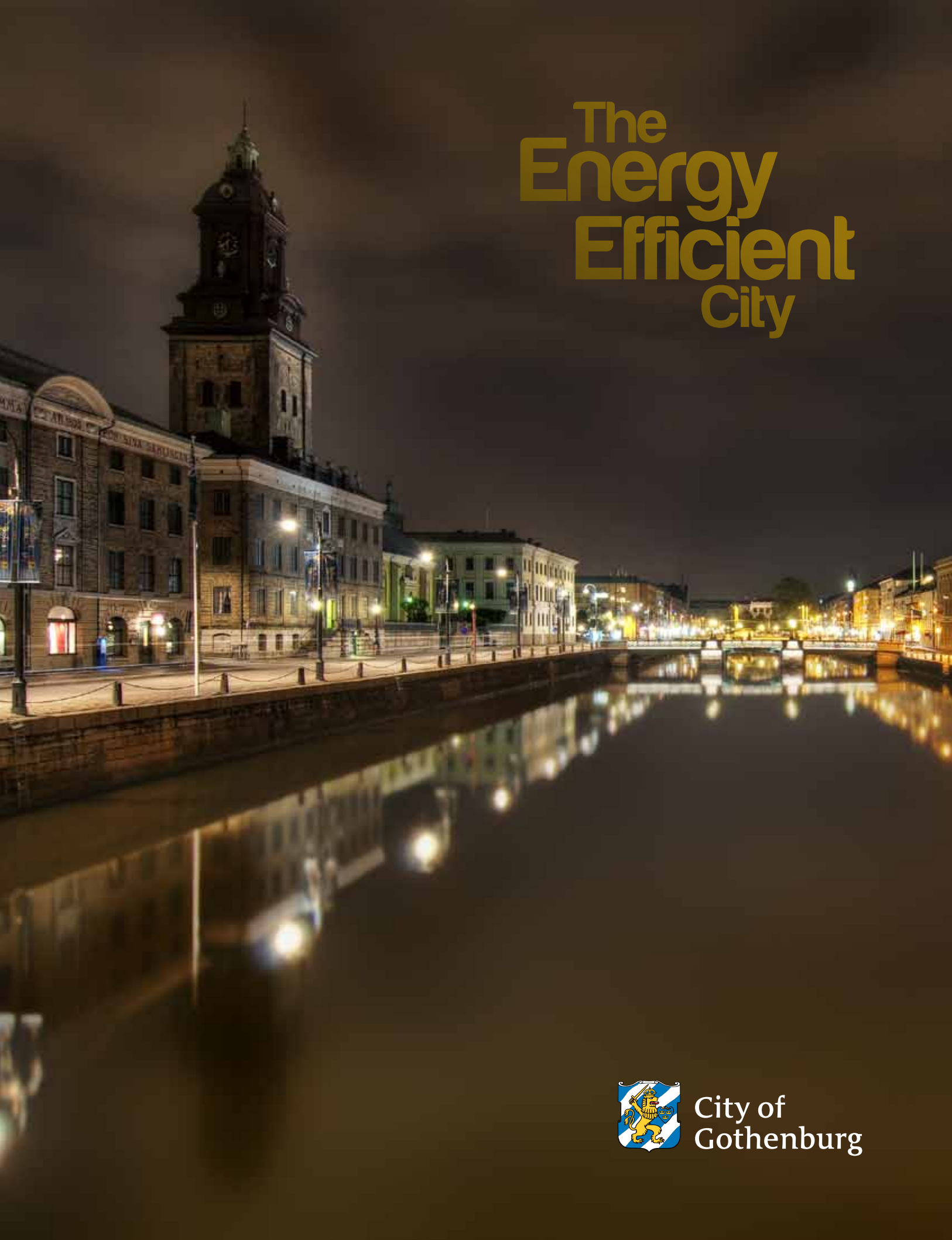
The Energy Efficient City



City of Gothenburg

The city of Gothenburg

The need to reduce our climate impact and to increase our energy efficiency are challenges facing the whole world. We are taking local action to make sure that we do our part to overcome these challenges.

