way been restructured into a more direct policy instrument for better accessibility. The introduction of a tax as a policy instrument for reduced greenhouse gas emissions requires a new Parliamentary decision.

5.2.3 Environmental zones

It should be possible to extend the regulations governing local environmental zones to include private cars and carbon dioxide emissions. In such case, cars with a carbon dioxide emission in excess of a certain level per km could be refused admission to the city. Emissions from car travel would be reduced by 2 per cent, or by 12,800 tonnes, on the assumption that 10% of the car journeys that today cause the most carbon dioxide emissions could be replaced by car journeys with an average of 20% less emissions. This is on condition that the environmental zones apply for the entire municipality. By 2020, it should be possible to define the environmental zones still further.

Consequences of environmental zones	
Carbon dioxide reduction 2010–2015	12,800 tonnes
Carbon dioxide reduction 2016–2020	25,600 tonnes
Municipality's costs	Administrative costs. The City's own vehicles do not need to be replaced.
Cost efficiency	Low
Municipality's right of disposition	Low (national laws)

5.2.4 Electric car procurement

This measure is based on the City of Stockholm, in co-operation with other private actors, purchasing 1 000 electric cars on the international market in order to press down prices and bring forward delivery times. The measure will result in only a minor reduction in greenhouse gas emissions. However, it could make it easier for more electric cars to be sold in Stockholm.

Consequences of electric car procurement	
Carbon dioxide reduction 2010–2015	3,000 tonnes
Carbon dioxide reduction 2016–2020	
Municipality's costs	Initially, electric cars will be considerably more expensive than ordinary cars. The operating costs, however, will be lower.
Cost efficiency	Average
Municipality's right of disposition	Very high (within own budget frame)

5.2.5 More electric cars — parking

The purpose of this measure is to increase the motivation to buy electric cars especially those people living in multi-family housing areas with street parking by introducing special parking places with electricity charging poles. These parking places would be reserved for electric cars and have a lower parking charge than elsewhere, which requires a change in legislation. The measure means that the proportion of electric cars in the vehicle fleet would increase by a further 0.25 percentage points by the year 2015. It would also be an advantage if the measure could cover car-pool cars, since they would then constitute a form of supplementary public transport.

Consequences of more electric cars — parking	
Carbon dioxide reduction 2010–2015	1,600 tonnes
Carbon dioxide reduction 2016–2020	1,600 tonnes
Municipality's costs	The revenue from parking decreases.
Cost efficiency	Average
Municipality's right of disposition	Low (national laws)

5.2.6 Increased biogas production

Biogas is the fuel that has the lowest emissions of carbon dioxide and the least environmental impact. The principal factor that limits the size of the biogas vehicle fleet is the supply of biogas. The measure is dependent on 35 per cent of food residues, or 33,000 tonnes of all food waste, being collected from Stockholm's restaurants, shops and households in order to be able to increase the production of biogas. There

are various conceivable policy instruments for creating an increase in collection volumes. One such instrument is a differentiated waste rate in which those who separate food waste are rewarded by being charged a lower waste collection fee.

Consequences of increased biogas production	
Carbon dioxide reduction 2010–2015	7,200 tonnes *
Carbon dioxide reduction 2016–2020	See above
Municipality's costs	Investment in a new digester plant for SEK 170 million at Henriksdal Waste Treatment Plant.
Cost efficiency	Average
Municipality's right of disposition	Very high (within own budget frame)

* In order to avoid duplication this potential is not counted. The reduction in emissions is assumed instead to occur when biogas is chosen as a fuel instead of a fossil fuel.

5.3 Energy-efficient buildings

Theoretical potential

The use of electricity and heat in all operations, apart from the City's own buildings, corresponds to a carbon dioxide emission of 1,240,000 tonnes per year. If all buildings within the municipal boundaries were to undergo an emission reduction programme that was as extensive as the City's, it would reduce greenhouse gas emissions by 16 per cent, or 200,000 tonnes.

Examples of economically viable measures are:

- **Adjustment of heating systems**
- **Installation of ESX ventilation systems**, i.e. a system by which extract and supply air ventilation is supplemented with a heat exchanger.
- **Operational optimisation of lighting** in commercial, service and office buildings.
- **Energy-efficient lighting** in private, commercial, service and office buildings.
- **Energy-efficiency improvement measures** within industrial buildings.

