Helsinki

# The Carbon-neutral Helsinki 2035 Action Plan

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# The Carbon-neutral Helsinki 2035 Action Plan

# Contents

# Summary

Helsinki is committed to doing its part in mitigating climate change. The objective of the Helsinki City Strategy 2017–2021 is to make Helsinki carbon-neutral by 2035. This goal will be achieved by reducing the greenhouse gas emissions in Helsinki by 80 per cent. The remaining 20 per cent will be compensated for by Helsinki taking care of implementing emissions reductions outside the city. The most significant sources of greenhouse gas emissions in Helsinki are the heating of buildings, electricity consumption and traffic. The climate goals not only affect the City organisation, but also the residents and the organisations operating in Helsinki. Helsinki can become carbon-neutral through cooperation. The Carbon-neutral Helsinki 2035 Action Plan has been approved by the City Board. The Action Plan outlines how the emissions reductions may be achieved in practice.

Information on the state of the greenhouse gas emissions in Helsinki is based on the calculations of Helsinki Region Environmental Services (HSY). The total emissions in Helsinki have decreased by a quarter since 1990. Even though Helsinki's emissions are on the decrease in the long term, emissions still need to be reduced more substantially and more rapidly in the future. The City of Helsinki is constantly growing, with approximately 8,000 new residents every year. The emissions of an average Helsinki resident are approximately 40 per cent lower than the emissions in 1990 even though the population has grown by 150,000 since then.

The surveys conducted in connection with the Action Plan, carried out by Gaia Consulting Ltd and WSP Finland Ltd, provided additional proof that Helsinki could indeed become carbon-neutral by 2035. However, achieving the objective requires significant investments in the energy-efficiency of buildings, renewable energy, low-emission transport and emission-free energy production. The City of Helsinki is directly responsible for some of the emissions reduction actions, but most of the actions require con-

tributions from Helsinki's residents, businesses and other organisation. To achieve its goal, Helsinki also needs support from the government, as well as ambitious national climate policy.

## Creation of the Action Plan

A work group appointed by the Head of the City Executive Office has been responsible for devising the Carbon-neutral Helsinki 2035 Action Plan. The work group included members from Helen Ltd, HSL and HSY collective authorities and the Smart & Clean Foundation, in addition to the Divisions of the City of Helsinki. The presentation of the work group was completed 28 February 2018. The Carbon-neutral Helsinki 2035 Action Plan was devised openly, with all documents available for reading and commenting by anyone interested on the www.stadinilmasto.fi website. The Plan includes suggestions for emissions reduction actions compiled from nine workshops. The suggestions were edited into their final forms by the steering group and City experts. A total of 147 actions were recorded in the Plan. There are 30 actions for traffic and transport and 57 actions for construction. There are 60 additional actions, which are related to consumption, procurements, sharing and circular economy, reduction of residents' carbon footprint and the advancement of Smart & Clean business.

Gaia Consulting Ltd and WSP Finland Ltd conducted preliminary estimates of the emissions reduction impact and costs of the actions related to traffic and construction. The complexity and costs of the additional actions have been roughly estimated by the experts of the City. As the implementation of the Action Plan progresses, the costs and other effects will be specified. The implementation of the Action Plan may affect business, tourism, the appeal of the City or the health of the residents, to name just a few examples.

The Action Plan presents the current climate actions of Helsinki, as well as the forecasts for 2030 and 2035. The actions required to achieve the emissions reduction goal are defined for different sectors. The Plan includes a description of the current state, the objectives and the key emissions reduction actions for each sector. The sectors are the following:

- **traffic**
- **construction and use of buildings**
- **consumption, procurements, sharing economy and circular economy**
- **Smart & Clean growth**
- **Helen Ltd's development programme**
- **carbon sinks and compensation for emissions**
- **communications and engagement**
- **coordination, monitoring and assessment of climate work.**

## Calculation of the required emissions reductions

In addition to the objective of becoming carbon-neutral, the City Strategy 2017–2021 also includes an intermediate goal: the greenhouse gas emissions will be reduced by 60 per cent during 1990–2030. To estimate the required emissions reductions for Helsinki, scenarios for the development of emissions until 2035 were devised. The Business as usual (BAU) scenario presents an estimate of how the emissions in Helsinki will progress if the development of the last years continues and the decisions already agreed upon are adhered to. The BAU scenario includes actions already decided upon, such as stopping the use of coal in the Hanasaari power plant area. If the BAU scenario is realised, emissions in Helsinki would be reduced by approximately 52 per cent by 2035, compared to the emission levels of 1990. This is not sufficient for reaching carbon-neutrality (which would require a reduction of 80 %): additional actions are needed.

