Stockholm action plan for climate and energy

2012–2015

WITH AN OUTLOOK TO 2030
Stockholm action plan for climate and energy
2012–2015 with an outlook to 2030
A report from the Environment and Health Administration
PROJECT LEADER: Örjan Löngren
This action plan for climate and energy, which is the fourth of its kind, provides an overview of the City’s climate work. The goal of the plan is primarily to describe measures and conditions for achieving the climate and energy objectives of the Stockholm Environment Programme for 2012–2015. Apart from these short-term goals, the plan also embraces the wider goals of the City’s Vision 2030.

Since signing the Mayors’ appeal, the City reports its climate and energy plan to the Covenant of Mayors Office in Brussels. Every second year, a report regarding the implementation of the plan must be sent to the Covenant of Mayors Office for evaluation and monitoring.

The Stockholm action plan for climate and energy has been produced by the Environment and Health Administration by order of the City Executive Office.

Staffan Ingvarsson
Vice CEO, City of Stockholm

Gunnar Söderholm
Head of the Environment and Health Administration
Introduction

Stockholm has a long, unbroken tradition of ambitious environmental work. A hundred years ago, it was mainly a question of creating healthy living conditions. Today, the City is working to improve the environment on a wide front. In the new Environment Programme, there are concrete goals for how to achieve this. Many of these can be directly connected to the climate and reduced emissions of greenhouse gases.

The City adopted its first climate plan in 1998. The current action plan for climate and energy is the fourth. This long-term perspective is essential in keeping the global frontrunner position that Stockholm has on the environmental stage and is a precondition for achieving its long-term targets for the city.

Stockholm takes it one step further than the EU
In February 2009, the Mayor of Stockholm signed the European mayors’ agreement Covenant of Mayors. Through this covenant, the signatories commit to working towards reducing emissions of greenhouse gases 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 a sustainable action plan, i.e. this plan. In Stockholm, emissions have already been reduced by 23 per cent. This plan details how the City’s own targets can be met.

The status of the action plan
The action plan for climate and energy is intimately connected to the City’s various guiding policies, among others the Stockholm Environment Programme and the comprehensive City Plan with a more detailed energy plan. The action plan is subordinate to the Environment Programme. It defines more precisely the actions that can be decided in committees, on boards or in city councils in order for the interim targets of the Environment Programme concerning energy and climate to be reached during the programme period. These actions also specify the energy plan’s reasoning behind energy conservation.

The action plan is thereby a guiding document and should be seen as an important basis in the upcoming budget and operations planning for the City.

The sectors of the action plan
The targets relating to climate and energy in the Stockholm Environment Programme affects four sectors: transport, building, energy use and energy production within the Stockholm geographic area. The actions mentioned in this plan aim to reach the goals of the Environment Programme within these sectors.

The action plan also suggests a number of knowledge-enhancing measures that will prepare the City for coming action plans as well as for new climate and energy goals. The issue of climate is fast-changing with a steady stream of new data and recommendations regarding necessary emissions reductions, not least from the UN climate panel, IPCC.

Greenhouse gas emissions included in the Stockholm City climate targets
The action plan includes all energy use, and its accompanying emissions of greenhouse gases, involved in the production of goods and services within the geographical boundaries of the City of Stockholm.

The plan encompasses the total amount of greenhouse gas emissions resulting from heating and cooling of all buildings, all road traffic work within City boundaries no matter who is performing it, and all gas and electricity use. The figures for the transport sector include shipping within city limits and flights from Bromma airport up to an altitude of 915 meters. Electricity use is divided into heating, transports

1. Included in the figures for exhaust emissions are all exhausts pertaining to the Landing and Take-Off cycle (LTO cycle), meaning exhausts from planes flying below an altitude of 3,000 feet (915 meters) including taxiing (rolling on the ground).
and other electricity use.

The action plan does not include emissions from Stockholmers’ travels by car, train, airplane and ferry outside city limits. Likewise not included are emissions from the production of foodstuffs and other goods that Stockholmers consume but that have been produced outside the city. Greenhouse gas emissions from sources other than combustion and electricity use, for example CFCs in refrigerants, construction waste and nitrous oxide, are not included.

The action catalogue mainly includes measures beyond those already underway in the city. Completed or ongoing measures are not included. Examples of measures that are not included are Royal Seaport, reduced energy demand in new buildings, more energy-efficient street lighting and the nationwide procurement of electric cars. All measures that involve increases or reductions of greenhouse gas emissions as a result of political decisions, technological developments or changes in the cost structure are described in connection with their respective measures.

The place-name Stockholm is used when all activities within the geographical borders of the city are referred to. The term “the City” is used in reference to municipal activities.

Principles applied in estimates
The estimates of greenhouse gas emissions cover carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) from energy use for heating, electricity and transportation in Stockholm. Since methane and nitrous oxide have a stronger greenhouse effect than carbon dioxide, these emissions have been converted into carbon dioxide equivalents (CO₂e) so they can be added with carbon dioxide to a combined figure for all greenhouse gas emissions. 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 City’s estimates of greenhouse gas emissions are primarily based on data from Statistics Sweden regarding heating and electricity use. The figures for road transport come from the City’s Environment and Health Administration, based on data from the Traffic and Waste Administration. Emissions from the use of district heating are primarily based on emissions from production at Fortum Värme in Stockholm. Emission figures relating to electricity use have been estimated based on emissions from production within the Nordic electricity system. For railbound traffic and the City’s electricity use, where there are long-term agreements for electricity that meets demands for eco-labelling, this is taken into account. The emissions from electricity are adjusted by an average value based on the year of measuring and the actual values of the previous four years, in order to balance the variations in electricity generation during different years. The energy use for heating purposes during a normal year is adjusted on the basis of changes in the weather. If no other source is specified, estimates and statistics have been provided by the Environment and Health Administration, with adjustments by the consultancy ÅF. Prognoses have been carried out by ÅF.

Method and work process
The action plan for climate and energy has been produced by the City of Stockholm Environment and Health Administration. The project has had an internal management group containing representation by the City Executive Office, the City Development Administration, the Traffic and Waste Management Administration, the City Planning Administration, the Real Estate Administration and the City’s housing company Svenska Bostäder. The project’s reference group has consisted of Tomas Bruce, Chairman of the Energy Efficiency Inquiry; Agneta Persson, Secretary of the Energy Efficiency Inquiry; Egil Öfverholm from the Swedish Energy Agency; Håkan Johansson, climate expert at the Swedish Transport Administration; Tea Alopaeus, climate expert at the Swedish Environmental Protection Agency and Kjell-Åke Henriksson, energy expert at building contractor JM.
Waste separation in Hammarby Sjöstad.
2 City of Stockholm climate and energy efforts 1990–2010

The first inventory of greenhouse gas emissions in Stockholm was initiated in 1995. From an emission level of 3,700 thousand tonnes of greenhouse gases in 1990, we have managed to drop to a level of just over 2,800 thousand tonnes per year in 2009. This equates to a reduction of 23 per cent.

The demands set forth by the Covenant of Mayors specify a reduction of 20 per cent by the year 2020. This, in other words, has already been accomplished. If one takes the population increase into account, the reduction has been even greater, from 5.4 to 3.4 tonnes of CO₂ per person – a reduction of 37 per cent.

Reduced emissions from 5.4 to 4 tonnes of greenhouse gases per Stockholmer 1990–2005

The goal of the first climate plan (Action programme against greenhouse gases, decided 1998) was to reduce emissions of greenhouse gases from electricity, heating and transportation to the 1990 level, in other words 5.4 tonnes per Stockholmer and year. This goal was surpassed; in 2000/2001, emissions were 4.5 tonnes per year.

In 2005, the goal for the second action programme (2000–2005) was reached when emissions dropped to 4 tonnes per Stockholmer and year. With this, emissions in Stockholm had been reduced by a total of 655,000 tonnes of CO₂ between 1990 and 2005.

3.0 tonnes of greenhouse gases per Stockholmer 2015 and a fossil fuel-free Stockholm in 2050

In the year 2007, the Environment and Health Administration was tasked by the Vice Mayor for Environment to investigate the conditions for reducing greenhouse gas emissions to 3.5 and 3.0 tonnes per person, respectively, by the year 2015. The mission was presented in the report Reduced emissions of greenhouse gases in the City of Stockholm in 2015. In the budget for 2008, it was stated that:

Stockholm should be free of fossil fuels by the year 2050, but already by 2015 we should have reduced our emissions of greenhouse gases to 3.0 tonnes per Stockholmer, which means an emissions reduction of 43 per cent between 1990 and 2015. The goal for 2015 is specified in concrete goals regarding energy efficiency measures in the City’s properties and measures for reducing environmental impact.

Reduced impact from district heating

The effort of reducing emissions of greenhouse gases in Stockholm has been successful due to a number of large investments, above all in the system for district heating. The city is supplied by four major cogeneration plants where both electricity and heating is produced. Today, district heating is produced by Fortum Värme with almost 80 per cent renewable fuels or energy from waste or waste heat. The district heating system covers almost 80 per cent of Stockholm’s entire heating needs. The district heating grid is constantly

Measures that have led to reduced greenhouse gas emissions

The largest reductions during 1990–2010 have been achieved within:

- conversions from oil heating to district heating and a switch to biofuels in district heating: approximately 500,000 tonnes
- conversions from oil heating to heat pumps: approximately 300,000 tonnes
- replacing fossil fuel-powered vehicles with green cars: approximately 80,000 tonnes
- replacing diesel buses with ones powered by renewable energy sources in public transport: approximately 10,000 tonnes
being expanded in order to further increase the proportion of district heating in the city. Meanwhile, energy efficiency measures are being implemented in the property stock, and there is a smaller degree of disengagement from the district heating system. The overall effect of this is that the amount of district heating produced has remained more or less unchanged. The conversion from oil heating to district heating has reduced emissions of greenhouse gases by almost 500,000 tonnes since 1990.

**More traffic efforts**

More efforts have been taken to make the transportation system of Stockholm more environmentally adjusted, and to increase the proportion of pedestrians, cyclists and public transport users.

Stockholm Transport (SL) is responsible for the county’s public transport. Close to 75 per cent of SL’s total transport mileage is today powered by renewable energy. For example, rail traffic is powered by electricity based on wind and hydropower, and all buses in the inner city of Stockholm are powered by renewable energy.

During the most intensive periods of the morning rush hour, 79 per cent of all motorised trips to the inner city are made using public transport, which is an increase from 75 per cent in the year 2000. This while the number of overall travellers has increased. During daytime, an average of 60 per cent of all trips are made using public transport. SL’s proportion of fossil carbon emissions from road traffic in Stockholm County in 2006 was only 5.3 per cent, and within Stockholm city the figure was even lower. Between their homes and their work or school, 60 per cent of Stockholmers take public transport most days, while 14 per cent say they most often walk or bike. Only 19 per cent take the car for work-related travel.¹

Since the mid 1990’s, the City has been working to increase the number of green cars and the use of renewable fuel in vehicles. This is occurring in close cooperation with manufacturers and distributors of renewable fuels and green cars, as well as with actors with large car fleets. The effort also includes increasing the number of filling stations for renewable fuels and making them more readily available. Since

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¹. Citizens’ Survey 2010, Stockholm City Environment and Health Administration
2008, the City is working to create a market for electric cars. Among other things, this involves setting up an infrastructure for electric cars and tests of plug-in hybrids that can both charge and be driven on different kinds of fuels.

**Energy efficiency in the property portfolio**

The City is systematically working at improving energy efficiency in its own property portfolio. The work is coordinated through the City's *Energicentrum*, which was founded in 2005. In close cooperation with the City's property-owning companies and administrations, Energicentrum identifies and initiates technical measures, follows up on energy use, trains operating personnel, participates in testing of new energy-efficient technology and assists property owners with technical business intelligence.

Thanks to the efficient social planning of Stockholm, infrastructure and buildings are used more efficiently. New production of homes and workplaces is carried out through making urban areas more dense, utilising already available public transport, district heating, services, etc. This means that existing infrastructure can be utilised by more people. In Stockholm, we can see that energy use and emissions of greenhouse gases per person is being reduced in spite of a rapidly increasing population. During the period from 2005 to, and including, 2010, emissions of greenhouse gases per person have declined by almost 0.4 tonnes.

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**Graph 2: Energy use in the City of Stockholm.** The energy use for heating in the City of Stockholm has decreased by 12 per cent. Energy use in the transport sector shows an increase of 10 per cent. Traffic measurements, however, do not support the conclusion that transport mileage in the city has increased that much. An increasingly energy-efficient vehicle fleet is also evidence of a development going in the opposite direction. Emissions of greenhouse gases have declined more than the reduction of energy use through conversions to biofuels.*

* Sources: Heating from Fortum Värme and scb, transport from sla and the Swedish Transport Administration, gas from Fortum Värme and electricity from scb.
3 Strategy for climate and energy efforts in the Stockholm Environment Programme

These strategies account for how the City can reach the climate and energy targets in the Stockholm Environment Programme 2012–2015. For those environment programme targets where the City has authority of action, the target is expressed as “the City will...” Where the City lacks direct authority to act, the target is expressed as “The City will strive to...”

Interim targets 3.1 and 3.4 of the Stockholm Environment Programme

*The City will, through energy-efficiency measures, reduce energy use in its own operations by at least 10 per cent. Energy efficiency will be increased in the City’s properties in connection with major renovations.*

Apart from leading to a more resource-conservative society, these targets also reduce operational costs in the City as a result of reduced expenditure on energy.

Energy efficiency measures in the City’s properties

The City’s five property companies, in cooperation with the Real Estate Administration, together with Energicentrum at the Environment and Health Administration, suggests programme for energy efficiency up until, and including, the year 2015. These investments are made possible by reducing the demands on financial return from the companies in relation to their costs for investments in energy efficiency.

Through the proposed measures, the City’s property stock will achieve a reduction of 14 per cent in energy efficiency during the period 2012–2015, provided that the current forms of financing are maintained. This improved efficiency is equivalent to a reduction of emissions by just under 40,000 tonnes of greenhouse gases by 2015, and beyond that a reduction of operating costs by 210 million kronor annually (calculated using 2011 price levels).

Strategy for making the City’s property stock more energy efficient

The concerned companies and committees are encouraged to secure that the planned efficiency measures are implemented and acted upon.

Procurement of energy-efficient goods and services

The City of Stockholm spends roughly 13 billion kronor annually on goods and services and can in this way influence supply in certain areas. Furthermore, the City’s companies and committees are charged, where it is appropriate, with carrying out innovation procurements in order to test the latest technology. One area that can be affected is energy efficiency. By placing demands on energy-efficient goods and services, conditions are improved for reducing the City’s energy use. To facilitate this for City committees and companies, guidance is necessary for how to place requirements on energy efficiency during procurements.

Strategy for procurement of energy-efficient goods and services

The City Executive Office is requested to produce a guideline for the City to be used at procurements of, among other things, energy-efficient goods and services.

Interim target 3.2 of the Stockholm Environment Programme

*Procured electricity for the City’s own activities will meet the requirements for eco-labelling.*

In the year 2009, 73 per cent of the City’s procured electricity reached the target: 497 GWh out of a total of 677 GWh. For
There are as yet no fully reliable statistics, but it looks as if the situation is unchanged. Two companies and one committee use fully or partially unspecified electricity. If this electricity were to be replaced by electricity that meets the requirements for eco-labelling, the City’s emissions of greenhouse gases would be reduced by 1,400 tonnes.

Strategy for procurement of eco-labelled electricity

The two companies and the committee that lack agreements for electricity that meet the requirements for eco-labelling should procure such agreements.

Interim target 3.5 of the Stockholm Environment Programme, and the climate target of achieving a fossil-free city by the year 2050

The City will strive to reduce emissions of greenhouse gases to a maximum of 3.0 tonnes of CO\textsubscript{2}e per Stockholmer by the end of 2015. Emissions of greenhouse gases in the city will continue to be reduced at the same rate, which means that the city will be fossil-fuel free no later than 2050.

In the target on a maximum of 3.0 tonnes of greenhouse gas emissions per inhabitant by the end of 2015, there are the following specifications in the Environment Programme 2012–2015.

The interim target requires that:

- emissions from district heating be reduced by 50 per cent
- the property stock of Stockholm be made 5 per cent more energy efficient
- emissions from traffic be reduced by 15 per cent

The point of the specifications is to show the way to achieving the City’s long-term goal of becoming fossil-fuel free. These specifications are also based on the national objectives for energy efficiency regarding the current property stock, and reduced emissions from, among other sources, the transport sector.

For the City to reach the long-term national energy and climate objectives, there is a need for the City to continue reducing emissions after 2015 at a pace equivalent to that of the previous 10 years. This means more far-reaching measures to make existing properties more energy efficient and to reduce emissions from the transport sector. On a national level, there are overarching goals that can serve as a basis for setting the City’s objectives:

- Parliament has decided that energy use in the property stock shall be reduced by half by 2050, measured from 1996 levels.
- the vehicle fleet shall be fossil fuel independent by 2030.

How the City can reach 3.0 tonnes of greenhouse gases per inhabitant by 2015

It is fully possible to reach the planned target of 3.0 tonnes of greenhouse gases per inhabitant by 2015 already with ongoing and planned measures. However, this requires that measures are actually carried out. It is also important that the conditions that make these goals achievable are not altered in a negative way. After 2015, it will be considerably harder to reduce emissions at the current rate.

By the year 2015, emissions from the following sectors are estimated to be:

- the transport sector, roughly 915,000 tonnes
- heating (heat and hot water), roughly 720,000 tonnes
- electricity and gas, roughly 500,000 tonnes

Stockholm is estimated to have 910,000 inhabitants by 2015. Since the population will increase at the same time as total energy use and emissions of greenhouse gases are reduced, emission estimates per inhabitant will be even lower. This effect leads to a reduction by 0.4 tonnes of CO\textsubscript{2}e per inhabitant from 2005 to the end of 2009.

Energy production (Fortum)

- Emissions from district heating are reduced by 50 per cent by the end of 2015.