Of central importance in all energy-efficiency improvement activities is skilled and involved personnel. Therefore, when operational work is out-sourced, it is important to sign an incentive or bonus agreement with those firms that are to operate the buildings.

In addition, there is considerable potential for reducing the emissions from older oil-fired boilers by converting them to, for example, district heating, individual pellets-fired boilers or heat pumps. Exactly how viable this measure is depends on the age of the boiler and the extent of the alternative costs.

Experience shows that there are many economically viable measures that are not being taken. This is frequently the case for efficiency improvement measures. One example of why the measures are not being taken is that the party who is responsible for paying the investment costs is not the same party who will benefit from lower energy costs. Other explanations are lack of knowledge, a pending sale or decommissioning, and that the organisation is merely focusing on its core business.

The potential for reducing greenhouse gas emissions through energy-efficiency improvements between the years 2010 and 2015 is judged to be a total of 200,000 tonnes. Between 2015 and 2020, the potential is estimated to be 300,000 tonnes.

Potential for measures taken to create energy-efficient buildings, 2010-2020	Total potential thousand tonnes
Total emission of CO_2e in 2015 according to the reference scenario	1,463.0
Reduction in emissions from planned and ongoing measures by 2015	– 34.3
Further potential 2010–2015	– 200.0
Further potential 2015–2020	– 100.0

5.3.1 Conversion loan

This measure means that the City offers property owners the chance to replace their oil-fired boilers or take other energy-efficiency improvement measures, which would otherwise not be taken, by means of a favourable conversion loan. The idea is that introducing a financial incentive will speed up development. We assume that this policy instrument could cover 10 per cent of the total potential by the year 2015. The measure can be combined with the measure *Inspection and advice*.

Konsekvenser av konverteringslån	
Carbon dioxide reduction 2010–2015	20,000 tonnes
Carbon dioxide reduction 2016–2020	20,000 tonnes
Municipality's costs	Administration by the loan institute
Cost efficiency	High
Municipality's right of disposition	High (own right of disposition over control instrument)

5.3.2 More energy-efficient buildings in connection with new construction

The measure means that the City, through demands made in connection with land allocation agreements, can make sure that new property developments are more energy-efficient than the level prescribed in current building standards. During the period 2010 to 2015, a total of 1,400,000 m² of new multi-family housing and premises will be built (in addition to the new city district Royal Seaport). If 80 per cent of these are covered by more demanding land allocation requirements corresponding to 80 kWh/m² for residential buildings and 70 kWh/m² for non-residential buildings, it could save 3,000 tonnes of greenhouse gases per year up until 2015. For the period 2015 to 2020, the demands should be further increased to 55 kWh/m². For the measure to have full effect new incentives may need to be introduced, for example in the form of a combined bonus/penalty ladder for all developers who sign a contract.

Consequences of more energy-efficient buildings in connection with new construction	
Carbon dioxide reduction 2010–2015	3,000 tonnes
Carbon dioxide reduction 2016–2020	9,500 tonnes
Municipality's costs	Costs for signing a land allocation agreement and for following it up.
Cost efficiency	High
Municipality's right of disposition	High (own right of disposition over control instrument)

5.3.3 Inspection and advice

The purpose of this measure is to ensure that more building owners and companies receive an inspection visit from the municipality every year. During the municipal inspection of buildings and companies, it is possible to demand that building owners have control over their energy use and review the possibilities of introducing energy improvement measures in line with the Environmental Legislation.

Even if there is a major technical potential to improve the energy efficiency of buildings and companies, the municipality has very little right of disposition to bring this about. However, the City can conduct inspection and energy advisory services. In 2004, there were 24 million m² of housing area, 15 million m² of premises area and 4 million m² of industrial premises within the Stockholm boundaries. Only a small proportion of the buildings are visited for annual inspection in accordance with the Environmental Legislation. The estimates below are based on a tenfold increase in the number of inspections.