BY SIGNING the Covenant of Mayors we have committed ourselves to go beyond the objectives of EU energy policy. To live up to this commitment we face challenges that are related to the city's size, geography and industrial history. Substantial industrial activities and traffic in combination with low population density and low public transport use are examples of this. But our current situation in Gothenburg also provide us with interesting opportunities to face these challenges.

Our city

Gothenburg is Sweden's second largest city with a population of a half a million. It is situated on the west coast of Sweden at the mouth of Göta Älv river and is the largest of the sea ports in the Nordic countries. After its foundation in 1621 shipping and trade dominated the industry in Gothenburg. In the 19th century, Gothenburg developed into a modern industrial city that continued on into the next century with the development of major companies such as SKF and Volvo. Today Gothenburg has a highly diverse industrial structure and is the heart of a large and growing business region. Gothenburg is also home to many students and researchers, as the city includes both the University of Gothenburg and Chalmers University of Technology.

Our solutions

Our mercantile and industrial history has fostered a spirit of cooperation between the city government, the academia and the private sector in the city. Special platforms have been created to stimulate this, such as *Lindholmen Science Park*, *Business Region Göteborg* and *The Mistra Centre for Urban Futures*. Through cooperation with industry and universities, we and our city owned companies are developing new technologies and methods to lower our environmental impact. Among many things this has resulted in large investments in our modern district heating system and various biogas projects. Old residential buildings are being renovated into low energy buildings and new buildings are required to live up to tough standards on energy use. Through urban planning, information campaigns and investments in public transport we are moving towards a sustainable transportation system. The aim is to create more densely populated mixed function areas in the city. These solutions and others are further described in this booklet. There is still a long way to go, but we firmly believe that we can and will overcome these challenges.

30%

REDUCTION OF CO_2 EMISSIONS BY 2020

Our goals

We have adopted a local environmental objective to reduce our carbon footprint. The aim is that by 2050 the city will have a sustainable and fair level of carbon dioxide (CO2) emissions. The average level of CO2 equivalent emission per person in Gothenburg will have to be reduced from the current level of about 10 tons per person to less then 2 tons per person for the goal to be reached. We have also adopted an interim target which states that by 2020 emission levels of CO_2 will be reduced by at least 30 % compared to the levels in 1990.

Gothenburg´s maritime and mercantile history has shaped the city. The town was planned after Dutch cities to have canals that offered an easy way to load and to land goods in and from ships. During the 18th century the East India Company made Gothenburg an important trade city. The merchants erected imposing stone houses with a Classical look. ABOVE TO THE LEFT: The East Indiaman "Götheborg III" is a replica of the original ship from the 18th century. ABOVE TO THE RIGHT: Kungsportsplatsen in central Gothenburg, once the location of the main city gate. DOWN TO THE LEFT: Kronhuset, the oldest building in Gothenburg, was ones used as an armory. Today it´s a popular tourist attraction. DOWN TO THE RIGHT:

Powering a future without fossil fuels

By combining existing infrastructure with new sustainable solutions we are finding innovative paths towards sustainability based only on renewable resources.

IN GOTHENBURG THE challenge of creating a sustainable energy system has motivated us to try to make the best use of the resources already available, including existing infrastructure and waste products. As a result, we, together with our publicly owned energy company *Göteborg Energi*, have made large investments in the district heating system and into various biogas projects. At the same time we are also making better use of the solar and wind energy available.

Waste put to use

Construction of the district heating network started in the fifties and today it's over 1 000 km long. Through the enclosed tunnel and buried pipeline system it provides heating to more than 90 % of all apartment buildings and commercial premises. For the production of hot water in the district heating system, Göteborg Energi primarily uses waste heat from industries, power production and the incineration of waste. In total this accounts for about 80 % of the fuel mix for district heat production. During the summer months no additional fuel is needed.

Göteborg Energi produces most of the remaining heat in its own power plants. The fuel mainly used consists of different forms of biofuel and natural gas. The long term goal is to only use fully renewable energy sources. Our district heating efforts are the most significant contributing factor to improved air quality in Gothenburg over the past four decades. In the same period, CO2 emissions decreased by over 90 % (per unit of district heating produced). The reason behind these reductions is that we now use the district heating grid for recycling of energy already produced in Gothenburg, thus almost eliminating the need for dedicatad heating plants.