Helsinki's greenhouse gas emissions in the year of comparison, 1990, amounted to approximately 3.5 million tonnes of carbon dioxide equivalents (Mt $CO_2e$.). The objective of carbon-neutrality, the reduction of emissions by 80 per cent, requires that the annual emissions amount to no more than approximately 700 kt $CO_2e$ in 2035. Emissions were reduced by 940 kt $CO_2e$ by 2015, which means that an additional 1,870 kt $CO_2e$ of reductions are required. It is estimated that about half of these reductions will be realised through the actions already decided upon by Helen, HSL and the state and through the decrease in the demand for heating, while the other half will be realised through the Action Plan. The remaining emissions (700 kt $CO_2e$) will need to be compensated for (figures 7 and 8). In the calculations, the data from 2015 presents the current status.

The majority of Helsinki's emissions are generated by the energy consumption of buildings and traffic. These sectors have been assigned their respective emissions reduction goals. The emissions from buildings and traffic are significantly affected by how the energy used is produced, which is why the volume of emissions centralised energy production (electricity and district heating) will produce in 2030 and 2035 needed to be estimated. The emissions impact is presented with an emission factor: how many carbon dioxide equivalents are produced in the production of one energy unit (for example, 120 g $CO_2e$/kWh). The emission goals are based on scenarios created earlier, presented in the publication "Report on Helsinki's new climate goals" (City of Helsinki, 2017a).

Helen Ltd has its own development programme for reducing the emissions from the energy production facilities it owns. When the development programme and the decisions of the government are implemented, in practice, by replacing coal with emission-free energy sources, the emission factor of the district heating produced in Helsinki will decrease from the current level of 190 g/kWh to 49 g/kWh. For the emissions of electricity production, the emission factor derived from the national energy and climate strategy (Ministry of Economic Affairs and Employment of Finland 2017), in which case the national emissions from consumption electricity will decrease from 121 g $CO_2$/kWh (2015) to 45 g/kWh (2035) and the emissions from heating electricity will decrease from 234 g/kWh (2015) to 88 g/kWh (2035).

## Emission reductions of traffic

The volume of greenhouse gas emissions from traffic in Helsinki amounted to approximately 600 kilotonnes ($CO_2e$) in 2015. The volume has decreased in the last few years: in 2015, the emissions were 15 per cent lower than in 2005. To reach the goal of becoming carbon-neutral, the traffic emissions were set a separate goal: the objective is to reduce greenhouse gas emissions by 69 per cent from the level of 2005 by 2035 (this would mean a reduction of 60 per cent from the level of 2015: 363 kt $CO_2e$). The goal set by the Finnish Government is to reduce traffic emissions by 50 per cent from 2005 to 2030 at a national level. Considering this goal, Helsinki is reducing traffic emissions more rapidly than required by the national goal. As a city that is constantly growing denser and that has good public transport connections, Helsinki has good conditions for reducing emissions. There is also a denser number of electric cars in Helsinki than in the rest of Finland.

According to the report created for the Action Plan, the 69-per-cent reduction in traffic emissions can be reached by 2035. However, this will require a significant number of actions that the City needs to take both by itself and in cooperation with others. The emissions reduction goals for traffic can be achieved if all reduction actions identified in this Acton Plan are implemented. In addition to this, the vehicle technology needs to

develop at the predicted speed, at the minimum. The most effective methods for reducing the emissions from traffic are the pricing of vehicle traffic, the minimisation of the specific emissions of heavy traffic and the significant growth of the electric car stock. When reducing traffic emissions, the reduction of emissions caused by cars is the most effective method, which can be achieved by reducing transport by car and decreasing the emissions per unit of cars.