Consequences of inspection and advice	
Carbon dioxide reduction 2010–2015	2,500 tonnes
Carbon dioxide reduction 2016–2020	2,500 tonnes
Municipality's costs	Costs for inspection, income in the form of inspection fees
Cost efficiency	High
Municipality's right of disposition	High (own right of disposition over control instrument)

5.3.4 Climate investments in the administrations

There are a number of different climate measures that can be taken in the City's various administrations and building companies. Above all, it is a question of additional, but more expensive, energy efficiency improvement measures within the building sector in addition to those already in progress or planned. But the efforts should also cover other initiatives within the overall climate area. Within the City's own buildings alone, the emissions amount to 174,000 tonnes of greenhouse gases per year. The measure means that these emissions will be reduced by a further 4 per cent by the year 2015 and by 14 per cent by 2020. This measure aims at covering the *added costs* incurred by the administrations in implementing the measures. The investment cost will be higher but the operating costs lower.

Consequences of climate investments in the administrations	
Carbon dioxide reduction 2010–2015	7,000 tonnes
Carbon dioxide reduction 2016–2020	18,000 tonnes
Municipality's costs	Incremental costs of approximately SEK 20 million (by the year 2015) and administration costs.
Cost efficiency	Average
Municipality's right of disposition	Very high (within own budget frame)

5.4 Power and heat production

Theoretical potential

During combined heat and power (CHP) production, both electricity and heat are generated. The CHP production is owned jointly by Fortum and the City of Stockholm. The City thus has a certain degree of influence over investments

via the Board of Fortum Heat Company.

The potential for reducing emissions from district heating production is substantial. The single largest source of greenhouse gas emissions in Stockholm is CHP Plant 6 in Värtan, which is fired by coal and a small amount of biofuel. The individual measures that would lead to the largest decrease are to replace coal by renewable energy sources in CHP Plant 6 in Värtan, which could serve to reduce emissions by as much as 500,000–600,0000 tonnes of greenhouse gases, and to introduce carbon dioxide storage, which could reduce emissions by over 600,000 tonnes. (ERR · X)

The potential for reducing greenhouse gas emissions from energy production between the years 2010 and 2015 is estimated to be 500,000 tonnes.

Between 2015 and 2020, the potential is estimated to be 1,160,000 tonnes.

Potential for energy production measures, 2010–2020	Total potential thousand tonnes
Total anticipated emission of CO_2e in 2015 according to the reference scenario from district heating production	761.0
Emission reduction from planned and ongoing measures until the year 2015	– 241.7
Further potential 2010–2015 (ERR · XI)	– 265.0
Further potential 2015–2020	* – 660.0

* Including the storage of coal from renewable fuel which creates a carbon dioxide sink, i.e. the carbon dioxide in the atmosphere decreases.

5.4.1 Renewable energy sources instead of coal at the Värtan Plant

In addition to the 50 per cent reduction that is planned to be completed by 2015, there is a further potential for replacing coal with biofuel. This would mean a further 235,000 tonnes in emission reductions from the use of coal that is set aside for district heating production. (ERR · XII)

Consequences of using renewable fuels instead of coal at the Värtan Plant	
Carbon dioxide reduction 2010–2015	235,000 tonnes (ERR · XIII)
Carbon dioxide reduction 2016–2020	-
Municipality's costs	Investment costs initially incurred to build up storage space, distribution chain and boiler conversion. (ERR · XIV)
Cost efficiency	High (ERR · XV)
Municipality's right of disposition	Low (external financing and co-operation with other players)

5.4.2 Carbon dioxide storage, CCS

With the help of technology for carbon dioxide capture, separation and storage, the emissions can be lowered by a further 660,000 tonnes by storing the carbon dioxide from use of coal or biofuel on a long-term basis. The long-term storage of carbon dioxide from biofuel would result in the district heating production changing from an emission source to a carbon dioxide sink.

The measure requires the installation of equipment to capture carbon dioxide from the Värtan plant and to transport it to a place where the long-term storage of carbon dioxide is possible. The required investment is estimated to be SEK 1.7 billion.