Fortum has an extensive programme for conversion and extension of the district heating system and electricity production. These measures were decided by the board of Fortum Värme in November, 2009. The measures are conditioned on a continued tax exemption for renewable energy. There
is nothing that indicates that these conditions will change, wherefore it can be assumed that the annual emissions of greenhouse gases will decline by 320,000 tonnes by the end of 2015, as compared to 2010.

After 2015, Fortum will not be able to achieve any major reductions of greenhouse gas emissions from its energy production. As long as the coal-powered plant (KVV6) in Värtan is operational, greenhouse gas emissions of 260,000 tonnes will remain. It is considered technically very difficult to convert more than half of the coal to biofuels in this cogeneration plant. At this time, Fortum Värme has no plans of hastening a closure of KVV6.

**Strategy for energy production**
The City strives, through its representation on the board of Fortum Värme, to ensure that the plans for conversion and extension are carried out according to the agreed schedule. Above all, focus is on the proportion of biofuels increasing as far as it is technically possible at the cogeneration plant (KVV6) at Värtan.

**Property in Stockholm**
- Energy use in the property stock of the entire city (Stockholm) needs to be reduced by 5 per cent through energy-efficiency measures by the end of 2015.

The buildings of Stockholm are renovated at an average rate of just under one per cent annually. Included in these renovations are also energy efficiency measures, but to a low extent since most of them concern simple actions.

In order for the entire property stock of Stockholm to reach Parliament’s goal of cutting energy use in half within the sector, more extensive renovations must be undertaken. Above all, it is important that far-reaching energy-efficiency measures are carried out in connection with major renovations.

Measures concerning financing should be connected to some form of extended energy consultancy in order to disseminate knowledge regarding efficient methods of reducing energy use.

In total, these energy-efficiency measures could reduce energy use in Stockholm by about 2,800 GWh per year. Above all, this would lead to a reduced need for district heating, since the larger part of Stockholm’s buildings are heated by way of district heating.

**Transports**
- Emissions from traffic will be reduced by 15 per cent by the end of 2015.

Greenhouse gas emissions from traffic are not expected to decrease sufficiently. Traffic-related emissions of greenhouse gases have declined by 10 per cent between 2000 and 2010. This reduction is a result of investments in public transport and bicycle paths, an increase in the use of biogas, more fuel-efficient vehicles and green cars.

As a result of the conversion moving faster in the heating sector, traffic’s proportion of total greenhouse gas emissions is expected to increase from 22 per cent in 1990 to 40 per cent in 2015.

The Traffic and Waste Management Administration is developing traffic strategies in order to increase the possibility of walking, biking and travelling by public transport. The City has also made room in the budget for 2012 for large investments to increase the number of cyclists in the city. The largest increase in road traffic is expected to come from an increase in the amount of goods transported to supply the growing city.

**Strategy for more efficient goods transports**
The Traffic and Waste Management Administration is encouraged to investigate how efficient goods transports can be developed in cooperation with goods deliveries and a rational terminal structure, in order to reduce transport mileage on the roads.

**Public transport**
Stockholm Transport (SL) has developed a Public Transport Plan 2020. The plan is based on the Stockholm agreement from 2007 and the national infrastructure plans for 2010–2021, adopted by the Swedish government in the spring of 2010. SL’s Public Transport Plan 2020 describes an extensive expansion of rail traffic and trunk bus network, as well as a reinforcement of the bus network in general. If these expansions are implemented by 2020, the capacity of public transport will be judged to meet demand. In spite of these expansions, however, public transport as a proportion of the total traffic mileage for passenger transport will remain unaffected in the city of Stockholm, and decline in the county. Reasons mentioned for this are the expanded road network and increased disposable income, both of which increase the tendency to use personal cars.

Accessibility for trunk buses is mentioned as a lingering problem, even after the introduction of the Public Transport Plan 2020. More separate lanes would be needed, combined with prioritised traffic signals. The accessibility strategy of the Traffic and Waste Management Administration provides suggestions for measures.

Stage 1 of Stockholm Transport’s Tramway and Trunk Network Strategy provides an analysis of how the core
network in the inner city of Stockholm can be developed in order to increase both capacity and accessibility. SL’s strategy is in tune with the accessibility strategy of the Traffic and Waste Management Administration. The measures analysed aim to increase the proportion of public transport in passenger transport mileage by the year 2030.

**Strategy for more efficient public transport**
The City, through the Traffic and Waste Management Committee, strives to increase the expansion of public transport and development of the trunk line network. The City supports the implementation of planned capacity-enhancing measures and expansion projects within public transport in greater Stockholm, aimed at maintaining its market share and eventually increase its proportion of users.

**Green cars**
The work of stimulating sales of new green cars in the city has been successful. During these last few years, the proportion of green cars has hovered around 40 per cent of new-car sales. A more stringent green-car definition is crucial as an incentive to further be able to reduce emissions of greenhouse gases, and for the effort to be widened to also include heavy vehicles. The demand for biogas has exceeded supply, and the City is currently working on a biogas strategy to increase the availability of biogas, primarily through an increased collection of food waste, expanded production capacity and new production facilities. It is also important to increase cooperation between producers, distributors and users. Together, this is estimated to lead to emissions reductions equalling 31,000 tonnes of greenhouse gases by 2015.

In order to meet the national objective of a vehicle fleet free of fossil fuel, the renewal of the vehicle fleet must be accelerated. Furthermore, extensive work must be made to increase the proportion of users who choose walking, biking or public transport over cars. In the city, this can mean that larger areas of street space must be reserved for alternatives to cars.

In order to approach the target of a transport sector free of fossil fuels, vehicles need to be more energy efficient and to a greater extent powered by renewable fuels. Even if all vehicles were green cars according to the current definition, it would not be enough to reach the targets. There is need for a new green-car definition that is more strict than the current one, as well as incentives for directing new-car sales to green cars.

**Strategy for green cars**
The Environment and Health Committee continues its investment in green cars.

**Development of the congestion tax**
As part of its efforts to produce a new action programme for environmental air quality norms, the County Administrative Board is investigating possible options for developing the congestion tax so that environmental quality norms for PM$_{10}$ and NO$_2$ are met throughout the county. Meanwhile, the government is reviewing the congestion tax law to see if and how municipalities might gain more influence over how the system is designed and authority to dispose of the net income, etc.

In this regard, it is only natural to study in greater detail what the possible climate effects are of the congestion tax contributing to reducing greenhouse gases. However, it is too early to specify how such changes might be designed, and these will – if they are put forth at all – be possible to implement no earlier than toward the end of the programme period.
The government is looking into how the congestion tax might be developed.
4 Long-term goals and visions

The City has both a long-term goal and a vision to guide it in its ongoing climate efforts for Stockholm. On top of this, there are a number of national objectives that the city must adhere to. In the action plan’s catalogue of measures, further ahead in this document, examples are presented of measures that can contribute to the meeting of long-term goals and visions up until the year 2030.

The City’s long-term goal is to be free of fossil fuels by the year 2050. To meet this goal, the City is developing a guiding document during 2012.

Vision 2030 is the City’s long-term vision that describes what Stockholm shall and will be in just under 20 years. There are expected to be more than one million Stockholmers by that time, which is 150,000 more than today. Vision 2030 describes a sustainably growing major urban centre, with new innovations that have solved many environmental problems, reduced energy consumption among enterprises and residents, increased accessibility and reduced emissions through smart traffic solutions and information technology. In the year 2030, Stockholm will be an international role model when it comes to climate and the environment.

National objectives for transports
- In 2030, Sweden should have a vehicle fleet that is independent of fossil fuels.

National objectives for energy efficiency in buildings, objectives for Swedish climate and energy policy:
- that energy efficiency is increased by 20 per cent by 2020 as compared to 1990
- that energy use in the building sector is cut in half by 2050 compared to the 1996 level.

National objectives for energy production, objectives for Swedish climate and energy policy in 2020
- that at least 50 per cent of Swedish energy is renewable
- that emissions of greenhouse gases in Sweden be reduced by 40 per cent compared to 1990.

Under the condition that the City reaches the long-term national energy and climate objectives, emissions will develop according to the graph below. The City estimates electricity use to remain constant. Fortum Värme is assumed to have carried out planned conversions in its combined heat and power production. The building sector has been made 25 per cent more efficient, which is necessary for cutting energy use in half by 2050. The vehicle fleet has been renewed and is independent of fossil fuel.

\[\text{co}_2\text{e emissions per sector}\]

\[\text{Effect of population increase}\]

\[\text{Heat} \quad \text{Electricity} \quad \text{Miscellaneous} \quad \text{Transport}\]

Graph 4: Expected change, under the condition that measures are carried out, in greenhouse gas emissions per sector 2010–2030. The estimate presupposes a population increase of 15,000 new inhabitants per year, which corresponds to the increase 2005–2010. Lacking a population increase, emissions per person based on the population of 2005 is shown on the dashed line.
The Stockholm Environment Programme 2012–2015 posts ambitious goals for sustainable urban development. In the proceeding chapters, examples are presented regarding measures that support the targets of the Environment Programme relating to climate and energy. The relevant goal is orientation goal 3 – Sustainable energy use.

The catalogue of measures lists examples of measures that may serve as sources of inspiration for City committees and companies. For each measure there are analyses and calculations showing how they can lead to reductions in greenhouse gas emissions and reduced energy use.

There are many climate efforts underway in Stockholm, and many measures are in place to reduce the emissions of greenhouse gases. The catalogue of measures encompasses new measures, but above all a reinforcement of current measures.

Orientation goal 3 on Sustainable energy use contains interim goal 3.5: The City will strive to reduce emissions of greenhouse gases to a maximum of 3.0 tonnes of CO₂e per Stockholmer. The interim goal deals with energy production and all energy use. This means that those parts that pertain to climate and energy in orientation goal 1 on Energy-efficient transport and orientation goal 5 on Eco-efficient waste management touch upon this goal. Several of the developed measures contribute to also meeting these goals.
5 Measures for eco-efficient transports

Every day, Stockholmers make two million trips. Even today, the region’s transport system lacks capacity and the Stockholm region continues to grow. In order to solve the problems of congestion and environmental impact, it is necessary to convert to more resource-efficient and less environmentally straining modes of transport.

The transport sector is responsible for around 40 per cent of all emissions of greenhouse gases in Stockholm. Most of the transport sector’s emissions of greenhouse gases, just under 86 per cent, comes from road traffic. Emissions from shipping and construction machinery combined are responsible for more than 12 per cent of transport sector emissions. Airline emissions from take-offs and landings at Bromma Airport make up 1.5 per cent. When it comes to road traffic emissions of greenhouse gases, passenger transport is responsible for two thirds and goods transport for the rest.

Emissions of greenhouse gases per person from the transport sector in Stockholm have remained relatively constant during the last few years. The reduced emissions are mainly due to an increased proportion of green vehicles as well as an increased population, which leads to emissions being spread out over a larger number of individuals. Other positive trends are increases in the number of cyclists and public transport passengers, and that the proportion of renewable fuels has increased to more than 7 per cent by the year 2010.

In order to reduce the climate impact of the transport sector and to solve other environmental problems, significant changes must be made in both transport systems and vehicle fleets. The City needs to, in cooperation with Stockholm Transport, implement a row of measures within both passenger transport and goods transports. Measures are necessary to increase the use of public transport, increase bicycle and pedestrian traffic, alter the vehicle fleet, reduce emissions from existing vehicles and promote efficient goods transports and commercial traffic.

Graph 5: Distribution of emissions from the transport sector in 2010, preliminary figures.

5.1 Planning of new construction for eco-efficient transports

The structure of the City is of great importance for its transport needs. A more dense building structure, with shorter distances between housing, service and workplaces, creates possibilities of utilising public transport and choosing walking and cycling ahead of driving. Experiences from research shows that a 10 per cent increase in settlement density reduces vehicle mileage by 1–3 per cent. It has been shown that areas with well-developed public transport has 10–30 per cent lower car ownership and a correspondingly lower road traffic mileage. Early in planning, before the formal planning process has commenced, there is an opportunity to influence the choice of transport modes and measures. With a basis in systems analyses and the four-stage principle, which assumes that the transport system will be designed and developed with an overview perspective, it is possible to find the best measures for solving problems or deficiencies in the transport system.

The four-stage process means that possible measures are analysed in the following order:

- **STAGE 1** – Measures that can affect the need for transport and choice of transport mode.
- **STAGE 2** – Measures that increase the efficient use of existing infrastructure and vehicles.
- **STAGE 3** – Limited renovation measures.
- **STAGE 4** – New investments and major renovation measures.

The City’s comprehensive plan Promenadstaden 2010–2020 includes a pronounced strategy encouraging new built-up areas to be situated where there is already good access to public transport and service. The development should move towards dense and attractive city districts with mixed housing and commercial buildings.

5.2 Passenger transports by road

Passenger transport by private cars or buses make up more than 80 per cent of the total motorised traffic mileage of Stockholm, and cause two thirds of the city’s greenhouse gas emissions resulting from transports. Private cars are responsible for most of the traffic mileage of passenger transport and emissions of greenhouse gases. Bus traffic contributes eight per cent of the traffic mileage but only two per cent of the greenhouse gas emissions.

The petrol car is still the most common type of private car, but the proportion of diesel cars has increased and today makes up more than 20 per cent. Vehicles powered by renewable fuels, that is, ethanol and gas cars, make up 15 per cent of passenger car transports but only contribute 10 per cent of the emissions of greenhouse gases resulting from passenger car transport in Stockholm.

The proportion of passengers who use public transport compared to those who drive is roughly on the same level as it was in 2007 (66 per cent). The number of public transport passengers has increased during the last few years. SL’s investments in ethanol and gas buses have resulted in the proportion of renewable fuels in bus traffic reaching 40 per cent.

Bicycle traffic has increased by 10 per cent annually since 2005. The City has invested in new bicycle paths, new parking facilities and measures that facilitate access. Roughly 14 per cent of Stockholmers either walk or bike to work every day.

The proportion of green cars (including low-consumption diesel or petrol) has steadily increased since 2004 and in 2010 amounted to 20 per cent in Stockholm. More than 40 per cent of new car sales were green vehicles. Ethanol cars are still the
most common green vehicles, but during the last few years low-
consumption petrol and diesel cars have increased the most.
The distribution of green vehicles per fuel is shown in graph 8.

5.2.1 Expected development to 2015 and to 2030, provided measures are taken
The following calculations assume an annual increase in road transport by one per cent of road traffic mileage under the periods 2010–2015 and 2020–2030 in Stockholm. This means a total increase of about 20 per cent between 2010 and 2030. Bus traffic is also expected to increase by one per cent annually and by a total of 20 per cent during the period leading up to 2030. Public transport journeys, however, are not expected to gain an increased market share. Goods traffic is expected to increase more than passenger traffic.

Regarding bus traffic, it is assumed that Stockholm Transport will meet its goals of the proportion of renewable fuels being 50 per cent by 2011, 75 per cent by 2016, 90 per cent by 2020 and 100 per cent by 2025. Low-concentration ethanol is assumed to account for 6.5 per cent in 2015, and incorporation of FAME 5 per cent.

If all the measures suggested for transports in the action plan were to be implemented, emissions of greenhouse gases would be reduced from 623,000 tonnes to 185,000 tonnes, which corresponds to a reduction of 70 per cent. The most important measures are the phasing out of petrol and diesel vehicles, even those with low consumption, and a conversion to a vehicle fleet consisting of plug-in or electric hybrids, electric cars and gas cars by 2030. Regarding the bus fleet, diesel buses are expected to be phased out and replaced by ethanol, gas and plug-in hybrid buses. The expected development of emissions is presented in graph 9.

5.2.2 Passenger transport in City activities
The City’s administrations and companies have at their disposal 872 vehicles, as of 2010. The large majority of these are cars leased for an extended period (3–6 years). The number of vehicles that meet the demands for green cars was 761 vehicles (92 per cent) at the beginning of 2011. The current annual fuel consumption in the City’s vehicle fleet is petrol (311 m³), diesel (148 m³), ethanol (225 m³) and compressed natural gas, CNG (292,000 Nm³).

When procuring transport for household waste, mobility services, taxi for work-related travel and medical travel, environmental demands are placed on both vehicles and fuel. The City will improve statistics and follow-up of environmental demands for procured transports, for example eco-driving, green vehicles and fuel choice.

\[\text{Graph 9: Estimated change in emissions of greenhouse gases resulting from passenger transports 2010–2030.} \]
\[\text{The development is the one expected if the measures of the action plan are implemented.}\]

\[\text{Environmentally efficient transports in City activities}\]
\[\text{The City’s activities can work to meet its climate and energy targets by:}\]
a) using video conferencing to reduce the number of long-distance business trips
b) building bicycle parking at all the City’s workplaces
c) procuring winter clearing services for the City’s bicycle parking lots
d) providing public transport travel cards for work-related travel inside the city
e) providing access cards to the City’s loan bicycles
f) reaching the target of 100 per cent green cars
g) actively working with City procurements of transport services so that they to an increasing extent are carried out with green vehicles and powered by renewable fuels
h) actively working with the City’s own work-related trips and procured transports so that they are carried out in an energy efficient manner, through for example eco-driving and logistics
i) making a survey of how many work-related trips are made by City employees and with which modes of transport they are made, in order to assemble a better empirical basis for measures
j) investigating the possibility of encouraging tele-working for City employees.
5.2.3 Measures for passenger transport in Stockholm

The most important measure for stimulating the transfer from car to other modes of transport is to increase the space and thereby accessibility for pedestrian, bicycle and public transport. The goal should be that journeys of shorter length than 10 kilometers be made with modes of transport other than cars, where bicycles can and should be an attractive alternative.

**Increase the proportion of cyclists and pedestrians**

Bicycle traffic has increased by 10 per cent per year in Stockholm during the last five years. Cyclists today make up about 18 per cent of the total number of travellers using vehicles to and from the inner city of Stockholm. The number of bicycles trips is 150,000 in the inner city of Stockholm during a 24-hour weekday period in summer. In the winter the number of cyclists is 30–40 per cent lower, or lower still if road conditions are unfavourable.