The traffic-related actions analysed have many economic effects. It is easiest to estimate the direct costs for the City organisation caused by the implementation of the actions. Some measures, such as the pricing of traffic and the increases in parking fees, will also generate income for the City organisation, in addition to costs. Many plans and programmes related to traffic define the required costs and their distribution amongst various actors. Some traffic-related emissions reduction actions can be implemented as a part of the current operations of the City organisation (such as land use planning and traffic policy) through the programmes that have been already been created. At this point, the precise costs of reducing traffic emissions to the target level and the distribution of the costs between various actors cannot be defined. In addition to the direct cost effects, the implementation of the actions will also have indirect effects on Helsinki residents. These effects include the health benefits gained from the decrease in local traffic emissions and the increase in bicycling and walking. Developing the assessment tools for impacts further is a necessary step if we are to be able to assess the different impacts of the actions in a more diverse and precise manner.

## Emission reductions of construction and use of buildings

In addition to traffic, construction and use of buildings are another sector causing significant emissions, since the majority of Helsinki residents' emissions come from the heating of buildings and electricity consumption. The emissions reduction goal for the energy use of buildings is 82 per cent during 1990–2035. The goal can be feasibly reached, but it will require a rapid and large-scale start for the actions (Table 2 and Figure 8). The actions compiled in the Action Plan create a path that supports the achievement of the goals. It is important to monitor the progress of the actions regularly to be able to ensure the achievement of the goals.

To reach the emissions reductions in Helsinki, action is required both for the existing buildings and the new building stock to be built. In the report by Gaia Consulting, it is stated that the base level of repair construc-

# The emissions reduction potential of buildings is over 80 % (1990–2035).

tion should be sufficient for maintaining the total energy consumption of buildings at the current level. The improvement of the buildings' energy efficiency through repair construction would be sufficient to compensate for the additional construction required by population growth. However, the energy efficiency of buildings can be improved significantly more through repair constructions that are more effective than the base level. The technical and economic savings potential of the more effective actions would be as high as 2,300 GWh by 2035, compared to the current level of consumption, when both heating and electricity consumption are taken into account. The savings would amount to around 20 per cent of the electricity and heating consumption in the Helsinki area in 2015. The total emissions reduction potential of buildings is approximately 576 kt $CO_2e$ (Figure 8). The majority of the potential comes from the heating consumption becoming more efficient. The renewable small-scale production of heat and electricity also has remarkable potential.

To realise the emissions reductions of construction and use of buildings, the Action Plan needs to be implemented and this sector also needs to adhere to the Finnish energy and climate strategy while Helen implements its own development programme. When all of the above are achieved, the emission factors of the electricity and district heating used by buildings will be significantly reduced.

According to the report by Gaia Consulting,

a considerable number of the actions that reduce the emissions in the construction sector will be financially profitable for owners of the buildings in the long term. The energy efficiency actions and the increase in renewable production are largely profitable, even with the current prices. The profitability of small-scale production is affected by how much of the production may be used locally in the properties.

## Emission reductions in City procurements

The City of Helsinki has many opportunities to reduce emissions in its procurements of construction materials, food services and ICT equipment. Through sustainable procurements, the energy and material consumption and negative environmental impact can be reduced in Helsinki during the entire lifecycle of the product, service or building. Additionally, we can create incentives for the creation and adoption of cleantech solutions. As a high-volume procurer, the City Of Helsinki can influence the development of the markets towards a low-emission direction.

The City should identify the procurements that are significant with regard to emissions and develop emission calculations, lifecycle models and the assessment of climate impacts for these procurements.

Procurements form more than 40 per cent of the City of Helsinki's expenses. The total value of procurements in the entire Helsinki Group is more than two billion euros each year. Construction makes up around half of these procurements. Total economic procurements, where the full lifecycle is taken into account, may increase the costs in the short term. However, in the long term, the procurements can be used to reduce emissions, improve quality and also achieve financial savings.