Local fuel for local use

We are developing urban forest utilisation in collaboration with *Göteborg Energi*. They take care of the biomass that is left after the thinning and pruning of city green areas, and use it to produce heat. Energy production today from this source is roughly 50 GWh per year. The goal is 300 GWh per year by 2015.

90%

OF ALL APARTMENT BUILDINGS HEATED BY DISTRICT HEATING.

Göteborg Energi is also selling district cooling that is distributed in central Gothenburg. It's produced using free cooling, collected from the cold water of Göta river, supplemented by absorption cooling. Absorption is a process which converts waste heat to cooling during the summer months.

Biogas

Biogas is a renewable fuel that can be extracted from sewage sludge, compost, forest residues and other biomass. Today, both natural gas and biogas are used in cars, buildings and power plants in Gothenburg. By investing in biogas research and production, Gothenburg can take advantage of the existing gas infrastructure to provide a sustainable alternative.

When Göteborg Energi opened the *Gasendal plant* in spring 2007, it was the world's largest biogas upgrading facility. The plant receives biogas from *Gryaab*, our local wastewater treatment plant, and upgrades it to natural gas quality, with an annual production of around 65 GWh. The biogas is then sold, via the natural gas grid, to cars and buses in Gothenburg area

Göteborg Energi and *Renova*, our publicly owned recycling company, are planning to build a new plant for anaerobic digestion of sorted household waste in Gothenburg. The plant is expected to produce 25 GWh of biogas, which can be sold to gas customers in Gothenburg. Biogas production is expected to start in 2011.

We view wind power as a key part of a sustainable electric power production system. Gothenburg, situated on the Swedish west coast, has a big potential for wind power. Our goal is to have 300 GWh of windpower by 2020. In central Gothenburg we are expanding our district cooling network to provide energy efficient cooling to more customers. It's distributed through an enclosed tunnel and buried pipeline system, similar to the one used for heating. Using the cold water of Göta Älv river we can provide a better in-door climate to shops, offices, public facilities and housing.

Gothenburg Biomass Gasification Project, GoBiGas

Locally produced biogas is one of the best fuels to use from a climate perspective. In 2016 our facility is expected to deliver biogas equivalent of 1000 GWh of energy.

GOTHENBURG BIOMASS Gasification Project, *GoBiGas*, is the name of *Göteborg Energi*'s large investment in biogas production by gasification of biofuels and waste from forestry. In 2016 our facility is expected to deliver biogas equivalent of 1000 GWh of energy. That represents about 30 % of the current consumption in Gothenburg or fuel for 75 000 cars.

THE GOBIGAS PLANTS will produce biomethane (Bio-SNG) from forest residues such as branches, roots and treetops. The biomass is converted to a flammable gas by thermal gasification in the gasification plant. This so-called synthesis gas is then converted to biogas with a quality comparable to natural gas. The biogas will then be injected into the natural gas grid. Since biogas is produced from renewable sources this does not contribute to increasing emissions of CO2 as fossil fuels do. In the choice of technology and plant design the project aims to get as high efficiency as possible. The goal is to convert 65 % of the biomass into biogas, and to reach an overall energy efficiency of 90 %.

THE LOCATION HAS BEEN chosen so that the plant will be close to a gas, electricity and district heating hub. The location is situated near the existing natural gas fueled combined heat and power plant and will have acces to the Göta Älv river. The location allows for a long-term and flexible fuel reception because it has the potential for both ship and rail transport. Additionally, cooling water for the process can be taken from the river.

Building a sustainable city

In Gothenburg we have constructed some of the most energy efficient residential buildings i Sweden. We have also successfully started to convert our old building stock into low energy buildings.

MUCH IS BEING DONE to lower the climate impact from the production of heat and electricity. But the best way of making sure to avoid harmful consequences from energy use is to not use it in the first place. Therefore we are hard at work to reduce the energy use in our current building stock and to make sure that all future buildings apply the latest energy saving technologies.

In the coming years more than half of the residential buildings in Sweden will need to be renovated. Many of these were built in the years before the energy crisis of the early seventies and were constructed at a time when energy was readily and cheaply available, reducing the incentives to construct energy efficient buildings. This means that there is both an opportunity and a large potential to reduce energy use in the near future. Through our publicly owned housing company group Framtiden we have already started to take advantage of this.