Bicycle traffic has low environmental impact and takes up relatively limited space, which is why it is important to promote increased use of bicycles as a mode of transport. Eighty per cent of work-related travel by car in the city of Stockholm is shorter than 10 kilometers, which is normally considered as the distance where the bicycle is competitive.

The City has increased its ambition when it comes to cycling; the City of Stockholm will invest a total of one billion kronor until the year 2018 to expand the cycling infrastructure of Stockholm. Bicycle roads that bind together the different parts of the city and bicycle paths between the municipalities constitute the backbone of the effort.

The City of Stockholm can contribute to increasing the proportion of cyclists by:

a) carrying out information campaigns about alternatives to cars, as well as information about laws and regulations pertaining to bicycles

b) improving information about bicycle paths, for example informing about the network of bicycle roads, cycle travel planners, current re-direction of traffic in connection with traffic works, as well as making this information accessible via mobile phones

c) expanding the system of lending bicycles in the city with more lending places and more bicycles.

The City of Stockholm can facilitate for cyclists by:

a) improving road maintenance on bicycle paths and bicycle parkings, especially during wintertime.

Bicycle paths are used for storage and container parking, in connection with road works re-directions are often missing for cyclists and snow clearance is sub-standard. Cyclists must be offered a coherent network of good and even quality, good signage, comfortable and safe design, good visibility and lighting, and good access to parking and snow clearance within a reasonable time frame.
b) improving cycling infrastructure with an increased number of bicycle lanes and widening of existing bicycle lanes, as well as separate pedestrian roads and bicycle roads.

Perceived traffic safety is an important quality factor for unprotected road users. In order for cyclists to be able to maintain sufficient speed and a good traffic flow, separate pedestrian walkways and bicycle paths are necessary. It also increases the safety and well-being of pedestrians.

c) separating bicycle traffic from car traffic, or introducing more zones where drivers must show consideration for pedestrians and cyclists.

d) introduce signal controls that prioritise bicycles in intersections with many cyclists.

One measure for increased security for cyclists is to increase the number of bike boxes – signal-controlled intersections with forward bicycle areas and drawn-back stop lines for cars.

e) bicycle planning should be included initially in the planning process when new areas are built, and new bicycle paths should be integrated into existing cycling infrastructure.

The City of Stockholm already has two cycling plans, one for the inner city from 2006 and one for the outer city form 2005. The City of Stockholm is currently producing a new cycling plan where these two plans will be merged and developed to support regional bicycle commuting.

f) strive to increase the possibility of combining bicycle traffic with public transport.

At the current time it is possible at certain times to bring bicycles on the commuter trains and the Saltsjöbanan suburban train. On buses and metro trains, there is no room to make this possible.

g) act to improve accessibility of safe bicycle parking at traffic hubs.

In order to combine cycling with public transport, accessible and safe bicycle parking are necessary.

Developing an attractive and low-carbon public transport

Every winter’s day, more than 700,000 people travel by public transport in Stockholm County. Public transport has strongly increased during the last few years. The reason is primarily the population increase, but also a raised standard in the shape of increased seating capacity.

With a strong population increase, measures that maintain and increase the proportion of passengers who choose public transport are important. The most significant reduction in emissions and savings in energy use are reached if many drivers choose to avoid car journeys and instead travel by public transport.

Several large projects are underway to increase the capacity of rail public transport. Among them:

- Stockholm City Line, a separate commuter train tunnel through Stockholm than enables more trains per hour. The project is estimated to be finished in 2017
- Spårväg City. In November of 2010, it was decided that the next phase in the expansion of Spårväg City will be to Ropsten, where the tram line will be connected to the Lidingöbanan and the new city district Royal Seaport. The project is estimated to be finished by 2014.
- Expansion of the Tvärbanan tram line north from Alvik to Solna 2009–2014

Stockholm Transport estimates that there are limited possibilities for increasing the market share of public transport in relation to car journeys by more than 2–3 percentage points during the next few years. This is primarily due to Stockholm Transport already having a relatively large market share, especially in the inner city and during peak traffic hours when Stockholm Transport is competitive compared to the car. Travel by public transport is concentrated to the morning and afternoon rush hours, during which about half of all journeys of a 24-hour weekday take place. This uneven demand means that neither personnel, vehicles and rail capacity are used optimally.

The City of Stockholm can contribute to a more attractive public transport by:

a) providing information and initiating projects for increasing the use of public transport.

The City of Stockholm can, in cooperation with Stockholm Transport, work to persuade companies in Stockholm to choose public transport, both for work-related travel and for journeys to and from work. Private citizens are more inclined to change their travel habits just at the time they have moved. The City can carry out information activities about the benefits of public transport to those who move to or within the city. The city district administrations can be of help here with their good local knowledge.

4. Customer segments and increased travel, Stockholm Transport 2010
5. Customer segments and increased travel, Stockholm Transport 2010
EmT Barometer of public transport in European metropolitan areas, 2006
Data from the Traffic and Waste Management Administration

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b) work for faster public transport by way of more reserved bus lanes and signalling priority.

As a result of the traffic congestion in the city, public transport is slow and irregular. Wrongly parked vehicles further frustrates the situation. One of the measures that the City of Stockholm has most authority of action over is the proportion of lanes that are reserved for public transport. Compared to many European cities, Stockholm has a lower proportion of public transport lanes – less than two per cent of the total road network is reserved for public transport.

c) use signalling priority and optimising adaptive traffic signal control systems.

Signalling priority can be a cost-effective way of increasing accessibility for public transport on roads.7 The City of Stockholm today prioritises public transport through bus prioritisation for all trunk bus lines by way of a self-developed strategy called Pribuss.

An optimising adaptive traffic signal control system is a system that can learn the traffic situation and adapt the signal control according to the needs of the moment. With such a system, even other incoming vehicles than buses can be given priority if it is necessary to reduce traffic. However, the Traffic and Waste Management Administration of the City of Stockholm has found the system too expensive in relation to the traffic benefits, which can instead be achieved with the help of conventional technology.

d) work to improve the possibilities of switching between different types of traffic.

The changing hubs are strategically placed and designed so that they are seen as safe and inviting, and with safe and convenient bicycle parkings.

e) work for the continued expansion of rail traffic.

Expansion of public transport in Stockholm is primarily expected to focus on an expansion of commuter trains and tramlines. Stockholm Transport in particular is stressing better east-west connections.8

f) work to implement the City’s and Stockholm Transport’s Tramline and Trunk Network Strategy.

The City of Stockholm and Stockholm Transport are working jointly to develop the Tramline and Trunk Network Strategy for the central Stockholm region. The objective is to lay down the principles that will guide trunk traffic and point to suitable routes that can complement and relieve the metro and other rail traffic. The strategy will also, with the year 2030 as the goal, prepare material for suggestions on routes, traffic types and supply. The trunk traffic serves as a basis that through a wide-mesh net covers the entire county with rail and bus lines. The goal of these is to bind together the different city districts and hubs, but also to provide connections to other municipalities. Important principles for this trunk traffic is that it should maintain a high average speed (at least 20 km/h) and good capacity with high-frequency traffic of 2 and 7.5 minutes and around 500 meters’ distance between stops. The strategy will be supplemented by an investigation into the feasibility of using long articulated buses driving in their own lane, so called Bus Rapid Transit (BRT).

g) support Stockholm Transport’s work in changing the bus fleet. Stockholm Transport is working on increasing the proportion of buses using renewable fuel. The goal of Stockholm Transport is that:

- 50 per cent of buses shall be powered by renewable fuels before the end of 2011
- 75 per cent of buses shall be powered by renewable fuels before the end of 2016
- 90 per cent of buses shall be powered by renewable fuels before the end of 2020
- The bus fleet shall be free of fossil fuels in 2025.

The City of Stockholm can continue to support Stockholm Transport’s change process by, for example, participating in demonstration projects and continue working with infrastructure issues and secure the supply of fuels.

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7. The Trendsetter project
8. Customer segments and increased travel, Stockholm Transport 2010
h) work to realise an investigation into the City’s possibilities of promoting and expanding boat commuting.

The proportion of boats in public transport today is limited. As the amount of residential building near water increases, it is likely that demand will increase for the option of commuting in to the inner city of Stockholm by boat. In order to launch boats as a viable commuting alternative, frequency can be a deciding factor. It is also important that there are functioning hubs where the switch between land-based public transport and boat traffic can be made quickly and easily. Commuter boats often have good capacity for bringing along bicycles and can therefore be a good way of prolonging bicycle roads, and even relieve and complement tram and trunk network traffic. From a climate viewpoint, the effect depends on the fuel type and fuel consumption of the boat.

A further expansion of rail traffic according to the current plan is expected to lead to public transport reaching the capacity to meet population growth, but will most likely not lead to any significant transfer of drivers to public transport users. Expansion in combination with limitations to motoring, however, can have a noticeable effect. The effect of realising the City’s and Stockholm Transport’s Tramline and Trunk Network Strategy is expected to that the average travel duration in the inner city of Stockholm is reduced by just over one minute compared to unchanged traffic-operation principles. The trunk network strategy is estimated to produce 17,400 new public transport journeys per day, whereof half through transfers from car journeys, which will result in emissions reductions.

Increased accessibility for buses leads to more attractive public transport in terms of punctuality and time-saving, which in turn can lead to a transfer of passengers from cars to public transport. The size of the transfer is hard to estimate, however. The increased accessibility also entails a real fuel consumption saving of about 16 per cent. See the presentation in the matrix above.

Increased opportunities of mixed-mode travel can lead to increased use of public transport. A noticeable effect is only reached in combination with other measures.

The effects of information efforts are hard to estimate and measure. It depends on how long the information efforts continued, how it is designed and what other influences the
The receiver takes in during the period. The best effect is reached in combination with other measures.

**Increase accessibility for pedestrian, bicycle and public transport**

Private cars today make up 60 per cent of energy use and emissions from road traffic in Stockholm. A rough estimate is that around 80 per cent of the total traffic mileage of the city takes place in the outer areas or on the thoroughfares. There is need for an expanded traffic count and conducting travel habit surveys, especially in the outer areas. Several of the measures require a legal change. A certain re-direction of traffic may also be necessary in order it to work in practice. Some of the measures can be introduced immediately, for example an increase in parking fees. Current legislation inhibits differentiated parking fees in the city for different types of vehicles; this, however, is possible on private property.

**The City of Stockholm can contribute to increasing accessibility and capacity for pedestrians, cyclists and public transport in Stockholm by:**

a) working actively with parking measures.

In the inner city of Stockholm, free parking is offered along the streets on evenings and weekends. The outer parts of the city enjoy free parking practically everywhere around the clock. This leads to many people taking the car in to the city for leisure trips on evenings and weekends. Today, residential parking (parking on streets) is considerably cheaper than renting a spot in a garage or car park. This leads to a large number of drivers circling around in order to find a free parking space on the street instead of parking in a car park. This affects traffic safety, accessibility and emission levels in the city negatively.

In order to increase the incentives for households to choose to travel by public transport, use a car pool, rent a car, walk or cycle instead of owning and driving a car, higher fees are necessary for parking. Also, active work must be done to promote accessibility for pedestrians, cyclists and public transport.

The City of Stockholm can promote a transfer of cars from the streets to parking structures or garages by way of an increased fee for residential parking on the street. One way of accelerating the transfer of parking from the street to car parks is that the City of Stockholm offers space in the car parks of Stockholm Parkering at a reduced rate during, for example, the first year.

Yet another effect of more people parking in car parks is that the distance to the car park from the home is likely to be longer than from the residential street parking. It is likely the the longer the distance you have to your car, the less likely you are to use if for short errands.

The Traffic and Waste Management Administration is currently working with a parking strategy for Stockholm and is investigating measures such as increased residential parking and increased parking fees in the evenings. The result will provide a foundation for developing clear parking measures.

b) working to reduce the number of parking spots near workplaces, or introducing/raising parking fees.

Parking conditions are very important for individuals’ choice of transport mode regarding journeys to work. Free car parking or low parking fees lead to a large part of employees driving to work. If the supply of parking spaces is limited and/or the fees are raised, a larger proportion will cycle, walk or use public transport. Surveys show that the proportion of cars can vary considerably between workplaces with more or less the same location, but with different conditions for employees to park.

Access to parking at workplaces can be handled with climate-smart parking norms when operations are

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9. Parking – policies, measures and consequences for urban transport. Tomas Svensson and Ragnar Hedström. VTI (Swedish National Road and Transport Research Institute) December 2010
established. When it comes to parking fees, the City has no authority of action over fees charged on developed land. In order for the City to be able to influence these, a legal change is required. The City can work towards establishing voluntary agreements and activities with companies with the aim of reducing car travel in the city.

c) starting an inquiry regarding traffic in the outer city.

In order to find out how traffic in the outer areas of Stockholm can be reduced, as well as achieve a transfer form cars to other alternatives in these areas, the City should investigate which type of traffic takes place in the outer parts and what is necessary for reducing traffic in these areas.

d) construct, or alternatively work for, more park-and-ride facilities.

Two important conditions for park-and-ride options to be seen as an attractive alternative is proximity to the public transport trunk network and proximity to an arterial road. Another success factor is the design of the parking spaces – travellers should feel safe leaving their car or their bicycle. In order to ensure that the spaces are reserved for Stockholm Transport travellers, the car parks can be connected to the Stockholm Transport Access Card. Stockholm Transport has in cooperation with minic Desktops constructed park-and-ride facilities and together with Stockholm Parkering carried out a trial where six parking spaces were connected to the Stockholm Transport Access Card, which ran until August 31, 2011.

e) working to minimise the increase of car traffic in connection to new road infrastructure.

Today large resources are invested in moving traffic outside of the city centre through construction of the Förbifart Stockholm project and Norra länken. A transfer of traffic outside the city core is desirable from many viewpoints. However, it is important that traffic on existing roads is limited so that the new infrastructure does not lead to increased traffic. A good example is how it was decided to remove the thoroughfare past Årsta when Södra länken was opened. It is, for example, important that congestion taxes are introduced on Essingeleden when Förbifart Stockholm is finished, since part of the traffic that currently utilises Essingeleden will be moved over to Förbifart Stockholm. When Förbifart Stockholm is being built, it is important that planning includes ideas for functioning public transport on the new stretch right from the start.

The effects of reduced car traffic and a transfer from car to alternative modes of transport are among the things increased accessibility for public transport, goods transports and cyclists, as well as a more attractive city environment. It also results in reductions in carbon dioxide, reduced noise and less pollution.

### Increase the proportion of green vehicles

Stockholm is the Swedish municipality that had the highest number of new car registrations during 2010. During the last four years, about 12.5 per cent of the vehicle fleet has been renewed each year. The proportion of green vehicles in Stockholm was at the ned of 2010 18.0 per cent. The City

<table>
<thead>
<tr>
<th>Measure</th>
<th>Timetable</th>
<th>Year</th>
<th>Reduction of greenhouse gases (CO₂,e)</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the number of green vehicles</td>
<td>● 50 per cent of newly registered private cars should be environmentally classified vehicles by 2014. ● 100 per cent of newly registered private cars should be powered by alternative fuels by 2020.</td>
<td>2015</td>
<td>54,600 tonnes</td>
<td>195.6 GWh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2020</td>
<td>153,000 tonnes</td>
<td>548.3 GWh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2030</td>
<td>555,500 tonnes</td>
<td>1,673.2 GWh</td>
</tr>
</tbody>
</table>

**Assumptions for the calculations**

- 50 per cent of new car registrations in 2014 are green cars, small change in the type of cars being bought.
- 100 per cent of new car registrations in 2020 are green cars.
- 12.5 per cent of the vehicle park is renewed every year, of which half of the green cars remain in Stockholm. This means that there is an relocation of green vehicles from the city at a rate of 30 per cent of the rejuvenation.
- Increased low-concentration inmixing to 6.5 per cent ethanol
- When it comes to the distribution of vehicles, consideration has been taken to the EU’s suggestion regarding demands that emissions from newly registered cars can be no higher than 95 grams of CO₂ per kilometre from 2010 and 70 grams of CO₂ per kilometre in 2025. (The Swedish Transport Administration, Traffic-type-independent planning basis for limited climate impact, Publication 2010:095)

**Finance**

The cost of participating in and running demonstration projects depends on the financing of each separate project. In certain cases there is an opportunity for seeking support.

**Responsible**

The City of Stockholm is responsible for promotion and the actors for execution.
of Stockholm has as its goal that new private car sales in Stockholm County should be made up of 50 per cent green cars by the year 2014. In a longer perspective, the government’s decision regarding a fossil-fuel-free vehicle fleet 2030 should function as a guide. Therefore, 100 per cent of the newly registered private cars should be independent of fossil fuels by 2020 at the latest. In the year 2010, 38.9 per cent of the newly registered private cars were green cars. Out of these, the main part was ethanol vehicles and low-consumption diesel vehicles. Other green vehicles were gas vehicles, plug-in hybrid vehicles and low-consumption petrol vehicles.

The EU has a preliminary goal ending in 2020 that means that the average carbon dioxide emissions at the most may reach 95 grams per kilometre for new private cars, as compared to 120 grams per kilometre for 2012. In order to meet the demands of 95 grams per kilometre by the year 2020, hybridisation will most likely be necessary. In order for the proposed demand of 70 grams per kilometre by the year 2025, there will likely be a need for electrification through electric cars and plug-in hybrids.

With an increased use of renewable fuels, it is important that the supply of renewable fuels is secured. A clear example is the problems that have occurred in Stockholm on account of the supply of biogas being lower than the demand during a few years. Prognoses for the supply of fuels and recommendations to the actors is therefore good. To secure the supply of biofuels, it is important with long-term instruments, for example continued tax exemption for biofuels after the year 2013. A change of the environmental zone demands a legal change and follow-up and control.

The City of Stockholm can promote the conversion of private cars by:

a) informing in order to get interested private citizens and companies to buy green cars.

b) placing demands on transports at procurements of services, for example home care, and being prudent at following up these demands.

c) participate or drive demonstration projects where vehicles and fuel handling are included.