Consequences of carbon dioxide storage	
Carbon dioxide reduction 2010–2015	-
Carbon dioxide reduction 2016–2020	660,000 tonnes.
Municipality's costs	An investment cost of SEK 1.7 billion for separation equipment and a variable cost for setting-off the collected carbon dioxide.
Cost efficiency	Average
Municipality's right of disposition	Low (external financing and co-operation with other players)

5.5 Summary of conceivable measures

The list of measures indicates that there are three distinct groups of measures viewed from the point of view of right of disposition and cost efficiency.

First, there is a group of measures with a high right of disposition and a high degree of cost efficiency. It is possible for the municipality to put these measures into effect relatively quickly, but they will rarely produce really large emission reductions. It is assumed that the greatest effect will be achieved by favourable conversion loans for property owners.

Measures prior to 2015 with a high or very high level of cost efficiency and a high right of disposition (within own budget frame or with own right of disposition over means of control):

- More car-pool cars — parking −6,400 tonnes
- More efficient travel choice – parking −6,400 tonnes
- More efficient corporate travel −5,100 tonnes
- Electric car procurement −3,000 tonnes
- Conversion loans −20,000 tonnes
- More energy-efficient buildings in new developments − 3,000 tonnes
- Inspection and advice −2,500 tonnes

The second group consists of measures with a high level of cost efficiency but with a low right of disposition for the City. These measures are characterised my major potentials to reduce emissions but require decisions by the County Council or Parliament in order to be implemented.

Measures prior to 2015 with a high or very high level of cost efficiency and a low right of disposition (national laws):

- Increased bus traffic −12,000 tonnes
- Increased level of freight vehicle loading −20,000 tonnes
- More efficient vehicle fleet – climate tax −48,500 tonnes
- Increased low blending −26,000 tonnes

The third group comprises measures that cost more per reduced tonne of greenhouse gases but in which the municipality still has a high right of disposition. Among these, the measure involving more bus lanes and cycle zones offers the largest emission reductions.

Measures prior to 2015 with a medium-high or low level of cost efficiency and a high right of disposition (within own budget frame or own right of disposition over means of control):

- Increased travel by public transport – marketing −6,900 tonnes
- More electric cars – parking −1,600 tonnes
- Climate investments in the administrations −7,000 tonnes
- More bus lanes and cycle zones −12,800 tonnes
- Environmental zones −12,800 tonnes

Measures prior to 2015 with a medium-high or low level of cost efficiency and low right of disposition have been filtered out, with the exception of track investments.

As can be seen, it is measures in energy production that are of the greatest importance for development. It is therefore very important that the City, together with Fortum, work for the implementation of these measures.

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Errata

Page and chapter, table or graph	Text	Correction
PAGE 4 **Table 1 caption** **(ERR·I)**	Emission of greenhouse gases, 1990–2020.	Emission of greenhouse gases, 1990-2020. The City does not have right of disposition over all conceivable measures in the action plan. In these cases external measures, eg. changes in legislation, have to be in place in order to perform the measure.
PAGE 5 **Summary** **(ERR·II)**	These measures do not include district heating, since this is included in the reference scenario.	*The text is deleted*
PAGE 5 **Summary** **(ERR·III)**	The measures include Fortum making a 50 per cent conversion from coal to renewable fuels in the company's coal-fired combined heat and power plant at Värtan. This would serve to decrease the emissions of greenhouse gases by 235,000 tonnes per year, or 0.3 tonnes per resident and year. Fortum considers that it will be possible to achieve this decrease by 2015.	Furthermore, there is a theoretical potential that Fortum replaces all coal by replacing the coal fired combined heat and power plant (CHP plant) at Värtan. This would further decrease emissions by 265 thousand tonnes, or by 0,3 tonnes per capita, on top of the reductions which are a result of Fortum's ongoing and planned measures. Fortum considers this measure unprofitable.
PAGE 5 **Summary** **(ERR·IV)**	These theoretical potentials are described in the plan, although not to the same extent as measures in which consideration has been given to cost efficiency and the City of Stockholm's right of disposition.	These theoretical potentials are described in the plan, although less detailed than the conceivable measures, in which consideration has been given to cost efficiency and the City's right of disposition.
PAGE 20 **4.4.1** **(ERR·V)**	Fortum Värme has plans for a staged conversion from coal to biofuel in their combined heat and power plant in Värtan with the aim of achieving at least a 50 per cent admix of biofuel by 2015. An entire transition to renewable fuels is not considered being economically viable by Fortum at the present, partly because lignin supplies are uncertain. Halving the use of coal would mean that the emissions allocated to district heating production are reduced by 235,000 tonnes, i.e. emissions from district heating production after they have been allocated between electricity generation and district heating production.	Fortum Värme has plans for a staged conversion from coal to biofuel in their combined heat and power plant in Värtan with the aim of achieving a 50 per cent admix of biofuel by 2015. An entire transition to renewable fuels is not considered technically feasible by Fortum. Moreover, lignin supplies are uncertain. Halving the use of coal would mean that the emissions allocated to district heating production are reduced by 235 thousand tonnes, i.e. emissions from combined heat and power production after they have been allocated between electricity generation and district heating production.
PAGE 23 **Graph 6** **(ERR·VI)**	Renewable district heating production 250 kt	Renewable district heating production 265 kt
	Ethanol-powered cars 50 kt	Ethanol-powered cars 45 kt
	After the table caption	The Rail track investments staple is a theoretical example, though no conceivable measures have been explicitley identified for this block of measures.
PAGE 24 **Table** **(ERR·VII)**	Further potential 2015–2020	Further potential 2015–2020
PAGE 27 **5.2** **(ERR·VIII)**	Between 2010 and 2015, the potential is estimated to be approximately 60,000 tonnes.	Between 2010 and 2015, the potential is estimated to be approximately 50,000 tonnes.
PAGE 27 **Table** **(ERR·IX)**	Further potential 2015–2020	Further potential 2016–2020