## Emissions reductions in consumption, sharing economy and circular economy

Helsinki will be considered carbon-neutral Helsinki when the direct emissions in the City area have been reduced by 80 per cent. This goal does not include all emissions created during the lifecycles of products. These emissions include the procurement of raw materials, the manufacturing of the product, the logistics, the use and the waste disposal. The carbon footprint of Helsinki residents also consists of other consumption in addition to the direct emissions created in Helsinki. Other consumption includes food produced outside Helsinki, travel and consumer goods imported to Helsinki, as well as the use of services outside Helsinki. The consumption-based carbon footprint of Helsinki residents is slightly more than twice the amount of direct emissions they produce. Even though the full carbon footprint of the residents cannot yet be included in the emission calculations, we considered it important to include actions that reduce the lifecycle emissions of consumption in this Action Plan. These actions include reducing the carbon footprint of food, as well as promoting the sharing economy and circular economy.

## Emission reductions in energy production

The Carbon-neutral Helsinki 2035 Action Plan, the development programme of Helen and the continuation of the latter will enable the City to reach its emission goals. The Action Plan deals with the improvement of energy efficiency and use of renewable energy at the consumer end, which is why the actions of Helen regarding power plants are not included in the Action Plan, and the steering potential of emissions trading is not considered in the Plan, either. Nevertheless, the actions of Helen at the consumer end are included in the Plan as Helen is one of the actors implementing energy efficiency

solutions, among other things.

Centralised energy production belonging in the emissions trading sector has achieved and will continue to achieve significant emissions reductions. In the emissions trading within the EU, the total amount of greenhouse gas emissions from production plants has been restricted through a shared emissions cap that is lowered annually. Even if Helen reduces the emissions of energy production more rapidly than the goal set for power plants dictates, the amount of emissions within the EU may not be reduced, as another actor may use the additional emissions reductions in their own operations. Because of this, the City or the state should cancel a corresponding amount of emission rights from the market so that the climate can benefit from the local actions taken in Helsinki.

The energy production in Finland is already 80 per cent greenhouse gas-free, and, according to the calculation, the emission factor of district heating will decrease by as much as 74 per cent by 2035 (year of comparison: 2015) through the actions of Helen and the national government. The emissions reduction goal of 40 per cent by 2025 presented in Helen's development programme is well in line with the emissions reduction goal of 60 per cent set by the City for 2030. Helsinki's emissions reduction goal of 80 per cent for 2035 and the government's energy and climate strategy mean that Helen will decide on the continuation of the development programme once all substitutive investments in Hanasaari or an investment decision on them have been made.

Helen has decided that its current development programme will last until 2024, and the programme presents the substitution of the district heating produced by the Hanasaari coal plant with other energy sources. It was decided that the substitutive production would be made in a decentralised manner, and it is included in this programme in the form of taking the plot and facility reservations for Helen's operations into account, as substituting coal with biomass and other emission-free, decentralised forms of energy production requires more space.

Helen Ltd is preparing further policies for its development programme, and its goal is to stop using coal entirely in the 2030s. The Finnish government has proposed that the use of coal for energy production end by 2029, which would mean that the fuel used at the Salmisaari cogeneration plant would need to be changed in an accelerated manner and at greater cost.

## Carbon sinks and compensation

Carbon-neutral Helsinki 2035 means that the usage-based greenhouse gas emissions created in the Helsinki area will be reduced by 80 per cent, at the minimum, from the 1990 level. The potential remaining emissions (up to 20 per cent) will be compensated for by Helsinki taking care of reaching emissions reductions outside the city. This will facilitate carbon-neutrality, meaning that the net emissions in 2035 will be at zero. Primarily, emission compensation should however, only be a temporary solution to reach a calculated emission-free state more rapidly without the operations being fully emission-free.

In the next few years, the City needs to examine the potential presented by emission compensation in more detail. Even if the carbon storage in the tree stand, vegetation and soil in the City area and the changes therein are not taken into account in the emission calculations for Helsinki, the urban nature plays its part in binding carbon dioxide from the atmosphere. Growing the carbon storage and carbon sinks from their current state may also present the City with an opportunity for emission compensation. This requires us to examine the carbon sink potential of the entire Helsinki Group and to

constantly monitor the carbon storage and carbon sinks in Helsinki.