Cutting energy use

One example of this is the *Solar Housing Renovation Project* in Gårdsten, an award winning transformation of a residential area dating from the early 1970s. By applying a range of energy saving technologies and installing solar energy collectors the buildings external energy use was reduced by 45 %. The renovation project, which mobilized and included the tenants in the planning process, also cut living costs, introduced modern recycling technology and greatly improved the areas aesthetic and social appeal. For these efforts the project has recieved many awards, among them the World Habitat Award.

New and stricter rules

Due to Gothenburg's industrial history and recent transformations, we have an opportunity to redevelop central areas of the city to new residential and commercial areas. To make sure that this and other new development is done in a sustainable way, we have adopted a new program for environmentally sound construction of residential buildings. Anyone who wants to build on land owned by the municipality, which is a large part of the available land, must follow these stricter guidelines. The goal of the program is to make sure that newly constructed buildings are built according to the best practice in the industry. Buildings should have as little environmental impact as possible during construction and throughout their life cycle.

The area where the ambition level has increased the most is energy use. According to the program, new residential buildings may not have an annual use of more than 60 kilowatt-hours per square meter (kWh/m2) for heating, hot water and building electricity. This is a lot lower than the national regulation limit of 110 kWh/m2.

60 kWh/m²

THE MAXIUM ANNUAL ENERGY USE PERMITTED FOR NEW BUILDINGS IN THE CITY.

Another example of how we are tackling energy use in buildings is the efforts made by our housing companies and our energy company to give residents in Gothenburg more direct control of their energy use and expenses. By installing measuring equipment that allows for more accurate and direct information feedback on heat, electricity, and hot water usage, residents will be able to see how their behaviour affect their energy use and costs and adjust it accordingly.

Passive Housing

Passive housing is a type of low energy housing that requires little external energy for space heating or cooling. The Gothenburg region has played an pioneering role in the development of passive housing in Sweden. Lindås, to the south of Gothenburg, is the location of the first passive houses in Sweden. And the City of Gothenburg is both the home of and the developer of the first large residential passively heated building in the country.

Gothenburgs recent transformations have opened up old shipyard areas for construction of new buildings. We are using this opportunity to construct energy efficient buildings in central areas of the city. But we are not forgetting the older areas of Gothenburg and the large existing building stock. Pioneering work is being done to transform these into low energy dwellings.

Hamnhuset is a great example of our ambition to build the most energy efficient and sustainable buildings possible. It's located beside the slightly curving quay, right in the heart of Sannegårdshamnen. The block is centrally located both in the area and in Gothenburg and is within walking distance of a shopping centre, schools, restaurants and public transport.

Hamnhuset

A low energy residential building that proves that energy efficient constructions can be more profitable than conventional ones.

HAMNHUSET IS A PROJECT that could very well be the way forward in terms of innovative housing construction. When Hamnhuset, with its 115 apartments, was completed in 2008 it became the first large residential passively heated building in the country. It's heated almost exclusively using surplus heat from electric equipment, the residents' own bodies and the sun. The result is an energy saving of at least 50 % compared with a conventional building without sacrificing the standards and comfort which are expected in a newly constructed building.

Hamnhuset was developed by *Älvstranden Utveckling*, our city owned housing company responsible for urban development in large parts of central Gothenburg. Hamnhuset is the third project in succession in their development programme for energy-efficient housing. They have now taken this programme a step further by building what is known as passive housing.

SINCE HAMNHUSET IS HIGHLY insulated, has a minimum of cold bridges and efficiently recovers heat from the ventilation air, it's largely self-sufficient in heating terms. Solar heating through the windows and surplus heat from people, pets and electrical appliances, etc., is enough to maintain a comfortable temperature indoors. This, combined with the fact that the housing company only buy ecolabelled electricity, means that Hamnhuset produces 75 % lower CO_2 emissions than a conventional newly built apartment building in Sweden.

THE FIRST AND LARGEST RESIDENTIAL PASSIVELY HEATED BUILDING IN SWEDEN.