Page and chapter, table or graph	Text	Correction
PAGE 31 **5.4** **(ERR · X)**	The single largest source of greenhouse gas emissions in Stockholm is CHP Plant 6 in Värtan, which is fired by coal and a small amount of biofuel. The individual measures that would lead to the largest decrease are to replace coal by renewable energy sources in CHP Plant 6 in Värtan, which could serve to reduce emissions by as much as 500,000–600,0000 tonnes of greenhouse gases, and to introduce carbon dioxide storage, which could reduce emissions by over 600,000 tonnes. The potential for reducing greenhouse gas emissions from energy production between the years 2010 and 2015 is estimated to be 500,000 tonnes. Between 2015 and 2020, the potential is judged to be 1,160,000 tonnes.	The individual measures that would lead to the largest decrease are to replace coal by renewable energy sources in CHP Plant 6 in Värtan, which could serve to reduce emissions by approximatley 500 thousand tonnes of greenhouse gases. Fortum's plans for a staged conversion to biomass, which are presented in section 4.4.1, would lead to emissions reductions of 235 thousand tonnes. The remaining approx. 265 thousand tonnes are considered as conceivable measures. The potential for reducing greenhouse gas emissions from energy production between the years 2016 and 2020 is estimated to be 660 thousand tonnes by introduction of carbon capture and storage.
PAGE 31 **(ERR · XI)**	Further potential 2015–2020	Further potential 2016–2020
PAGE 31 **5.4.1** **(ERR · XII)**	In addition to the 50 per cent reduction that is planned to be completed by 2015, there is a further potential for replacing coal with biofuel. This would mean a further 235,000 tonnes in emission reductions from the use of coal that is set aside for district heating production.	In addition to the 50 per cent reduction that is planned to be completed by 2015, there is a further potential for replacing coal with biofuel, by taking the coal fired CHP plant out of operation before its technical lifetime expires. This would mean a further 265 thousand tonnes in emission reductions from the use of coal in the CHP plant that is allocated to district heat when emissions are apportioned between electricity and heat production.
PAGE 31 **5.4.1** **(ERR · XIII)**	Carbon dioxide reduction 2010–2015 235,000 tonnes	Carbon dioxide reduction 2010–2015 265,000 tonnes
PAGE 31 **5.4.1** **(ERR · XIV)**	Investment costs initially incurred to build up storage space, distribution chain and boiler conversion.	Need for reinvestment in the range of billions SEK to replace the lost CHP production capacity.
PAGE 31 **5.4.1** **(ERR · XV)**	Cost efficiency High	Cost efficiency Low

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