## The effectiveness of the key action entities

As for the emissions reduction potential of the key action entities defined for traffic, construction and use of buildings, an extensive range of means is required to achieve the emissions reductions. Even in the calculations alone, only a few action entities have an impact of more than 5 per cent on the total target emissions reduction. The actions that impact the whole the most (which are calculated to make up more than 5 percent of the total emissions reduction) are reducing the total heating consumption, increasing the proportion of locally produced heating and electricity and increasing the proportion of electric cars. In the calculations, it is estimated that Helen's development programme will achieve approximately 32 per cent of the emissions reductions by 2035, while the actions of the Port of Helsinki will contribute approximately 2 per cent of the reductions. In several identified action entities, development work is required for the impact assessment.

## Monitoring, reporting and interaction

To achieve a carbon-neutrality, Helsinki will require cooperation between residents, businesses, research centres and the City organisation. The Action Plan cannot succeed without skilled communication and engaging interaction. This is why special focus needs to be directed at communication and the engagement of interest group when implementing the Action Plan. A communication and interaction plan will be drawn up for the Action Plan jointly with interest groups. It is important that interaction and open participation with the actors that are responsible for the emissions reduction actions – Helsinki residents, businesses, universities and research centres – be increased in the implementation and further development phases of the Action Plan. Interaction with political decision-makers is also required.

For the Action Plan to succeed, it needs to be actively and continuously monitored, and reactions to potential problems or new solutions need to be rapid. The actions will be developed based on new information and the feedback and ideas from residents.

The City requires a group for managing and being in charge of the implementation of environmental and climate-related matters. The group will also need to report to the executive group of the City on the realisation of the work on emissions reductions. In climate work, the tasks would be the same as those of the previous climate work group. The management team for climate and environmental matters of Environmental Services would continue to perform secretarial duties.

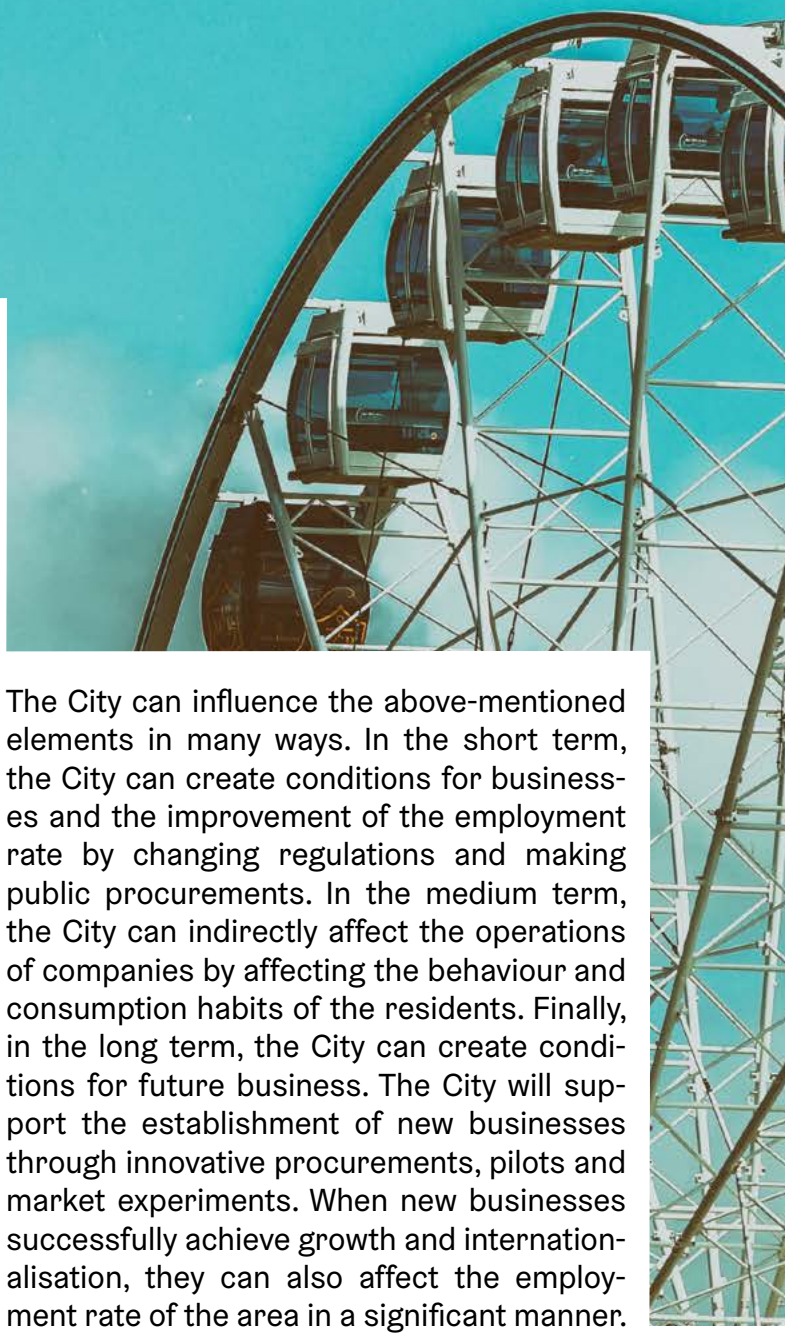
The most important channel for monitoring the Action Plan is the current environmental reporting system. The City Council will be provided with an annual overview of the progress of the Action Plan in connection with the environmental reporting: how the emissions in Helsinki are developing and how well the actions have been implemented.