ONE OF THE MAIN elements that steared the planning of Hamnhuset was the results of the numerous life cycle cost (LCC) calculations. The aim of these calculations was to reduce energy use without increasing operating costs, and hence rents for tenants. This required additional investment, the interest costs for which are paid by reduced operating costs. The analysis also showed that, although passive housing uses more materials than conventional housing, the increased CO_2 emissions produced during manufacturing are "repaid" in less than three years.

EXPERIENCES from the planning and construction of Hamnhuset show that it does not take groundbreaking innovations to build housing that is highly energy-efficient and looks to the future. *Älvstranden Utveckling* used proven technology and combined it in a more optimised way than before. This has not imposed any extra demands on the tenants, but by living at Hamnhuset they are helping to develop the energy-efficient housing of the future.

The building on Katjas gata 119 stands out, both due to its bright orange color and due to its low energy use. It uses about a third of the energy compared to a similar building of the same era and half of a conventional Swedish residential building.

Katjas gata 119

A great example of how we are taking on the challenge to lower the energy use of our existing building stock.

ON KATJAS GATA 119 in the heart of Gothenburg's largest coherent million programme area, surrounded by grey 40 year old structures, lies a bright orange building that looks like it was built yesterday. In fact it's just as old as the surrounding buildings, but after a recent renovation the buildings energy use is just a third of what it used to be. This is the result of a pilot project run by *Poseidon*, one of our city owned housing companies.

When applying energy saving technologies in construction of a building you face a number of technological and economical challenges. Applying them to an existing building is further complicated by the fact that you have to take into account the building's conditions. The project offers an opportunity to investigate how to overcome these challenges. Furthermore it will provide feedback from tenants on how such a large energy renovation project affects them. Experts from *Chalmers University of Technology*, *Lund Institute of Technology* and *SP Technical Research Institute of Sweden* have participated in the development of the project. The engineering designs have been developed in close cooperation between consultants and contractors, where everyone contributed with their knowledge and experience. Life cycle cost calculations played a big part in the design.

66%

LOWER ENERGY USE AFTER RENOVATION.

The insulation of the crawl space, roof and exterior walls was upgraded and all the windows were exchanged for energy efficient windows with insulated glazing. The building is very airtight, so to ensure the quality of the indoor climate a new heat recovery ventilation system was installed. The new system uses the indoor air to heat the incoming air to minimize energy loss. Together these measures have reduced the heating need to the extent that the building only need heating during the coldest months of the year. This will then be provided by the district heating system using water radiators. The total effect of this is a reduction in energy use from 178 kWh/m2 to about 60 kWh/m^2.

THE BUILDING'S ENERGY USE will be measured continuously and web based software makes it possible to check the current energy use at any time. In the follow up measurements an identical, but not yet renovated, building will be used as reference. To further help the residents to lower their energy use *Poseidon* is installing energy measurement equipment in every apartment. Tenants will get accurate usage information and only pay for the hot water and electricity they use.

Moving forward, thinking ahead

Through city planning and investments in public transport we are creating a sustainable transport system for the future. Other efforts, such as bicycle initiatives, green vehicles and rail shuttle systems, reduces our climate impact today.

We are working on several ways to reduce the climate impact of the city's transportation system. Gothenburg suffers from some traits of urban sprawl in that it has a relatively low population density and many single use areas with high car dependence. The use of public transport is rising but is still lower than in many other north European cities of similar size. This is a problem, but it also means that there is still a big potential for improvement.

An important tool in this process is the comprehensive plan for Gothenburg, which is a planning document that takes an overview over the whole city and its development. The latest plan states that the main areas for development of new housing within the city should be done at major hubs for public transport. It also states that residential, commercial, institutional and industrial functions should be mixed in the city areas. If the places where people live, work, shop, and recreate are closer together, more needs can be met locally. Through other policy work and planning the city is also limiting parking spaces in areas with good access to public transport.

To increase the share of regional and local trips made by public transport, we have developed long-term strategies for public transport in the Gothenburg region. The strategies, named K2020, aim to link and develop major transport nodes, prioritise public transport to achieve shorter journey times, integrate public transport better with city development and to overall increase quality. Since cooperation between regional authorities is key to successfully carrying out these strategies, they were developed in collaboration with the Gothenburg *Region's Association of Local Authorities* (GR), local public transportation authorities and the national road and railway administrations. The aim is to both increase the share and to have 1 million public transport trips per day by 2025 (Up from 450 000 public transport trips per day in 2005).