The City should strive to establish at least two rapid charging stations.

d) strive for conditions for secured supply of alternative fuels. Increased biogas production can be promoted by, for example, collecting more food waste within the City of Stockholm and set aside areas for biogas production.

e) strive for biofuel tax incentives to remain in place, are developed and made long-term.

f) strive to phase out older vehicles by expanding the existing environmental zone to include private cars and possibly even expand the area.

The environmental zones in Stockholm were incorporated in 1996 and today encompasses Södermalm, Kungsholmen, Vasastaden, Norrmalm, Östermalm and Ladugårdsområdet, with the exception of thoroughfares. The environmental zones place environmental demands on heavy diesel vehicles that operate in the city. The rules can be expanded to also include private cars, light trucks and light buses. This means that cars with carbon dioxide emissions above a certain level per kilometre are forbidden within the environmental zone. The rules can be expanded to include also a larger part of the outer areas.

g) strive for a re-introduction of the scrapping premium.

Up until 2007, there were premiums for whooever scrapped their car, if the vehicle satisfied certain demands, such as being of a certain age. The vehicle could

Graph 11: Estimates of vehicle distribution in Stockholm.
be phased out and in this way contribute to a conversion of the vehicle stock, while carbon dioxide emissions were reduced. One measure for speeding up the conversion is to strive for a re-introduction of this premium.

Savings are achieved in the opening phase primarily for fossil carbon dioxide emissions, but when a larger proportion of energy-efficient vehicles are introduced into the fleet, a real reduction of carbon dioxide and other emissions is achieved. A possible introduction of environmental zones also for private cars could quickly bring about an accelerated change in the vehicle fleet.

### Measures for Eco-Efficient Transports

<table>
<thead>
<tr>
<th>Measure</th>
<th>Timetable</th>
<th>Prognosis</th>
<th>Reduction in greenhouse gas (CO₂)</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction of gear-change indicator 2014–2015</td>
<td>2014–2015</td>
<td>Based on traffic mileage without measures taken.</td>
<td>5,400 tonnes</td>
<td>20.1 GWh</td>
</tr>
<tr>
<td></td>
<td>2016–2025</td>
<td></td>
<td>19,400 tonnes</td>
<td>72.9 GWh</td>
</tr>
<tr>
<td></td>
<td>2026–2030</td>
<td></td>
<td>35,000 tonnes</td>
<td>131.4 GWh</td>
</tr>
<tr>
<td></td>
<td>2014–2015</td>
<td>Based on changes to the vehicle fleet</td>
<td>4,900 tonnes</td>
<td>68.4 GWh</td>
</tr>
<tr>
<td></td>
<td>2016–2025</td>
<td></td>
<td>14,700 tonnes</td>
<td>56.1 GWh</td>
</tr>
<tr>
<td></td>
<td>2026–2030</td>
<td></td>
<td>8,200 tonnes</td>
<td>47.8 GWh</td>
</tr>
</tbody>
</table>

### Assumptions for calculations:
- See the matrix above.
- There is an annual migration of vehicles with gear-change indicators from Stockholm city corresponding to 30 per cent of the rejuvenation.

### Finance
- The cost for introduction of gear-change indicators will most likely be laid on the final customers.

### Responsible
- The government. Manufacturers.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Timetable</th>
<th>Prognosis</th>
<th>Reduction in greenhouse gas (CO₂)</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the mix of low-concentration fuel to 5–6.5% ethanol in petrol</td>
<td>2011–2013</td>
<td>With the same fuel consumption as 2010</td>
<td>5,300 tonnes per year</td>
<td>No or marginal.</td>
</tr>
<tr>
<td></td>
<td>2014–2030</td>
<td>With the same fuel consumption as 2010</td>
<td>14,000 tonnes per year</td>
<td>No or marginal.</td>
</tr>
<tr>
<td>Increase the mix of low-concentration fuel from 6.5% to 10% ethanol in petrol, 5–7% FAME in diesel</td>
<td>2015</td>
<td>Based on the vehicle fleet of 2015</td>
<td>11,100 tonnes 2015 Annual reduction is reduced due to changes in the vehicle fleet. In 2030, the reduction is expected to be marginal due to a small use of fossil fuels.</td>
<td>No or marginal.</td>
</tr>
</tbody>
</table>

### Assumptions for calculations:
- The calculations are based on the total amount of fuel that has been calculated for private cars with basis in statistics regarding traffic mileage, assuming a 5% low-concentration ethanol and FAME.
- Control against statistics regarding the county’s total fuel sales show a certain discrepancy. Those figures that do not correspond are diesel and FAME, where calculations with basis in traffic mileage gives a smaller volume than calculations from the county’s fuel sales.
- Calculation of the vehicle fleet accounted for in annual reports regarding Sales of green vehicles and renewable fuels in Stockholm for the years 2007–2010 show that the proportion of the private-car fleet that has been renewed yearly is 12.5%.

### Finance
- No cost apart from a reduction in tax revenue.

### Responsible
- The government. Oil companies.

### Reduced fuel consumption and the emissions from existing private cars
To make it long-term profitable for market actors to increase low-concentration inmixing in petrol and diesel, it is important with long-term policies and that biofuels remain tax-exempt even after 2013. An increased use of tax-exempt fuels such as low-concentration mixes or E85, clean FAME or biogas, however, means reduced tax income. Therefore, a certain resistance may be expected to retaining the subsidies, and/or increasing them.
The City of Stockholm can accelerate a reduction in fuel consumption and emissions from existing private cars by:

a) informing about fuel consumption and eco-driving, tyre pressure and the choice of tyres and rims.

In the new EU regulation concerning vehicles and tyres, demands are being introduced for monitoring of tyre pressure, road-surface grip, maximum rolling resistance and rolling noise as of November 1, 2012. The demands on rolling resistance and noise will be tightened from November 1, 2016. The decision also covers demands for tyre markings.

b) increasing the ban on studded tyres to entire areas in Stockholm city.

A reduction in the use of studded tyres gives a positive effect since rolling resistance is reduced by 15-20 per cent and fuel consumption likewise drops by 3-5 per cent, and reduces the need for energy-demanding road maintenance. It also includes significant improvements to air quality and reduced noise. The City of Stockholm has from January 1, 2010 banned studded tyres on Hornsgatan.

c) recommending companies in connection with, for example, inspection of transport-intensive activities, to work actively with eco-driving and to subsidise companies that establish routines and follow-up routines.

Eco-driving can lower fuel consumption by 5–15 per cent. A gear-change indicator facilitates eco-driving by informing the driver about the most fuel-efficient gear to use. In the year 2009, the EU adopted new rules regarding vehicles and tyres, including a rule requiring gear-change indicators in all new cars as of November 2014. For new models, the demand is introduced two years earlier.

d) striving to increase the proportion of low-concentration inmixing to 6.5 per cent in petrol, which today is the level that is exempt from tax.

Practically all petrol and diesel sold in Stockholm city today has a low concentration blend of biofuel.

In general, it is assumed that 5 per cent ethanol is mixed in all petrol, and that 5 per cent FAME is added to all diesel. As of May 1, 2011, it is permitted to increase the mix to 10 percent ethanol in petrol and 7 per cent FAME in diesel. However, increased low-concentration mixing is optional and actual inmixing is decided based on differences in production costs between fuels, possible tax reduction and access to biofuels.

As of now, biofuels (ethanol and FAME) are exempt from both energy tax and carbon dioxide tax until 2013.

For biofuels such as low-concentration inmixing in petrol and diesel, this is limited to inmixing up to 6.5 per cent ethanol in petrol and 5 per cent FAME in diesel. What will happen starting in 2014 is unclear.

e) striving to increase the proportion of low-concentration inmixing to the level approved by the fuel directive, i.e. 10 per cent low-concentration inmixing of ethanol in petrol and 7 per cent inmixing of FAME in diesel.

f) striving for a high proportion of biogas in CNG, as well as a high fuelling rate of E85 in ethanol cars and the use of diesel with an extra high inmixing of renewable fuels.

The effect of increased low-concentration inmixing is primarily carbon dioxide reduction. An increased proportion of renewable fuels also helps to meet the environmental goals of the City of Stockholm, as well as the EU goal of 10 per cent renewable transport fuels by 2020. Through gear-change indicators on all new vehicles, fuel consumption and consequently carbon dioxide emissions are assumed to decrease by 5 per cent. Measures such as information campaigns, contributions and a ban on studded tyres may increase the effect.

Promote alternatives to journeys by private cars

The City’s Vision 2030 stresses that the City of Stockholm should have a well functioning transport system with minimal environmental impact that enables people to rapidly and conveniently move about in the entire region. In order to achieve this ambitious target, it is necessary for the most resource-efficient modes of transport are utilised to as large an extent as possible, and that journeys made are so efficient that unnecessary transport mileage is avoided.

Public transport has a superior transport efficiency compared to other modes of transport and should therefore be utilised to as large a degree as possible. A well developed pedestrian and bicycle traffic is necessary to minimise the environmental impact of travel.

In order for car travel to be efficient, it is necessary that the majority does not choose the car option. Getting more people to switch from an individual car to a car pool can be one way to make travel more efficient. Only a few Stockholmers use a car from a car pool today, and the proportion has not reached one per cent since measurements started in 2004. The number of car pools, pool cars and members of car pools is steadily increasing, but seen to the total number of vehicles and journeys, it is still a very small proportion.

The City of Stockholm can promote travel alternatives for drivers by:

a) improving and informing about the possibilities of traveling by mixed-mode transport.

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11. Idea book for municipal transport work
One way of promoting increased use of public transport is to improve the possibilities for mixed-mode transport. This is best done when new tracks and routes are planned by connecting routes and transport modes, but important measures can also include encouraging, for example, cycling to public transport hubs.

Basic factor for high intermodality (using several transport alternatives) is accessibility of stations and interchange points and stops, well organised bicycle parking, proximity to car pools and rental companies, well designed stations and interchange points for the traveller, and good locations, through for example contact with surrounding target destinations. To facilitate mixed-mode travel, the City of Stockholm can together with Stockholm Transport strive for continued development of, for example, access cards so that travellers also can pay for services such as park-and-ride with a single card. The City should also continue expanding the system of loan bicycles in the city.

b) carrying out trial activities to those who scrap their old car.

In order to remove older vehicles and simultaneously encourage the previous car owner to try new alternatives, trial activities can be offered to those who scrap their old car, for example a free annual membership in a car pool, a one-month card for travel on Stockholm Transport or a contribution to a bicycle purchase. This can incentivise more people to not buy a new car, and make sure that older vehicles are removed from the market.

c) carrying out activities to encourage transfers from private cars to car pools.

Companies can switch to more environmentally compatible vehicles, replace company cars with membership in car pools, increase the use of public transport or encourage bicycle use for work, etc. In order to facilitate for companies and individuals to switch to more environmentally friendly alternatives, information measures and possibly counselling is necessary.

The City of Stockholm can help companies with information about alternatives and establishing itineraries. Another measure may be to investigate the possibility of letting pool cars use residential parking spaces, which is not possible today.

This can make more individuals aware of the possibility and benefit of car pooling. Based on experience from car pool users, there are a number of things that are considered necessary for them to function well:

- proximity to the car pool from the users’ homes
- good support available around the clock with good service
- varying vehicle size and the availability of good packing, such as roof boxes and bicycle carriers
- green cars
- investigating the possibility of designating parking spaces for use by car pool companies.

The effects of a transfer from car to alternative modes of transport is increased accessibility for public transport, goods transport and cyclists, as well as an more attractive urban space to spend time in. The transfer will also reduce noise, as well as carbon dioxide emissions and lesser pollutants.

5.3 Goods transports

Goods transports in Stockholm consist to a large part of light trucks distributing goods to retailers, restaurants and shops. Transports to and from industries are mainly carried out on thoroughfares and in the outer city. A large part of the heavy traffic is construction and waste transports.

Limited accessibility is today a central problem for goods traffic. It causes low average speeds, many stops and much idling. This in turn leads to high fuel consumption and increased emissions of greenhouse gases and hazardous substances.

The majority of all trucks are today powered by diesel. The proportion of green vehicles is low. This is due to limited availability of heavy green vehicles on the market. In the year 2010, 2.5 per cent of light trucks and 3 per cent of heavy trucks were powered by CNG. Other possible alternatives are trucks powered by ED95 and hybrid vehicles.
5.3.1 Expected development to 2015 and to 2030
In the following calculations, it is assumed that traffic mileage for both light and heavy trucks will increase by 0.5 per cent per year between 2010 and 2030, which will amount to a total increase of 10 per cent. The calculations also assume that the City’s goal has been met regarding 10 per cent of newly registered trucks being green vehicles by 2014, and 50 per cent by 2020. The significant change in both light and heavy trucks has here been estimated to show results in 2030, when the proportion of diesel trucks has decreased to just over 28 per cent and electric hybrid trucks has increased to 35 per cent of the total vehicle mileage. This would lead to emissions from goods transports decreasing by 20 per cent. The expected development of emissions of greenhouse gases from goods transports, provided all proposed measures are implemented, is presented in graph 12.

5.3.2 Measures for goods transports in Stockholm

Promote mixed loading of goods
Today, deliveries of distribution goods are primarily direct deliveries, and the filling ratio is generally low; direct deliveries account for an estimated 80 per cent of all deliveries13, and the average filling ration is estimated at 40 per cent.14 There is potential for making goods distribution in Stockholm more efficient through mixed loading.

The O-Centralen is an existing mixed-loading centre for mixed loading of foodstuffs to the Old Town. At the moment, work is underway to develop the concept of mixed loading of distribution goods, with the aim of facilitating the spread to other areas of the city.

For sector-wide mixed loading, cost efficiency is a decisive factor. To establish mixed loading is a large and complex project, and it often takes time before it becomes economically viable. Mixed loading should therefore be a long-term project with a clear goal of expanding and developing the activity.15 The City can help by initiating pilot projects and cover additional costs for start-ups, for example by applying for funds from national agencies and foundations or the EU. Important factors in sector-wide projects is that a clear

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<table>
<thead>
<tr>
<th>Measure</th>
<th>Timetable</th>
<th>Prognosis</th>
<th>Reduction in greenhouse gas (CO₂e)</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-distribution of goods</td>
<td>20% of transports are co-distributed by 2015</td>
<td>Based on traffic mileage without measures</td>
<td>12,000 tonnes</td>
<td>43.5 GWh</td>
</tr>
<tr>
<td></td>
<td>40% of transports are co-distributed by 2020</td>
<td>Based on changes to the vehicle fleet</td>
<td>24,000 tonnes</td>
<td>89 GWh</td>
</tr>
<tr>
<td></td>
<td>50% of transports are co-distributed by 2030</td>
<td>Based on changes to the vehicle fleet</td>
<td>31,500 tonnes</td>
<td>117 GWh</td>
</tr>
<tr>
<td></td>
<td>20% of transports are co-distributed by 2020</td>
<td>Based on traffic mileage without measures</td>
<td>11,900 tonnes</td>
<td>43 GWh</td>
</tr>
<tr>
<td></td>
<td>40% of transports are co-distributed by 2030</td>
<td>Based on changes to the vehicle fleet</td>
<td>22,500 tonnes</td>
<td>81 GWh</td>
</tr>
<tr>
<td></td>
<td>50% of transports are co-distributed by 2030</td>
<td>Based on changes to the vehicle fleet</td>
<td>23,100 tonnes</td>
<td>84.4 GWh</td>
</tr>
</tbody>
</table>

Assumptions for the calculations:
● Mixed loading is expected to reduce emissions by 25 per cent.
● 100 per cent of heavy trucks and 50 per cent of light trucks are assumed to transport goods.
● 20 per cent of the fleet (as defined above) is assumed to participate in mixed loading by 2015, 40 per cent are assumed to participate by 2020 and 50 per cent are assumed to participate by 2030.
● All savings are given in relation partly to the prognosis of traffic mileage without measures, i.e. an increase in traffic mileage without any change to the vehicle fleet when no other measure is included, and partly to the prognosis of a change in the vehicle fleet.

Finance
The cost of a terminal and personnel for co-distribution is covered by reduced delivery costs. Negotiations with suppliers should result in a price reduction of 8–12 per cent depending on the goods and the sector, which corresponds to the transport cost. (Vägverket, publication 2010:008, ”Idee skrift för samordnad varudistribution“ (The Swedish Road Administration, publication 2010:008, ”Idea paper on coordinated goods distributions“)

Responsible
The City of Stockholm is responsible for realising municipal mixed loading, to investigate possibilities of supporting sector-wide mixed loading, as well as for urban planning.

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14. Samordnade varuleveranser inom Stockholms stad, WSP, 2008 (Coordinated goods deliveries in the City of Stockholm, WSP, 2008)
15. Vägverket, publication 2010:008, ”Idee skrift för samordnad varudistribution“ (The Swedish Road Administration, publication 2010:008, ”Idea paper on coordinated goods distributions“)
decision-maker is assigned\textsuperscript{16} and that common administrative systems and routines are established.

\textit{The City of Stockholm can promote mixed loading by:}

a) placing demands for mixed loading when procuring goods.

The City of Stockholm is one of the largest purchasers of goods and foodstuffs in Sweden. They are mainly delivered to schools, pre-schools and assisted-living facilities. For example, the procurement of foodstuffs for municipal activities is today spread out over many product groups, which leads to a large number of actors delivering their products to each separate activity. The measure consists of the municipality procuring foodstuffs and other goods through agreements on deliveries to a mixed-loading centre.

b) investigation possibilities for the City to facilitate sector-wide mixed loading.

Sector-wide mixed loading can be seen as cartel creation and should therefore be illegal according to competition laws. The City of Stockholm can facilitate sector-wide mixed loading by volunteering as the principal party for the mixed-loading project. In order to derive good results and long-term viability, it is important that the actors themselves initiate and run the project and that they realise the benefits of mixed loading. Another way of facilitating is to offer a cooperative platform with information, routines and checklists.

c) urban planning for good terminal structure.