90%

OF THE MUNICIPALITY'S VEHICLE FLEET ARE GREEN VEHICLES.

Cycling and walking

We are working on several projects meant to encourage the citizens and visitors of Gothenburg to cycle and walk more. By upgrading and enlarging our network of cycle lanes and paths we allow for speedier, safer and more comfortable travel for the cyclists of Gothenburg. We are also establishing more bicycle parking and bicycle loan schemes. Creating more car free pedestrian zones in the commercial areas of central Gothenburg will encourage more people to walk, cycle and use public transportation.

Every year during the European Mobility Week about 100,000 employees are encouraged to leave their car at home. Companies and organizations compete against each other to have the highest number of participants and the results are published on the project website. The initiative have significantly reduced emissions from car transports during the annual campaign week, and hopefully it will have lasting effects as more people discover alternatives to driving to and from work.

Green vehicles

When cars are used, it's important that the vehicles are energy efficient and use the most sustainable fuels available. More than 90 % of the vehicles in our own fleet are green vehicles (with low CO2 emissions). Many of them are methane gas fueled cars that utilize our biogas production facilities. By 2020, all bus traffic will use biogas, preferably in hybrids. The City trams are all powered by electricity from sustainable energy sources. We are also involved in strategic work to support the use of electric vehicles and plug in hybrids.

Sustainable transport solutions comes in many shapes and forms. In Gothenburg, our work with rail shuttles, gas vehicles, commuter trains and bicycle lanes all contribute to a less CO_2 intensive transportation system.

Rail shuttles

The *Port of Gothenburg* has an ideal position, with only 1½ hours from open sea to quay. 70 % of Nordic industry and population can be found within a radius of six hours. Two thirds of the container traffic in Sweden is handled by the Port. It's the only Nordic port with trans-oceanic direct calls from the Far East, Central America and North America.

The port

The port, which is owned by the city, is investing heavily in expanding rail traffic to and from the port. In 2000, 22% of the shipping containers went by train. By 2009, this share had risen to about 50 %. In 2009, 50 000 tonnes of CO2 were saved by transporting goods to and from the *Port of Gothenburg* by rail instead of by road. This is equivalent to the annual emissions from 14 000 passenger cars. Together with rail operators, industrial companies, forwarding agents, shipping lines and the *National Rail Administration*, the port has built up a system of rail shuttles. The fist shuttle began operating in 1999. The number has now risen to 27, with daily departures to 25 towns in Sweden and Norway. Rail shuttles make it possible to establish a direct route between towns throughout Sweden and the largest port in the Nordic region. Instead of companies themselves moving their freight to the port, it is driven to the nearest inland terminal before being loaded onto a train bound for Gothenburg.

BY SIGNING THE COVENANT OF MAYORS we have committed ourselves to go beyond the objectives of EU energy policy. In this booklet we present examples of our work to reduce our climate impact and increase energy efficiency in Gothenburg.

IN ADDITION TO THIS BOOKLET, we have also taken the opportunity to present three Benchmarks of Excellence on the Covenant of Mayors website:

- From Waste to Wheels – Biogas for transport in Gothenburg
- How to supply a city with recycled heat
- The Challenge – get to work without your car!

MORE INFORMATION and the presentations of our Benchmarks of Excellence can be found on the Covenant of Mayors website: www.eumayors.eu

Links

THE CITY OF GOTHENBURG: www.goteborg.se/english/
GÖTEBORG ENERGI: www.goteborgenergi.se
FRAMTIDEN HOUSING GROUP: www.framtiden.se/en
POSEIDON HOUSING COMPANY: www.poseidon.goteborg.se/en
ÄLVSTRANDEN UTVECKLING, URBAN DEVELOPER: www.alvstranden.com/english
THE PORT OF GOTHENBURG: www.gotport.se
PUBLIC TRANSPORT DEVELOPMENT PROGRAM FOR THE GÖTEBORG REGION: www.k2020.se
GRYAAB, SEWAGE WORKS: www.gryaab.se
RENOVA: www.renova.se

City of Gothenburg

Covenant of Mayors
Committed to local sustainable energy