In consultation with the sector, plan for and make land available for mixed-loading centres, re-loading terminals and combined terminals, and retain terminals in close proximity to the city. Existing terminal areas in the City of Stockholm are: Värtahamnen (mostly passenger traffic, also goods), Stadsgårdskajen (mostly passenger traffic, also goods), Logistikcentra in Västberga (the DHL domestic terminal), Lunda domestic terminal (the Schenker terminal, 20–25 per cent within the Stockholm region), Årsta (operated by CargoNet, Sweden's largest combined terminal).

d) creating statistics for transports of goods in Stockholm.

Statistics are necessary as a basis for decisions regarding measures to make transports more efficient. A number of investigations and projects have shown savings of 20–30 per cent, while other show even higher savings.\textsuperscript{17}

An important factor for realising the potential is that transports are well planned and well filled. Therefore, logistical know-how is necessary in planning and mixed loading. The effect depends, among other things, on the degree of mixed loading, i.e. how many distribution routes are substituted by mixed loading. This in turn depends on the customers’ demands on

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|}
\hline
Measure & Timetable & Prognosis & Year & Reduction of greenhouse gases (CO$_2$e) & Energy efficiency \\
\hline
\textbf{Efficient goods transports:} & & & & & \\
\textbullet{} Increased control of loading zones & More measures can be implemented immediately & Based on traffic mileage without measures & 2015 & 25,200 tonnes & 91.9 GWh \\
\textbullet{} Exploring the possibility of allowing nighttime deliveries. & & & 2020 & 25,800 tonnes & 94.2 GWh \\
\textbullet{} Striving to increase the congestion tax, assumption of implementation in 2019. & & & 2030 & 27,100 tonnes & 99.0 GWh \\
\hline
\textbf{Assumptions for the calculations:} & & & & & \\
\textbullet{} Assumes a reduced consumption of around 15 per cent for 20 per cent of the fleet of heavy and light trucks. & & & & & \\
\textbullet{} The savings in emissions and energy are given partly in relation to the prognosis of traffic mileage without measures, and partly in relation to the prognosis of the new vehicle fleet. & & & & & \\
\hline
\textbf{Finance} & & & & & \\
Surveillance of loading zones will increase costs. & & & & & \\
\hline
\textbf{Responsible} & & & & & \\
Government. The parking enforcement officers of the City of Stockholm. & & & & & \\
\hline
\end{tabular}
\end{table}

17. The project “Sustainable goods transports in Uppsala municipality” shows a reduction in carbon dioxide emissions of 20–30 per cent. Simulations of savings in the Linne project show a possible reduction of 40 per cent. In Halmstad, a reduction of 50 per cent of transports has been achieved according to Halmstad municipality. Swedish Energy Agency: “Sustainable municipality: Idea book on municipal transport work.”
deliveries, the type of delivery and the starting point. Yet another effect of municipal mixed loading is that the municipality can procure transports from the mixed-loading centre separately and in this way place more stringent demands on the type of vehicles, eco-driving and route planning.

Reducing driving time and distance for goods transports
Reduced accessibility on account of too much congestion and misparked cars leads to low average speeds for goods transports. This leads to many stops and idling, which in turn leads to increased fuel consumption and gives longer and more unreliable delivery times, as well as increased emissions.

The City of Stockholm can promote a reduction in driving time and distance for goods by:
a) investigating changed delivery times, for example for silent trucks.

The City of Stockholm explore the possibility of a trial period for allowing nightly or early-morning deliveries during a limited time within a certain area. Nighttime or early-morning deliveries may mean disturbances for residents, and other activities relating to deliveries can disturb.

b) facilitate loading and unloading.

The City can facilitate loading and unloading by requiring more frequent surveillance and stronger measures against misparking in loading zones. By controlling for delivery opportunities when granting permits for activities, delivery difficulties can be prevented. Routines for ensuring delivery opportunities when granting permits for activities should be prepared, regarding everything from liquor licenses to service licenses for restaurants. For prioritising loading zones to be controlled, a basis can be found in the City’s project Gatans användning (Street usage), where loading zones and their use is detailed. Based on this work, routines for inspection and control of loading zones, as well as the introduction of quality classification of existing loading zones/loading docks, should be prepared. The City of Stockholm can facilitate loading and unloading by limiting parking along streets in areas that receive many deliveries. These measures will result in savings in both time and fuel for goods transports. Increased accessibility increases average speed and reduces idling and the number of stops. Tests of fuel use for trucks (4 tonnes, empty)
18 noted differences in fuel use of 36 per cent between driving in dense city traffic and driving in somewhat less dense traffic, as a result of the average speed increasing from just above 10 km/h to just above 20 km/h. It is not considered likely that the corresponding conditions can be achieved for heavy trucks; a reduction of 15 per cent is assumed likely.

The largest effect can be seen in measures that increase accessibility in the city and on arterial roads. In the calculations, 50 per cent of the traffic mileage of trucks is carried out in the inner city or on arterial roads. Time savings lead to carriers needing fewer vehicles, which results in better accessibility.

18. Test performed by the National Renewable Energy Laboratory, USA
Increase the number of green trucks

Most trucks today are powered by diesel, and there have as yet not been many trucks available powered by alternative fuels. The alternative fuel mostly used for both light and heavy trucks is compressed natural gas (CNG), which was used by 2.5 per cent of light trucks and 3 per cent of heavy trucks in 2010. Now more alternatives are starting to emerge on the market for heavy vehicles, for example trucks powered by ethanol (ED95) and hybrid vehicles. FAME diesel can be used in regular diesel vehicles and contributes to reduced fossil-fuel dependency. RME has a relatively good price position, but also contributes to increased emissions of particulates and is not accepted as fuel by a majority of vehicle manufacturers. For lighter vehicles there is E85, electric hybrids and electric vehicles.

In a first step, the goal is to achieve the environmental target of the City of Stockholm that ten per cent of newly registered heavy vehicles should be green vehicles by 2014. In the longer perspective, the government’s decision regarding a vehicle fleet free of fossil fuels by 2030 should be the guide to follow.

At least 50 per cent of newly registered trucks should be powered by alternative fuels by 2020. Certain incentives to change the vehicle fleet are within the City’s authority to decide on, others require national decision, for example congestion tax, tax limits for different fuels and the tax value of company cars. In order to transfer goods between different modes of transport, a terminal structure is necessary.

The City can only indirectly influence supply and demand for different types of fuel. Confidence in new technology can easily be damaged when demand for renewable fuels increases faster than the supply.

The City of Stockholm can promote the conversion to green trucks by:

a) influencing and informing transport-intensive activities.

The City will conduct active information efforts regarding new vehicle technologies, access to renewable fuels, and provide advice and good examples regarding procurement and management.

b) conducting or participating in demonstration projects consisting of both vehicles and fuel handling, for example the expansion of filling infrastructure.

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Graph 13: Distribution of light trucks and fuels in the vehicle fleet if 11.5 per cent of the fleet is renewed annually to green vehicles. Estimated for the years 2010, 2015, 2020 and 2030.

Graph 14: Distribution of heavy trucks and fuels in the vehicle fleet if 10 per cent of the fleet is renewed annually to green vehicles. Estimated for the years 2010, 2015, 2020 and 2030.
The City is working to increase demand for green vehicles through information campaigns and demonstration projects such as Clean Truck, which aims to facilitate for companies to choose green vehicles.

c) placing demands on transports in connection with procurements of goods and services, and carefully followup these demands.

The City of Stockholm can influence business actors by placing demands at procurements of goods and services. For example, the environmental demands of the Swedish Environmental Management Council’s procurement criteria for goods transports can be used. Following up the demands is very important. Companies that have built a reputation for sustainable transports normally have a additional cost for their environmental work, and this cost is decisive.

d) promoting the supply of renewable fuels.

One condition for a conversion to vehicles powered by alternative fuels is good and safe access to the fuel. The City of Stockholm can contribute by continuing cooperation with business and Stockholm Transport regarding issues such as prognoses for supply and demand, promotion of supply and filling stations, information and communication. The City of Stockholm can also conduct forums for dialogue with actors in order to promote other renewable fuels.

e) identifying proper incentives for conversion to environmentally viable transport vehicles.

An investigation should be undertaken regarding the effects of measures such as diversified congestion tax, free parking for green vehicles, use of bus lanes, expanded delivery hours, additional demands in environmental zones and signaling priority.

f) investigating how to facilitate conversion of goods between road, railway and seaborne traffic.

Improved possibilities for intermodal transports, above all transfer of goods from road to railway or boat, can radically reduce energy use and the climate impact transport mileage. The City can identify in which ways goods transports by rail or sea can be promoted and initiate execution of prioritised activities. All measures aim to stimulate a change in the vehicle fleet. The savings achieved by changes in the vehicle fleet relate primarily to fossil carbon dioxide. Energy savings can for example be achieved by converting to energy-efficient vehicles, for example hybrid vehicles, or where good are transferred from road to rail or sea.

Reduced fuel consumption and emissions from existing trucks

Increased demands for reduced emissions of greenhouse gases places high demands on the vehicle sector and the conversion of the vehicle fleet. This takes time, particularly when it comes to heavy vehicles where the conversion has barely begun. It is therefore important to initiate measures that reduce

<table>
<thead>
<tr>
<th>Measure</th>
<th>Timetable</th>
<th>Prognosis</th>
<th>Reduction in greenhouse gas (CO₂e)</th>
<th>Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase low-concentration in-mixing from 5 to 6.5% ethanol in petrol</td>
<td>2011–2013</td>
<td>With the same fuel consumption as in 2010</td>
<td>350 tonnes per year</td>
<td>None or marginal</td>
</tr>
<tr>
<td>Increase low-concentration in-mixing from 6.5–10% ethanol in petrol, 5–7% FAME in diesel</td>
<td>2014–2030</td>
<td>With the same fuel consumption as in 2010</td>
<td>5,200 tonnes per year</td>
<td>None or marginal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Based on a change in the vehicle fleet</td>
<td>Annual reduction decreases because of changes in the vehicle fleet. By 2030, the reduction is expected to be marginal because of a limited use of these fossil fuels.</td>
<td></td>
</tr>
</tbody>
</table>

Assumptions for the calculations:
- The calculations are based on the total amount of fuel that has been estimated based on traffic mileage statistics, with the assumption of a low-concentration in-mixing of ethanol and FAME of 5% at the current time.
- Controls against statistics of the county’s total fuel sales show a discrepancy. Values that do not correspond to fuel volumes are those for diesel/FAME.

Finance
- Reduced tax revenue.

Responsible
- The government. The oil companies.
emissions from the existing vehicle fleet. For heavy vehicles, it is important to remember avoiding excessive speeds, but also to reduce the number of stops since these significantly increase fuel consumption.

To stimulate increased low-concentration inmixing in petrol and diesel, it is important to have long-term guiding instruments and incentives for increased use. Potential tax exemptions up to allowed maximum limits of low-concentration inmixing leads to serious reductions in tax revenue. For this reason, there can be resistance to continue subsidising, and/or increasing subsidies, for alternative fuels.

The City of Stockholm can accelerate a reduction of emissions from heavy vehicles by:

- striving to increase the proportion of low-concentration inmixing to 6.5 per cent in petrol (which today is the level which is exempt from tax), striving for a high proportion of biogas in CNG and striving to increase the use of diesel with a high proportion of renewable raw material.

The City of Stockholm can work together with fuel actors to achieve a higher proportion of low-concentration inmixing of ethanol in petrol up to the level which is currently tax exempt.

- striving to expand the proportion of low-concentration inmixing to the maximum permitted levels. Low-concentration fuel is 10 per cent ethanol in fuel and 7 per cent FAME in diesel. The City of Stockholm can strive to introduce incentives that stimulate low-concentration inmixing to the maximum levels. From 2014 on, it is not sure whether biofuels will be tax exempt or not, which leads market actors to consider the market volatile.

- striving for more efficient driving with the help of eco-driving and ITS.

The City of Stockholm should recommend companies in connection with, for example, information and inspection of transport-intensive activities to actively practise eco-driving. Delivery runs can be made more efficient by taking advantage of ITS – Intelligent Transport Systems. ITS is a generic name for the use of IT systems for facilitating planning and distribution of goods. The most common are IT systems for route optimisation, but also new systems for real-time updating of information to drivers, driver support for eco-driving and environmental reports. With the help of route optimisation, a company can realise savings of 5–15 per cent of the

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20. Idea book for municipal transport work
driving distance. The City of Stockholm can contribute by offering companies information and by shining light on good examples, as well as participating in projects.

d) investigating the possibilities of making delivery runs more efficient, so-called green routes.

In residential neighbourhoods with individual housing in the outer areas of the city, there is a potential for making mail delivery and waste collection more efficient by placing mailboxes and waste containers on the same side of the street. A pilot project from the city of Östersund shows a cost reduction of roughly 30 per cent for driving distances for mail and waste collection. The City of Stockholm can explore the possibilities of carrying out similar measures in suitable areas.

e) develop the City’s organisation for handling goods issues.

The City can facilitate climate-smart goods transports by allocating personnel to promote goods transport issues within the City, gather and coordinate the City’s administrations, and offer a clear mode of contact and a forum for dialogue for both public and private actors within the sector. The work needs to comprise a development of common guidelines for infrastructure and goods, a strive for a regional strategy for goods and an enhanced dialogue with business and other actors.

Eco-driving can lower fuel consumption by 5–15 per cent for heavy vehicles. The higher savings are only achieved if counselling systems are introduced in vehicles and if follow-up and motivation measures are undertaken. Other measures such as information campaigns can enhance the effect.

5.4 Combined results of suggested transport measures

According to the Swedish Transport Administration’s interpretation of the national objective on a fossil-independent vehicle fleet, the objective means that emissions of carbon dioxide from the transport sector need to be reduced by 80 per cent by 2030 compared to today’s levels. The Swedish Transport Administration judges that it is not possible to phase out all fossil fuels by 2030, but an 80 per cent reduction is seen as possible with the help of, among other things,energy efficiency, transfer to renewable energy and urban planning. In order for the City of Stockholm to reach this goal by 2030, emissions from the transport sector must be reduced by roughly 15 per cent by 2015 (provided a linear reduction), or by a decrease of 170,000 tonnes of carbon dioxide by 2015 compared to the emission level in 2010.

If all proposed measures in this plan were to be realised, emissions of carbon dioxide from the transport sector are estimated to be reduced by 103,000 tonnes by the year 2015, which corresponds to a decrease of 9 per cent. This means that the measures are insufficient for leading to the goal of a vehicle fleet independent of fossil fuels by the year 2030.

It should be noted that many of the proposed measures affect each other. In order to avoid counting double, the effects of individual measures have been adjusted when summarising the total effect.

Those measures that can contribute most to emissions reductions by the year 2015 are measures for a changed vehicle fleet and for increasing accessibility in goods and bus traffic, 31,000 tonnes and 27,000 tonnes respectively. Increased low-concentration inmixing of ethanol in petrol and FAME in diesel in private car traffic, mixed loading and eco-driving are expected to reduce emissions by roughly 10,000 tonnes each (11,000 tonnes, 12,000 tonnes and 9,000 tonnes respectively). The effect of introducing gear-change indicators, increased low-concentration inmixing of FAME in diesel in goods transports and transfers from car traffic to cycling contribute another 4,000–5,000-tonne reduction each. Estimated emissions reductions for each respective measure, emissions in 2010, 2015 and goals for 2015 are shown in the graph above.

In order to reach the goal by 2030 of an 80 per cent reduction of greenhouse gases, emissions need to decrease by 920,000 tonnes compared to 2010. The largest long-term emissions reductions come from changes in the vehicle fleet, which reduces emissions with more than 400,000 tonnes by the year 2030. The large reduction relies on an assumption of large-scale changes in primarily the private vehicle fleet as a result of demands that emissions from private cars not exceed 95 grams of CO₂ per kilometre by 2020 and 70 grams CO₂ per kilometre by 2025, and that the fleet is expected to consist of 100 per cent green cars by the year 2020.

Other measures that provide large reductions in

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22. The Idea book for municipal transport work reports 5–15 per cent, in Climate-neutral goods transports on roads – a scientific feasibility study, Swedish Road Administration, publication 2007:111, the figure is set to 9–15 per cent for distribution traffic and 3–6 per cent for long-distance traffic.
greenhouse gas emissions are striving to realise the Tramline and Trunk Network Strategy (24,000 tonnes), mixed loading of goods (23,000 tonnes), increased accessibility for both private cars and goods transports (22,000 tonnes) and an expanded congestion tax (19,000 tonnes). The total emissions reduction if all measures were to be realised is estimated at 606,000 tonnes of CO₂, which corresponds to a reduction by more than 50 per cent compared to 2010.

In order to reach the goal of an 80 per cent reduction of greenhouse gases from transports by 2030, emission would need to decline by another 320,000 tonnes, roughly, of carbon dioxide. To reach such a large emissions reduction would require wide-ranging measures, since we in this assessment have already factored in the effect of an altered vehicle fleet with low emissions of carbon dioxide. A rough estimate shows that the total traffic mileage of private cars and light trucks would have to be reduced by have in order to reach the 80 per cent goal by the year 2030.
6 Measures for sustainable energy use in buildings

Stockholm have more than 66 million square meters of heated space. More than 12.5 million of these are owned by the City of Stockholm. Other owners include companies, private citizens and tenant-owners’ societies, foundations or the state or county councils. Stockholm’s buildings are mostly housing units, and offices, but also encompass commercial premises, schools, care facilities, sports halls, theatres, restaurants, churches and other premise types, see graph 16.

Graph 16: Distribution of areas in different categories of buildings in Stockholm.*

* Compilation of energy certifications in Stockholm 2010, Swedish National Board of Housing, Building and Planning.

Most houses in Stockholm were built between 1900 and 1960. During these 60 years, more than double the number of houses as during the following 50 years, see graph 17. During the Million Programme (1964–1975), roughly 2,000 buildings were constructed. These buildings are of particular interest when it comes to energy efficiency, since many of the use twice the amount of energy as most multi-family houses that are built today, and many of them are in great need of renovation.

The construction of outer walls and windows in older houses make up a worse climate shell than in newer facade designs. The result is that older houses (built up until 1940) use three times as much heat during the cold months as houses built during the 2000s. Older houses also suffer from more air leakage and have a smaller degree of mechanical ventilation with heat recovery systems. This means even more heat loss in older houses.
6.1 Municipally-owned properties
The City’s five property companies and the Real Estate Administration has, in cooperation with Energicentrum, started an energy efficiency program which has been made possible thanks to extra financial support from the City. On average, 14 per cent of the City’s property stock will be made energy efficient during the period 2012–2015.

This energy efficiency corresponds to a reduction of emissions by less than 40,000 tonnes of greenhouse gases by 2015 and thereafter a reduction of operating costs of 210 million kronor annually (calculated at the price level of 2011).

6.1.1 Energy efficiency improvements
According to the Stockholm Environment Programme 2012–2015, the City’s activities will reduce their energy use by 10 per cent during the programme period. Furthermore, there are detailed requirement levels for energy conservation in relation to different types of extensive renovation of buildings. The prognoses of the property companies and the Real Estate Administration themselves indicate a 14 per cent energy saving up to and including 2015 as compared to 2010.

Active energy efforts are being pursued in the city. Different types of technical solutions are tested and evaluated within the framework of Bebo (the housing procurement arm of the Swedish Energy Agency). For the period 1990–2010, the assessment was a saving of 6–7 per cent for the City’s own properties. Average energy performance according to energy certifications for the City’s own buildings is 176 kWh/m² ATemp, of which household electricity make up 17 kWh. If the plans of the property companies and the Real Estate Administration are implemented, energy performance will improve to 144 kWh/m² ATemp by 2015. This means an energy saving of around 24 per cent between 1990 and 2015.

For practical reasons, the City’s property companies and the Real Estate Administration do not use calculations according to Atemp, but those from LOA, BOA or BRA. These calculations provide results that are roughly 25 per cent higher than ATemp.

6.1.2 Reductions in greenhouse gas emissions
The goal of the City’s Environment Programme is to reduce greenhouse gas emissions to 3.0 tonnes of CO₂ per Stockholmer by 2015. The City’s property companies and the Real Estate Administration contribute to this, among other things, through investments in heat exchange systems and Stockholmshem’s conversion from oil- and gas-powered boilers to renewable energy. The installation of heat exchangers reduces the need for added heat, primarily district heating, while electricity use increases somewhat. The measure contributes to reducing both emissions of CO₂ and energy use.

<table>
<thead>
<tr>
<th>Property Company</th>
<th>Total number of m²</th>
<th>Total kWh/m²</th>
<th>Reduction of emissions (CO₂)</th>
<th>Reduction of energy use</th>
<th>Cost reduction, kronor per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familjebostäder</td>
<td>1,523,000</td>
<td>170</td>
<td>6,000 tonnes</td>
<td>55 GWh</td>
<td>45.7 million</td>
</tr>
<tr>
<td>Fastighetskontoret</td>
<td>570,000</td>
<td>220</td>
<td>3,500 tonnes</td>
<td>16 GWh</td>
<td>12.8 million</td>
</tr>
<tr>
<td>Idrottsförvaltningen</td>
<td>235,000</td>
<td>372</td>
<td>500 tonnes</td>
<td>4 GWh</td>
<td>3.2 million</td>
</tr>
<tr>
<td>Micasa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SISAB</td>
<td>1,462,000</td>
<td>187</td>
<td>3,000 tonnes</td>
<td>26 GWh</td>
<td>21 million</td>
</tr>
<tr>
<td>Stockholmshem</td>
<td>1,757,000</td>
<td>160</td>
<td>17,000 tonnes</td>
<td>112 GWh</td>
<td>70 million</td>
</tr>
<tr>
<td>Svenska Bostäder</td>
<td>2,417,000</td>
<td>175</td>
<td>6,000 tonnes</td>
<td>55.5 GWh</td>
<td>47 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>37,500 tonnes</td>
<td>281 GWh</td>
<td>211.7 million</td>
</tr>
</tbody>
</table>
### Measures in the City’s own buildings

Full effects of many of the measures will not be seen until after 2015. Combined, several proposed measures should improve the indoor comfort of tenants. Additional insulation of facades is considered expensive in relation to the energy savings it provides, and can be hard to realise since a number of buildings have high conservation values. In those cases where rent housing is planned to be converted into tenant-ownership, only necessary maintenance is carried out.

Those measures and savings figures presented above refer to already decided measures; additional measures have been identified but have not been decided upon. Effects of future district cooling connections have not been taken into account. Because of the many buildings (1,325), of which many are small, of varying age, character and cultural-value protection, profitability is in many cases low. In many of the buildings, rent tenants pay their own electricity bills and user data is absent.

---

#### Measures for achieving Familjebostäder’s savings goal for energy and \( \text{CO}_2 \text{e} \)

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat recycling with heat pumps or FTX (ventilation system with heat exchange) in ventilation systems that have previously had natural draft or mechanical exhaust air</td>
<td>Competence development of own operative personnel</td>
</tr>
<tr>
<td>Water conservation program, low-flow nozzles</td>
<td>Objective to be better than existing legal demands</td>
</tr>
<tr>
<td>Operating computer connection with remote reading of all energy and water meters</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>Installation of effect-limiting equipment for district heating</td>
<td>Participation in the Swedish Energy Agency’s ordering group (technology competitions and benchmarking)</td>
</tr>
<tr>
<td>Separation of joint sub-stations to once station per property</td>
<td>Pilot project using new technology</td>
</tr>
<tr>
<td>Sewage heat exchangers</td>
<td>Central measuring of tap water in sub-stations</td>
</tr>
<tr>
<td>Improvement of the climate shell with additional insulation and new windows</td>
<td></td>
</tr>
<tr>
<td>Installation of central measuring of energy for tap water in all sub-stations</td>
<td></td>
</tr>
</tbody>
</table>

#### Measures for achieving The Real Estate Administration’s savings goal for energy and \( \text{CO}_2 \text{e} \) (excluding the Sports Administration)

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of oil boilers by downhole heat exchangers or district heating</td>
<td>Separation of electricity subscriptions between building and activity electricity</td>
</tr>
<tr>
<td>Conversion from direct-acting electricity</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>New lighting technology with smart control</td>
<td>Participation in the Swedish Energy Agency’s ordering group (technology competitions and benchmarking)</td>
</tr>
<tr>
<td>Better recycling in ventilation units</td>
<td>Test new energy-efficient technology</td>
</tr>
<tr>
<td>Recycling of condensor heat from cooling machinery</td>
<td>Automatic transfer of user data to the energy monitoring system</td>
</tr>
<tr>
<td>Increased investment in district cooling, which leads to an increased energy demand</td>
<td></td>
</tr>
<tr>
<td>Switch to more energy-efficient windows</td>
<td></td>
</tr>
</tbody>
</table>
**Measures for achieving The Real Estate Administration’s savings goal for energy and CO₂e – the Sports Administration**

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling of energy from grey water</td>
<td>Inquiry into aquifer layers (seasonal heat storage in groundwater) for two swimming pools with large savings potential</td>
</tr>
<tr>
<td>New lighting technique with smart control</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>New ventilation apparatus with higher efficiency</td>
<td></td>
</tr>
<tr>
<td>Recycling of condensor heat from cooling machinery</td>
<td></td>
</tr>
<tr>
<td>Additional insulation of climate shell</td>
<td></td>
</tr>
</tbody>
</table>

The activities are often integrated into the technology of the building and the energy subscriptions are not separated, which has made follow-up more difficult.

**Measures for achieving Micasa’s savings goal for energy and CO₂e**

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of oil boilers by downhole heat exchangers</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>Replacement of thermostat valves</td>
<td>Investment in new technology</td>
</tr>
<tr>
<td>Adjustment of heating system</td>
<td></td>
</tr>
<tr>
<td>New lighting technique with smart control</td>
<td></td>
</tr>
<tr>
<td>Enhanced energy recycling with new ventilation apparatus</td>
<td></td>
</tr>
<tr>
<td>Investment in alternative technology such as solar cells or solar panels</td>
<td></td>
</tr>
</tbody>
</table>

The savings effects are only estimates since Micasa’s upcoming energy plan is under production. In many of the smaller properties, tenants are responsible for subscriptions and user data is absent.

**Measures for achieving SISAB’s savings goal for energy and CO₂e**

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of lighting and control with proximity and daylight sensors</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>Review of operating hours in ventilation systems</td>
<td></td>
</tr>
<tr>
<td>Decommissioning of oil- and gas-powered heating plants</td>
<td>Automatic transfer of user data to energy follow-up programs</td>
</tr>
<tr>
<td>Change to more energy-efficient windows</td>
<td>Test new energy-efficient technology</td>
</tr>
<tr>
<td>Additional insulation of attic</td>
<td></td>
</tr>
<tr>
<td>Improved heat recycling in ventilation in connection with renovations</td>
<td></td>
</tr>
<tr>
<td>Needs-based regulation of ventilation in classrooms and auditoriums</td>
<td></td>
</tr>
</tbody>
</table>

Because larger renovations occur infrequently, the main focus is on smaller efficiency measures.

**Measures for achieving Stockholmhem’s savings goal for energy and CO₂e**

<table>
<thead>
<tr>
<th>Proposed construction and engineering measures</th>
<th>Other measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment of heat and the ventilation system (normal maintenance work)</td>
<td>Competence development of own operations personnel</td>
</tr>
<tr>
<td>New thermostat valves</td>
<td>Business intelligence</td>
</tr>
<tr>
<td>Heat recycling with heat pumps in ventilation systems that have previously had natural draft</td>
<td>Participation in the Swedish Energy Agency’s ordering group (technology competitions and benchmarking)</td>
</tr>
<tr>
<td>Water conservation program (low-flow nozzles, etcetera)</td>
<td>Test new energy-efficient technology</td>
</tr>
<tr>
<td>Conversion of oil- and gas-powered boilers to renewable energy</td>
<td>Central measuring of tap water in sub-stations</td>
</tr>
<tr>
<td>Change to more energy-efficient windows</td>
<td></td>
</tr>
<tr>
<td>Additional insulation of attics</td>
<td></td>
</tr>
<tr>
<td>Improved control and surveillance opportunities</td>
<td></td>
</tr>
</tbody>
</table>

50 - ACTION PLAN FOR CLIMATE AND ENERGY
Other measures

- Heat recycling with heat pumps of FTX (ventilation system with heat exchange) in ventilation systems that have previously had natural draft or mechanical exhaust air.
- Water conservation program (low-flow nozzles, etcetera).
- Change to more energy-efficient windows.
- Improvement of the climate shell with additional insulation and window exchanges.
- Test new energy-efficient technology.

**Proposed construction and engineering measures**

<table>
<thead>
<tr>
<th>Category</th>
<th>Area, A&lt;sub&gt;temp&lt;/sub&gt;</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-unit housing</td>
<td>26,770,000</td>
<td>49%</td>
</tr>
<tr>
<td>Houses</td>
<td>6,500,000</td>
<td>12%</td>
</tr>
<tr>
<td>Offices</td>
<td>12,010,000</td>
<td>22%</td>
</tr>
<tr>
<td>Other premises</td>
<td>8,770,000</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54,050,000</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Energy use in privately owned properties is 11,550 GWh per year, including household electricity, activities electricity and property electricity, roughly 210 kWh/m<sup>2</sup> A<sub>temp</sub>. Of this figure, around 8,040 GWh is heat, including electric heat, and 3,510 GWh is electricity, excluding electric heat. Through knowledge of added energy and national studies of the distribution of energy use<sub>1</sub>, the distribution of energy use is estimated in graph 18.

Heat and hot water in housing make up the largest part of their energy use. Added heat consists to a very large degree to different administrations, with different main tasks, the introduction of energy efficiency measures is made more difficult.

Another example is school properties. Normal maintenance of schools and pre-schools is paid for by SISAB; including measures to increase energy efficiency. Conversions to adjust the building to the wishes of the user is paid for by the Education Administration (schools) and the respective city district administration (pre-schools). Large scale energy-efficiency measures are covered by SISAB, but only carried out when major renovations have been ordered. Such major conversions are ordered on a relatively small scale by the Education Administration and city district administrations, which results in major energy-efficiency measures not coming to pass.

6.2 Privately-owned buildings

The goal of the Stockholm Environment Programme is that energy use in the property stock of the whole city needs to decrease by five per cent through energy efficiency measures.

Those properties in Stockholm that are not owned by the City are mainly residential housing units and offices. More than 90 per cent of flats are in multi-unit family houses and the rest in small houses.

**Measures for tenants in the City’s properties**

It is in general harder to realise profitable energy-efficiency measures when the activity operators and property owners are different legal entities. Within the City there are indications that special measures are necessary when the City’s activities rent space from the City.

**Suggestion for measure**

- Create incentives and other ways of achieving energy efficiency for both property owners and tenants where an administration rents premises of another administration or company.

Example: the Real Estate Administration deals with the energy use of sports halls, while the Sports Administration is responsible for the energy use of the activities. Energy savings in sports halls can often be carried out by taking advantage of cold and heat that are created by the activity. Because the responsibilities for properties and activities are placed in different administrations, with different main tasks, the introduction of energy efficiency measures is made more difficult.

---

1. Sources: Delivery statistics from Fortum and Vattenfall regarding total amount of energy delivered; A compilation of energy certifications from the Swedish National Board of Housing, Building and Planning, which lists building year, total heated area (A<sub>temp</sub>), type of activity and use of district heating; the Swedish Energy Agency’s STILL<sup>2</sup> statistics for permits, which provide the distribution of electrical energy use for different activities per category of premise, and the Swedish Energy Agency’s measuring study of households, which gives household electricity use distributed across activities, as well as household water use.
of district heating, a small part is electric heat, oil boilers and other sources.

When it comes to housing units, household electricity use (the electricity that households themselves pay for) is higher than that which the properties provide (electricity included in the rent, such as ventilation, electricity for elevators or washing facilities). For offices and other premises, the posts are more equal, party due to offices and premises normally enjoying more comfort cooling and mechanical ventilation than dwellings. Lighting is a factor in both building electricity and in household and activity electricity.

The total energy use for Stockholm properties outside of the City’s ownership, including both electricity and district heating, causes 1,180,000 tonnes of CO₂ emissions per year.

### 6.2.1 Expected development by 2015 and 2030

According to the expected development, about 5,000 flats (70 m² flat) are added every year, along with 20,000 new workplaces (20 m²/workplace). The energy demands on new property construction are becoming harder and harder, and many contractors are already building in a more energy-efficient way than what is allowed by the national rules and regulations. Energy use in new properties built up until 2015 must, according to the BBR building rules of the Swedish National Board of Housing, Building and Planning, not exceed 90 kWh/m² and year, excluding household electricity. During a phasing-in period 2012–2015, Stockholm demands a maximum of 55 kWh/m² and year for new buildings on City land. For figures after 2020, the calculations in this plan assume that this demand will be lowered to 44 kWh/m². These demands do not include activity or household electricity; a reasonable assumption is that energy use will not exceed 30 kWh/m² and year after 2015 for newly built houses.

Roughly one per cent of the buildings of Stockholm are renovated each year. This does not mean, however, that energy-efficiency measures are carried out. In many cases the property owner chooses to invest in areas that immediately provide higher returns, for example standard-raising measures that allow a rent raise. According to one survey form 2005, only a small proportion of all planned, profitable measures are ever carried out. The scenario business as usual, see Graph 20 below, means that around 15 per cent of those who renovate replace their windows, and that in 5 per cent of all cases an FTX system (ventilation with heat exchange) is installed. The national objective to cut energy use in half is also shown in the graph.

---
2. These are political targets. Demolition of buildings is not quantified in the prognosis.

---

**Table: Heating per energy source**

<table>
<thead>
<tr>
<th>Source of Heat</th>
<th>GWh</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>District heating</td>
<td>6,448</td>
<td>80%</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>391</td>
<td>5%</td>
</tr>
<tr>
<td>Natural gas, city gas</td>
<td>61</td>
<td>1%</td>
</tr>
<tr>
<td>Biofuels</td>
<td>42</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Electric heat, including heat pumps</td>
<td>1,095</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,037</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Those who have the opportunity and know-how to carry out energy-efficiency measures often lack the financial motivation. One example: property owners add the energy cost to the rent and thus have no incentive to pay for energy-efficiency measures. The property owners’ association Fastighetsägarna have established that time restraints, resource shortages and low priority, but also uncertainty regarding the real savings of considered measures are causing unrealised energy efficiency steps.

The prognosis for the pace of energy efficiency and new production leads to increased energy use in the building sector, since construction of new buildings give a larger effect than energy efficiency measures in the existing property stock. Specific energy, however, decreases due to the improve energy efficiency of new houses.

In times of rapid turnover on the property market and short planning horizons, issues regarding energy efficiency are often pushed to the background since property owners stand to make considerably larger profits by simply buying and selling properties. Foreign ownership also tends to postpone or obstruct energy efficiency work.

Many large property owners have chosen to outsource property maintenance. One consequence of this is that opportunities for increasing energy efficiency are not given priority. Operations personnel do not have the time to discover or pass on knowledge regarding shortfalls and opportunities. This may not be a work task that is included in the outsourcing agreement. Yet another major obstacle is the shortage of relocation options and labour.

For smaller tenant-owners’ societies, there is a tendency not to want to borrow money even if the calculations show that it is a profitable investment. Smaller tenant-owners’ societies also in general have a shorter planning horizon than larger property owners, since many of their members only plan to live in the building during a few years and therefore have no interest in making investments that have a longer payback time than two-three years.

6.2.2 Possibilities and conditions

For the property stock of Stockholm to become more energy efficient, it is of prime importance to work with already existing buildings. Even if new and more energy efficient buildings are added to the stock, the large proportion existing buildings are the one that need to be made more efficient in order for Stockholm to reach its environmental targets.

The City of Stockholm needs to strive to persuade owners to implement energy efficiency measures in buildings that do not belong to the City. The fact that the City is making its own properties more efficient serves to build confidence and show opportunities. This is not enough, however, which is why the City must also carry out measures that can influence private property owners to increase the pace of energy efficiency work.

In order to reach the goals, both profitable and less profitable opportunities must be realised. Those energy efficiency measures that are the least profitable are those that demand large-scale renovations, for example facade renovation, changing of ventilation systems or conversion of heating systems. These measures need to be realised for the goals to be met. To make them as profitable as possible, they need to be carried out in connection with other types of renovations.

Improvements to the climate shell or the characteristics of the ventilation system have a long repayment time. Profitability estimates depend on which assumptions are made concerning the development of energy prices, and also which real interest rate is used. It turns out that especially higher investment costs, such as additional insulation, window replacement, replacement or renovation of ventilation systems. Insulating attic roof beams is profitable in 10–25
years’ time in Stockholm, according to estimates that the Ekan Group has carried out for Fastighetsägarna.\textsuperscript{6} The same report estimates that the recovery time for simultaneously changing to more energy-efficient windows is 15–30 years, and that a new FTX system (ventilation with heat exchange) in combination with an improved climate shell has a very long recovery time of 25–70 years.

At the current pace of renovation and implementation of all the technically feasible improvements, specific energy use can be reduced by 15 per cent by 2030 and 30 per cent by 2050. In order to meet the goal of 50 per cent reduction by 2050, the renovation pace must be increased so that 1.5 per cent of Stockholm’s buildings are renovated every year, see graph 20. This represents a total renovation of roughly 60 per cent of existing buildings.

Assumptions for technical potential up until 2050

CLIMATE SHELLS If the oldest properties (those built between 1900 and 1960) are renovated to what today is considered good climate shells, it would mean around 70 per cent less heat leakage per renovated building (the combined U-value for the group is reduced from 0.94 to 0.27 as an effect of better insulation, modern windows and fewer thermal bridges). Renovating more recent buildings gives relatively minor effects. For all buildings combined, around 50 per cent of heat can be retained. Given the current pace of renovation, only around 40 per cent of all buildings will be renovated, but if the pace increases to 2.5 per cent per year, all will be renovated by 2050. The cost for making climate shells energy efficient hover around 2,000–3,000 kronor per square meter.

VENTILATION For offices and commercial premises, it is possible to save energy by controlling ventilation flows and operating times and installing new and more efficient energy systems, with less pressure drop loss in channels and less energy loss in fan motors. With the correct adjustment of operating times and air flows, electricity use for ventilation can achieve an estimated reduction of around 25 per cent.\textsuperscript{7} Above that, an improved fan system can reduce hat losses. For multi-unit houses, it is assumed that 85 per cent of ventilation heat losses can be cut by 2050 with the help of better ventilation and heat exchange in houses undergoing renovation.\textsuperscript{8} Mechanical ventilation and heat exchange mean more fan operation, while systems and motors become more and more efficient. For multi-unit housing, it is assumed that electricity for ventilation use will only decrease by 5 per cent.

Replacing the ventilation system and installing a so-called FTX unit\textsuperscript{9} is a relatively comprehensive action that should be carried out in combination with a renovation. In other words, the actions is dependant on the pace of renovations. For offices, it is assumed that heat recovery is already installed to a certain degree, but that it can become even more common and better. The cost of replacing the ventilation system and installing FTX systems is 500–1,000 kronor per square meter.

LIGHTING Within 20 years, all lighting can be modernised both for residents and in the building as a whole. Beyond replacing light sources in all spaces (even houses), proximity control for lighting is installed in joint spaces such as staircases.\textsuperscript{10} Electricity savings can be as large as 80 per cent. The reduced heat added by lighting affects heat and cooling needs, which have also been taken into account. The cost for installing energy-efficient lighting is 50–100 kronor per square meter.

HEATING SYSTEMS It is assumed that new thermostats reduce heating needs by 5 per cent. Buildings heated by direct heating or oil can be converted to district heating or some form of heating pump. The cost for making the heating system more energy efficient and install thermostats lie in the interval 30–50 kronor per square meter.

HOT WATER By installing low-flow water taps and introducing individual measuring and charging of hot water in multi-unit residential houses, it is assumed that energy use can be reduced by a maximum of 20 per cent. According to the City’s assumption, roughly 25 per cent of added heat is used for hot water, which means that 6 per cent can be saved. The cost for installing individual measuring of hot water and low-flow water taps lies in the interval 40–70 kronor per square meter. (There are large variations of cost and effect. When installations have been made within the City’s property stock, the costs have been around 7,000 kronor per apartment).

OTHER APPARATUS AND EQUIPMENT Equipment that uses electricity is made more efficient while the trend is for households to acquire more equipment. An assumption of a 10 per cent reduction of energy use by 2030 has been made.

The total cost of energy efficiency measures in connection with a renovation has been estimated to 2,620–4,220 kronor per square meter. The cost of meeting goals for the entire property stock of Stockholm, except for the City’s own properties, has been estimated at 140–230 billion kronor,\textsuperscript{11} or 3.5–5.7 billion kronor per year (according to Fastighetsägarna).

\begin{itemize}
  \item \textsuperscript{6} Incentives for energy efficiency measures – or how do we pay for our energy?
  \item \textsuperscript{7} Swedish Energy Agency, report on statistics for premises, STIL.2
  \item \textsuperscript{8} Swedish Energy Agency
  \item \textsuperscript{9} Mechanical exhaust and intake air ventilation with heat exchange (FTX)
  \item \textsuperscript{10} Swedish Energy Agency, report on phasing-out of incandescent lighting
  \item \textsuperscript{11} The Stockholm City Environment and Health Administration, Hållbara Järva and other sources
\end{itemize}
In reality, other measures are also taken in connection with major renovations, for example pipe replacement. Social housing has in its finished renovations of multi-unit houses reported total costs of about 15,000 kronor per square meter, including energy efficiency measures.

**Examples**

It would be possible to reduce energy use in Stockholm’s buildings by half. A multi-unit residential house built in 1950 that has a specific heat use of $140 \text{ kWh/m}^2/\text{year}$ and specific electricity use of $50 \text{ kWh/m}^2/\text{year}$ can cut its energy use in half by taking the following measures:

<table>
<thead>
<tr>
<th>Heat</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use in baseline</td>
<td>$140 \text{ kWh/m}^2/\text{year}$</td>
</tr>
</tbody>
</table>

**Technical measures:**

- Improve the climate shell through added insulation on facade and attic, new windows and new FTX ventilation | $70 \text{ kWh/m}^2/\text{year}$ |
- Install individual measuring of hot water | $8 \text{ kWh/m}^2/\text{year}$ |
- Modernise lighting and install proximity control in joint-use areas | $8 \text{ kWh/m}^2/\text{year}$ |
- Upgrade washing machines and drying equipment | $1 \text{ kWh/m}^2/\text{year}$ |

**Total energy reduction** | $78 \text{ kWh/m}^2/\text{year}$ | $9 \text{ kWh/m}^2/\text{year}$ |

**Energy use after renovation** | $62 \text{ kWh/m}^2/\text{year}$ | $41 \text{ kWh/m}^2/\text{year}$ |

In order for uncomplicated measures to be achievable, two measures have been proposed:

a) Networks for knowledge sharing. Energy counselling is already available through the City, but a network could be more specific and provide more opportunities to share experiences.

b) Expert assistance for renovations of culturally valuable and older buildings, or for buildings of architectural value.

In order for technically advanced measures to be achievable, three measures have been suggested:

a) Demonstration projects

Show FTX and climate shell improvements in multi-unit residential houses

Show alternatives to increased energy use for cooling

Show good lighting planning.

**Network for knowledge sharing**

The city of Stockholm can contribute to creating networks where private property owners come in contact with knowledgeable professionals in regard to energy efficiency measures and the process involved. Activities in such a network can,
for example, be recurring breakfast seminars and a common web site as well as current energy statistics with benchmark indicators. By spreading knowledge regarding the technical, legal and financial aspects of energy efficiency project, conditions improve for more property owners to implement energy efficiency. All property owners in Stockholm can benefit from a network, even if the measure primarily concerns the smaller property managers, such as small tenant-owners’ societies, private citizens, foreign funds and the like.

It is primarily simple measures that benefit from the spread of knowledge and information. Networks can be used to spread awareness of other possible support measures and possibilities, such as courses, demonstration examples, relocation support, accessible financing or competency support for major renovations. A network thus reinforces the impact of other measures. The network can also serve to inform about the stated energy goals and how property owners through simple measures can contribute to reaching the goal. One way of inspiring action is to present benchmark figures for energy use such as kWh/m² and emissions in tonnes of CO₂ to compare with and follow up annually. A network for property owners is also a good channel for reaching out with information about other measures that the City is taking with regard to buildings.

**Examples**

Those measures that primarily will be carried out as a result of better knowledge are the technically uncomplicated and profitable measures, those that relate to more efficient lighting and machinery, as well as activity-dependant control.

Experiences from a follow-up of information dissemination in a knowledge network within the energy efficiency office of NUTEK (the former Swedish National Board for Industrial and Technical Development) reveals that out of one hundred individual participants, about ten of them are expected to carry out the suggested measures. The main goal of the network is to reinforce the effect of other measures such as demonstration projects and relocation assistance.

**Expert assistance for renovations of culturally valuable buildings**

The City can contribute to bringing together experts on buildings of high cultural or historical value and buildings of architectural value with experts in energy efficiency and property owners to inform about which technical improvements are possible to carry out.

Many buildings, especially older ones, in Stockholm have some kind of cultural or historical value, which places restrictions for efficiency measures concerning climate shells and ventilation. These buildings normally belong to the category of buildings in greatest need of energy efficiency. In spite of limited possibilities of re-structuring within these properties, it is possible to carry out certain smaller, often profitable, technical improvements. Lighting and machinery, for example, can be replaced without limitations. Even larger technical improvements, for example window complementation, can be achieved.

In order to initiate these technical improvements, the City of Stockholm can offer assistance from experts who can coordinate information and applications for building permits and establish connections to, among others, Stockholm City Museum.

**Effects** In order to carry out some of the complicated technical improvements in the very oldest stock, expert assistance is needed. To increase the impact and reach more property owners, the measure can be coordinated with the network for knowledge dissemination, demonstration projects and relocation assistance. An expert can also provide good advice regarding, for example, how lighting planning and other modern installations can be utilised, such as modern washing facilities.

**Demonstration of good examples of renovation and new constructions**

The City of Stockholm is leading by example, showing how much can be achieved through a well implemented renovation of an older or new building.

Missing today are good examples of successful renovations of buildings in the age intervals where most of the buildings are situated, i.e. building constructed between 1940 and 1969. The City of Stockholm has more renovations planned, and some of them can be promoted as good examples where comfort and cultural values have been retained.

The City has a demonstrations centre, Glashus 1 in the Hammarby Sjöstad area, where new techniques are presented. A private example in Stockholm is the tenant-owners’ society Konstnärsgillet (The Artists’ Guild), which after a conversion has reduced energy use from 128 kWh/m² to 64 kWh/m² (A_{area}), partly through an upgrade of the ventilation system with heat exchange and additional insulation of parts of the climate shell. Hålbara Järva (Sustainable Järva) will also be an interesting example of energy efficiency in existing properties. For new constructions, Royal Seaport may come to function as a good example. It is of utmost importance that the good examples are credible when it comes to costs and execution. They must be applicable for the current property stock and include cost analyses.

**Effects** Demonstration projects can mean that more actors receive information when it comes in concrete form.

**Dampen the growing demand for cooling**

The need for cooling is an effect of the amount of surplus heat produced in premises. The increasing cooling needs
depend more on heat-generating indoor equipment (for example computers), increased comfort demands, more larger windows and glass facades, and more people per square meter of office space. Through more energy-efficient lighting and energy-efficient machinery, the amount of surplus heat will decrease and with it the cooling needs. It is possible to reduce cooling demand with good sun screens for windows and with better use of night air. Converting from machine-produced cooling to district cooling or free cooling also reduces the amount of energy required to produce cold.

Within the limits of other proposed measures, such as knowledge dissemination through networks, demonstration projects and expert assistance, the City can work to persuade property owners to choose alternative cooling methods.

Effects The effect of the measure is that electricity use does not increase as a result of increased demand for cooling.

6.3 Planning and design of new buildings for reduced energy demand
The design, planning and structure of settlements affect energy use and energy inputs in the building sector. The conditions for eco-technological solutions need to be integrated in the building structure and architecture already from the start, so that there are good conditions for using eco-technology. Demands should be placed already at land designation, when development agreements are signed, and early in the planning process when plan structures are designed.

The energy needs of buildings can be reduced by buildings being located and designed to absorb the energy from insolation to as high a degree as possible. House bodies should, for example, be placed with their short sides in a north-south orientation in order to minimise insolation in the summer and minimise heat loss in the winter. By avoiding placing buildings in sinks (cold air lakes), energy use can be reduced. Simulations show that it is possible to reduce total energy use by 3–6.5 per cent by optimising orientation and settlement locations, depending on where in the country you are building.12

For energy input, conditions for using insolation are created by not placing buildings too close together since solar thermal collectors, but particularly solar panels, are sensitive to shadowing that can be caused by nearby structures or vegetation. There also needs to be room for utilising heat storage. These aspects must be taken into account at an early stage of planning and design of the building.

12. Planning and sustainable building development from a climate and energy perspective, Mats Johan Lundström, KTH 2010
7 Measures for sustainable energy production

Energy production in Stockholm is almost entirely carried out by heat and electricity production in Fortum’s cogeneration plant. Some local heating plants are maintained by property companies. According to Fortum, district heating is currently responsible for more than 80 per cent of the heat and hot-water needs of the city. A review of hitherto conducted energy certifications in Stockholm point to an even higher percentage of the market.

The remaining heating needs are primarily met by air and downhole heat exchangers and pellets-fired local heating plants. Direct-acting electricity remains in a few older multi-unit residential houses which earlier were heated by wood-heated tiled stoves, as well as in small houses built after the Second World War. An estimated 10,000-plus buildings have direct-acting electricity, whereof a few multi-unit residential houses.

There are still 600–800 oil-heated boilers in multi-unit houses. Most of them are only used for peak heating as a support for district heating or heat pumps. In the small-house stock, there are an estimated 1,000 oil-burning boilers left. Due to high operating costs, these will most likely be phased out within the near future. Therefore, it is not necessary to take any special steps to phase out the remaining ones.

Using solar energy to produce hot water and electricity is very uncommon in Stockholm. There is a large untapped potential here to increase energy production in a way that is gentle on the environment. To increase flexibility in the energy infrastructure of Stockholm, the City should strive for the development of an integrated heating system where all buildings in the long term are both producers and consumers of energy.

7.1 Measures in Stockholm’s district heating system

The expansion of district heating has been by far the most important reason for Stockholm being able reduce its emissions of greenhouse gases. District heating has reduced emissions by 600,000 tonnes between 1990 and 2010, 1.5 tonnes per Stockholmer and year. Fortum has decided on plans to decrease emissions by 200,000 tonnes by 2015. Fortum Värme has an investment plan until 2020. According to this plan, the climate impact of production will be minimised through switching to climate-neutral fuels, and the remaining emissions will be neutralised. There is a possibility of reducing emissions with a further 100,000 tonnes of CO₂ if the coal burning in Värtaverket (KVV6) is removed entirely. With the current technological design, further reductions would demand substantial new investments.

According to the view of the Environment and Health Administration, Fortum’s measures will lead to increased production of electricity and heat. Meanwhile, prognoses imply than energy efficiency measures and low energy needs in new buildings lead to reduced energy demand.

7.1.1 Fortum’s production facilities

Conversion of Värtaverket’s boiler P12 to pellets

P12 is still used for heat production at Värtaverket. Today, the boiler is powered by fuel oil, which makes up around 5 per cent of Värtaverket’s oil use and delivers around 10 GWh of heat per year to the district heating grid. The conversion is set to be completed in 2013.

Bio-powered boiler P4 is taken online in Hässelby

P4 will be powered by biofuels and replace the three boilers that today make up the biggest part of Hässelbyverket’s cogeneration production. The existing boilers are powered by biofuels and make up about 10 per cent (700 GWh) of the city’s district heating production. The new boiler will be more efficient than the existing ones but can be run using more fuel for increased heat production, which can lead to increased emissions from the facility.
Increased proportion of biofuel in Värtaverket KVV6

The work of increasing the biofuel share in Värtaverket’s coal-powered cogeneration boiler continues, with an objective of 30 per cent biofuel by 2015. If the total production remains constant, 50 per cent biofuel in KVV6 will result in a decrease of 40 grams CO₂/kWh heat, a reduction of 30 per cent. Per capita, this is a reduction from 1.36 to 0.94 tonnes of CO₂, provided the total production and population figures remain the same. This is the single largest planned measure.

Waste-powered plant P7 goes online in Högdalen

At Högdalenverket, waste is incinerated in large cogeneration boilers; yearly production averages reach 1,700 GWh of heat and 300 GWh of electricity. The new boiler is expected to increase production to 2,300 GWh of heat and 450 GWh of electricity. Fuel consists of two forms of waste, which makes it hard to estimate future production with any certainty. Since this signifies a production increase, climate impact will increase.

New cogeneration plant KVV8 replaces heat pump facility in Värtaverket

In connection with development of new housing settlements in Värtan, Royal Seaport, the heat pump facilities Rn1-3 will be decommissioned. These are powered by electricity and produce district heating. They will be substituted by a bio-fuelled cogeneration boiler that will produce district heating and electricity. Fortum will thereby reduce its electricity consumption while simultaneously increasing electricity production. All in all, the production capacity for heat will rise.

<table>
<thead>
<tr>
<th>Effects</th>
<th>In operation</th>
<th>Reduction in CO₂e</th>
<th>Increase in CO₂e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion of Värtaverket boiler P12</td>
<td>2013</td>
<td>5,200 tonnes per year</td>
<td></td>
</tr>
<tr>
<td>Bio-fuelled boiler in Hässelby P4</td>
<td>2014</td>
<td>6,600 tonnes per year</td>
<td></td>
</tr>
<tr>
<td>Increased proportion biofuel in Värtaverket KVV6</td>
<td>2015</td>
<td>190,000 tonnes per year</td>
<td></td>
</tr>
<tr>
<td>Waste-fuelled boiler in Högdalen P7</td>
<td>2016</td>
<td>29,000 tonnes per year</td>
<td></td>
</tr>
<tr>
<td>New cogeneration plant in Värtaverket KVV8</td>
<td>2018</td>
<td>4,900 tonnes per year</td>
<td></td>
</tr>
</tbody>
</table>

7.1.2 Development of the district heating system

The City is striving for developing and building an integrated district heating system

The way the district heating system is set up today, it provides small, if any, possibilities to take care or the excess heat generated by buildings, activity processes and small energy installations. This inhibits alternative heat and electricity production.

From a natural resource standpoint, we should be using solar energy as directly as possible, i.e. harness solar energy with the help of solar panels and generate electricity with solar cells. The trouble is that solar energy is unevenly distributed throughout the year on our northern latitudes, as is the demand for heat and electricity. When the sun gives us the most energy, we need it the least. By way of an integrated energy system, this problem can be mastered. The city needs an integrated energy system where all forms of energy resources work in unison. During the summer months, the main part of heating needs (hot water) can be met by way of solar panels. The same goes for cooling of buildings. It can be done efficiently and with little energy through energy from solar panels with absorption technology. The surplus energy that is created when the sun provides more energy than we need in summer can be stored for the colder part of the year or transported to building that for different reasons cannot utilise solar energy. Even during the colder part of the year, residual heat is created in buildings where many people are present at once, from business processes and machinery of varying types. This heat is today almost completely wasted. In an integrated heating system, this heat would be transported to buildings that have a heat deficit. Effect By way of an integrated heating system, emissions of greenhouse gases can be reduced considerably, primarily through the use of solar energy. This energy form does not emit any greenhouse gases (except in the production and scrapping of components).

The reduction of energy use is created in two ways: In part, the surplus energy that today goes to waste is instead utilised, and in part solar energy is utilised instead of valuable biomass. This biomass is saved for other uses, of from converting away coal and oil from electricity-generation plants in the rest of Europe.

7.2 Renewable energy production

Production of electricity from wind turbines

Within the geographical range of Stockholm, locations for large-scale wind energy plants are basically absent as a result of noise and lighting problems, proximity to built-up areas, etc. Small wind energy plants, however, could become an option.

The City buys roughly 680 GWh of electricity each year, paying more than one billion kronor for it. In spite of more efficient machinery and electricity use in activities, electricity use in the city is likely to increase. This is due to the increase in the number of electric cars and, more importantly, energy
savings measures in the property stock. Today, much heat seeps out of the City’s buildings by way of ventilation ducts and sewage pipes. With improved heat recovery technology, large amounts of heat can be re-transferred back to buildings, resulting in large energy savings. But heat recovery machinery uses electricity (one third to one fifth electrical energy compared to what it saves in heat energy. From a point where the City today represents a strain on the electricity system, the City should instead be able to contribute to increased electricity production. The City of Stockholm, which is a very large actor on the market, should be able to accelerate an expansion of wind energy. Being a large customer, the City can stimulate the establishing of new wind energy installations.

Effect The City reduces the cost of purchasing electricity by roughly 270 million kronor per year. The City contributes to an accelerated expansion of wind energy in Sweden.

The City buys electricity that meets the demands of eco-labelling
According the Stockholm Environment Programme 2012–2015, goal 3.2, electricity use within the City’s administration shall meet the requirements for eco-labelling issued by the Swedish Environmental Management Council, level 2, alternative 3.

In 2009, 73 per cent of the City’s procured electricity reached this target: 497 GWh out of a total of 677 GWh. For 2010 there are as yet no reliable statistics, but in general it looks as if the situation remains unchanged. Stockholm Vatten has just under 108 GWh of unspecified electricity, Familjebostäder 24 GWh, the Real Estate Administration 7 GWh and the Cemeteries Administration 2 GWh. Micasa had 39 GWh in 2009, but today has no unspecified electricity.

Climate-wise, a transfer from unspecified electricity (calculated as a so-called Nordic mix with 90 grams of CO₂ per kWh) to electricity that meets the requirements for eco-labelling (electricity from hydropower produces 5.4 grams of CO₂ per kWh) would result in a reduction of greenhouse gases by 1,400 tonnes.¹

Effect The effect of buying electricity that meets the requirements of eco-labelling are naturally limited as long as its production is significantly greater than what is demanded. However, the move is a signal to the market that there is a demand.

Measures for stimulating heat production from solar panels
In Stockholm, there is a large untapped energy resource in hot-water production through solar panel and electricity production through solar cells. Rooftops are the places that primarily should be used for hot-water production by way of solar panels, for several reasons. For a sufficient amount of hot water to be produced, at least on a multi-unit residential building, it is necessary that the larger part of the roof surface is utilised. Heat loss when transporting hot water is large compared to transporting electricity, which is why the hot water should be used near the place of production. Surplus hot water can, through absorption technology, be used to cool the building. Hot water can also be stored or used in the district heating system.

With solar panels integrated vertically along the facade, hot water can be produced at the same time as the building is cooled, which reduces or eliminates the need for energy-demanding cooling. Solar cells can be integrated into balcony railings, but efficiency in electricity production is usually 50 per cent better in places outside of urban areas. Losses through transport of electricity is relatively small.

a) The City facilitates installation of solar panels.
When installing solar panels on buildings, a permit is necessary. The City (the City Planning Administration, Stockholm City Museum and Stockholm Beauty Council) needs to develop a plan with guidelines concerning building permits for solar panels.

a) The City installs solar panels on City buildings.
The City has a large stock of buildings in its property portfolio where solar panels could be installed. In conjunction with the installations, an investigation is carried out as to how an efficient district heating system can develop so that the surplus heat can be utilised. The measure leads to the City reducing its energy costs. A solar panel installation has a technical life-span of 25–30 years.

a) The City strives to make it possible to use surplus heat from solar panels in the district heating grid.
The City should strive for integrating the district heating grid into a smart grid which is used for transporting heat energy from installations with surpluses to installations with deficits. The grid is expanded to include storage of surplus heat from summer to winter.

The need to keep the district heating system going is reduced. This leads to waste collected during the summer having to be stored, which has been done successfully in other municipalities. Should the collection of compostable substrates from food waste prove efficient, the only thing remaining will be relatively dry waste that should store well without inconveniences.

Electricity production in cogeneration plants will also disappear. But production that takes place during the summer months has low efficiency levels today since

¹ This reduction is not included in the calculations of the City’s goal of 3.0 tonnes per Stockholmer by 2015 in “Stockholm City’s emissions calculations of greenhouse gases”.

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there is a very small demand for heat. Electricity can then better be produced with the help of solar cells. Electricity needs are also considerably lower during the light and warm summer season.

There is a potential for 50 per cent of the hot tap water in Stockholm to be heating with solar panels (i.e. the total amount of hot tap water during summer). This would give a reduction in greenhouse gas emissions of 50,000 tonnes of CO\textsubscript{2}e per year and energy savings of 400 GWh per year.

**Effects** Utilising solar heat would reduce emissions of greenhouse gases, as well as the use of the limited resource of biomass. This favours conditions for biomass to be used as replacement for coal in installations in other countries. Furthermore, forest products are an increasingly sought-after product that can be refined to more valuable products than fuel. Biomass has become a rare, and therefore more expensive, commodity in the world. The use of biomass will in the long run become an even larger cause of over-exploitation of the world’s resources. This can jeopardise sustainable ecosystems and biodiversity. The benefit of using solar energy directly is that the technology does not lead to emissions of greenhouse gases at all (except in production and scrapping of the solar panel itself).

**Electricity production from solar cells**

In Stockholm, solar energy is utilised to a very small degree today, both when it comes to solar panels and conversion to electricity in solar cells. As has been established in the measure heat production from solar panels, the heat production from solar panels that we do have in Stockholm should primarily utilise sloping roofs and well-exposed facades for solar panels. In addition to these surfaces, balcony railings, other parts of facades, sports stadium roofs, parking lots, etc. can be used for solar cells. Apart from placing solar cells within Stockholm, the City can promote cooperations that lead to solar cell installations being placed in suitable locations throughout Stockholm County or in other parts of the country. The efficiency of electricity production is about 50 per cent better in locations outside of urban areas.

Lessons from Royal Seaport have shown that up to 30 per cent of property electricity can be produced using solar cells on a building. A more long-term ambition should be that all activity and household electricity should be produced locally. That is when incentives for using electricity with restraint are most likely to be the greatest.

a) The city facilitates the installation of solar cells.

When installing solar cells on buildings, a building permit is necessary. The City (the City Planning Administration, Stockholm City Museum and Stockholm Beauty Council) needs to develop a plan with guidelines concerning building permits for solar cells.

b) The City installs solar cells on City buildings.

The City has a large stock of buildings in its property portfolio which are very suitable for solar cells. Stockholm Vatten is considering installations on roofs covering treatment pools, Stockholm Parking on roofs over parking spaces. Other possible sites include sports arenas, bicycles parkings, recycling stations and industrial parking spaces. Since solar cells are placed into existing roof constructions, the installation cost is lower and consequently recovery times shorter.

c) The City promotes cooperation.

Solar cell installations will be more efficient if they are placed outside of built-up urban areas. Suitable locations for small- and large-scale electricity production using solar cell technology are currently being scouted. The best electricity yields can be extracted in fields, meadows, roads and water surfaces with northern orientation where ground and water reflection can be harnessed. Interest from land owners in the countryside is substantial, as is that from municipalities. Private citizens, companies, municipalities and others should be able to rent land where the solar cell installation is located, or rent space in a solar cell installation.

One advantage compared the establishing wind energy plants is that solar cell installations are more discrete in the landscape, and establishment costs are considerably lower. This also suggests that the time needed to establish an installation should be very short, at least for smaller installations.

The City can work to initiate cooperative ventures between municipalities and other interested parties in Stockholm County. (Just as the City does regarding the procurement of electric cars.) An established market facilitates the City’s demands for locally produced electricity in land designations.

**Effects** The measure would contribute to a rapid and significant expansion of environmentally sustainable electricity production. The technical potential for electricity production using solar cells in all of Stockholm has been estimated at 400 GWh per year. This equals six per cent of electricity use in Stockholm. With production placed outside Stockholm, production capacity can be increased several times.

7.3 Conversion from direct-acting electricity

In Stockholm, there are around 15,000 small houses that today are heated using direct-acting electricity. Their energy use is on average 26,000 kWh, whereof 20,000 kWh goes to heating and hot water.
The cost of heating and hot water with direct-acting electricity is around 32,800 kronor/year. There are profitable measures such as conversion to water-based heating and switching to a different heating alternative, such as district heating or downhole heat exchangers. The investment for this, however, is substantial.

Converting from direct-acting electrical heat to a water-based system connected to district heating costs around 140,000 kronor. Operating costs for district heating are around 18,700 kronor, so the saving is about 14,100 kronor per year and the recovery time is more or less ten years. When installing district heating, the customer pays for a culvert to the district heating pipe, which increases the cost of investment considerably.

Converting from direct-acting electricity heat to water-based geothermal energy costs roughly 235,000 kronor. The cost for heating and hot water is then 11,000 kronor/year, and the savings 21,800 kronor/year. Recovery time is around 11 years. Where there is no interest for switching to a less expensive alternative, the large investment costs can be the deciding factor, and that some cannot get the necessary loan or fear that interest costs will severely reduce the amount saved.

### 7.4 Biogas production

The City of Stockholm has a biogas strategy which has been developed by the Environment and Health Committee. Its purpose is to increase the availability of biogas as a vehicle fuel. The strategy contains, among other things, an analysis of how large amounts of biogas can be produced depending on the amount of collected food waste and choice of technology for collection and digesting, as well as an estimate of costs and energy use for the different alternatives.

Food waste is the substrate which has the single highest potential for biogas production within the City of Stockholm. The City also has authority of action over the waste, which is why it should be collected on a greater scale than today. During 2010, more than 8 million normal cubic metres of upgraded biogas at the waste treatment plants in Henriksdal and Bromma. There is potential for producing considerably more gas, provided that pumpable substrates are available. During 2010, the gas was primarily produced by way of sewage sludge.

Increased production of biogas gives larger amounts of nutrient-rich residual material, which can benefit agriculture and reduce the use of fertilisers.

**Measures for increasing the production of biogas**

The City of Stockholm can contribute to increased production of biogas by:

a) increase the collection of food waste for composting to biogas.

b) expanding capacity for biogas production.

The biogas producers active in the Stockholm area all have plans of greatly increasing their production these coming years. This will occur both through new facilities and through production increases at existing facilities.
c) increasing cooperation between actors.

The city works together with producers, distributors and end users of biogas to increase gas availability in Stockholm. Through, among other things, continued round-table discussions where politicians and biogas actors meet, the needs and questions of the business sector are addressed.

EFFECTS If 40 per cent of the food waste left over by the City of Stockholm were collected and composted separately, more than four million normal cubic metres of upgraded biogas could be produced. This is equivalent to 42 GWh. The image above shows production and import of biogas, as well as additions of natural gas to Stockholm County. The prognosis assumes that the planned facility in Skarpnäck will come online and produce gas by 2013. The image also shows an estimate of biogas demand, based on assumptions and therefore subject to cautious interpretations.

<table>
<thead>
<tr>
<th>Timetable</th>
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<tbody>
<tr>
<td><strong>Reduction of CO₂e</strong></td>
</tr>
<tr>
<td><strong>Energy efficiency</strong></td>
</tr>
<tr>
<td><strong>Finance</strong></td>
</tr>
<tr>
<td><strong>Responsible</strong></td>
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</tbody>
</table>
8 Measures for reduced energy use in City activities

**Administrations and companies** who do not own properties have the option of reducing their environmental impact and energy use through purchases of energy-efficient products and services. Many City units post energy demands and take climate considerations in procurements. In order to meet goal 3.1 in the City’s Environment Programme (the City shall through energy-efficiency measures reduce energy use in its own activities by 10 per cent), it will be necessary to pay increasing attention to energy use, not least in procurements. An overview analysis has shown that more knowledge is demanded from the procuring units for the City to be able to reduce energy use according to the Environment Programme.

**Public procurement as an instrument for reducing energy use and environmental impact**

a) Develop guidelines for the City that can be used in procurements by, among other things, energy-efficient goods and services.

To facilitate for City committees and companies, guidance is necessary for how to place demands in procurements on, among other things, energy efficiency.

The work to produce guidelines can include reviews of existing systems that the City can use for energy-efficiency products, such as Energy Star. Guidelines can very well be combined with good examples where the City successfully have placed demands on energy efficiency in procurements, as well as examples of how the demands can be followed up. Examples in which cases total cost calculations\(^1\) (costs for both purchase and operation) are used are also interesting. By placing demands of energy efficiency for goods and services, conditions improve for reducing the City’s energy use. This is also in line with the EU energy services directive which states that the public sector should take a front position in the conversion to an energy-efficient society. The City companies and committees are obliged to, wherever possible, to carry out innovation procurements,\(^2\) to test the latest technology. One area that can be touched upon is energy efficiency.

b) Delivery of more goods and services in a more limited area to the City’s activities.

Health care and welfare services often entail extensive use of single-use material and energy related to, for example, the recurring transports of home services within urban areas. Thereby, taking care of and minimising waste, as well as efficiency and coordination of deliveries, are important factors in these types of procurements. Even geographical aspects can need to be taken into account to enable each company to deliver more goods and services, but in a more limited area and not over too large distances.

**Effects** In Stockholm, no analyses have been carried out that show current figures of the energy use and environmental impact of procured goods and services. Neither has the extent to which the total cost is used in procurements been analysed. Therefore no effects of these measures are presented here. The City of Stockholm purchase goods and services for roughly 13 billion kronor annually. Because of these volumes, the measures can come to entail considerable energy savings.

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1. Directions for policies for procurements and competition. The City of Stockholm City Executive Office 2011.
2. Budget 2012 for the City of Stockholm
9 Information efforts for the climate and energy work

An important part of the work done by the City of Stockholm on the environment issue has to do with informing and through dialogue facilitate for Stockholmers to reduce their environmental impact. The City should inspire, lead the way and spread experience.

Stockholm's climate and energy information

Through strategic and continuous communication to Stockholmers, we will:

- Inform about and create attention for the climate efforts of the City of Stockholm
- Through dialogue and activities inspire and give advice and support to Stockholmers and those active in the city can reduce their own environmental impact
- Through counselling to City Administrations and companies as well as to Stockholm’s citizens reduce energy use and increase the use of renewable energy.

Communication goals

An overarching goal for all communication in the City is that it should strive for the vision of a world-class Stockholm. Dialogue should be the focal point, both with citizens and with those responsible for activities. The goal for climate communications is to strive to achieve a reduction of greenhouse gas emissions down to a maximum of 3.0 tonnes of greenhouse gases per Stockholmer in 2015, and work to reach the goal of a Stockholm free of fossil fuels in 2050. Stockholmers and those responsible in the City should have good knowledge about the possibility of reducing their emissions of greenhouse gases and be kept informed about, and be inspired by, the climate efforts being taken in the City of Stockholm.

The action plan mainly contains the following information efforts:

Efforts for bicycle travellers

- Implement information campaigns regarding alternatives to the car.
- Improve information regarding bicycle paths

Efforts an attractive and safe public transport

- Implement information and projects to increase the use of public transport.

Efforts for increased proportion of green vehicles and reduced fuel consumption

- Inform in order to persuade private citizens and companies interested in purchasing green cars.
- Inform about fuel use and eco-driving, tyre pressure and the choice of tyres and rims.
- Continued efforts about information measures regarding green cars.

Efforts to promote alternatives to journeys with private cars

- Improve and inform about the options of mixed-mode travel.
- Carry out activities for increased transfer from own cars to car pools.

Efforts for energy efficiency in buildings

- Increased energy counselling and networks for knowledge sharing with the aim of spreading knowledge regarding viable energy-efficiency measures.
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