The constant monitoring and assessing of the Action Plan will use the open policy practice and the related tools and principles. The premise is to keep the process open from preparation to decision-making. With this approach, residents, the City organisation, experts and interest groups are constantly encouraged to participate in discussions and provide feedback. An openly available monitoring tool will be developed for the monitoring of the actions and the assessment of larger-scale impacts.

## Assessment of the impact on business

The Technical Research Centre of Finland, VTT, has been commissioned by the City of Helsin-

**The emission factor of district heating will decrease by 74 % (2015–2035).**



ki to assess the impacts the Action Plan has on business. The assessment is based on the evaluations carried out by VTT's experts, statements from the interest groups and interviews with companies. The assessment team received 25 statements and held 33 interviews. All actors who participated in the assessment of the Action Plan see significant business impact potential in the Plan. At the same time, the statements of the interest groups, in particular, point out factors that may decelerate growth. The company representatives who participated in the interviews are mainly positive about the Action Plan and see significantly more opportunities than threats in the Plan. They hope the City makes bold investments in the implementation of the Plan. Based on the assessment of the impact on business, as well as the statements received, 12 actions in the Plan were modified and 4 new actions were added.

The significance of the impact on business depends on the implementation, target level and realisation of the goals of the Plan. The City can influence the above-mentioned elements in many ways. In the short term, the City can create conditions for businesses and the improvement of the employment rate by changing regulations and making public procurements. In the medium term, the City can indirectly affect the operations of companies by affecting the behaviour and consumption habits of the residents. Finally, in the long term, the City can create conditions for future business. The City will support the establishment of new businesses through innovative procurements, pilots and market experiments. When new businesses successfully achieve growth and internationalisation, they can also affect the employment rate of the area in a significant manner.

# 1 Introduction

The Carbon-neutral Helsinki 2035 Action Plan presents the actions required to achieve Helsinki's climate objectives. The Helsinki City Board approved the Action Plan on 10.12. 2018. Helsinki's newest climate objectives are presented in the City Strategy 2017–2021. According to the Strategy, Helsinki will be carbon-neutral by 2035. This goal will be achieved by reducing the greenhouse gas emissions in Helsinki by 80 per cent. The remaining 20 per cent will be compensated for by Helsinki taking care of implementing emissions reductions outside the city. The City Strategy also includes an intermediate goal for 2030: greenhouse gas emissions will be reduced by 60 per cent during 1990–2030.

Helsinki's climate objective encompasses the emissions created in the City area regardless of the actor causing the emissions. The progress of the climate objective and the emission development of Helsinki are monitored by calculating how much of the emissions are caused by the heating of buildings, electricity consumption, transportation and waste management. The emission calculations do not include the full lifecycle emissions of products and services (such as the emissions from the construction and use of buildings over several decades – this also applies to the production and waste management of construction materials) unless the emissions are created within the City borders. The emission calculations include the emissions of the Helen's centralised energy production through the consumption of district heating. Actual actions related to power plants are not included in this Action Plan; instead, they are included in the development programme of Helen. However, Helen's emissions reduction actions that reduce the residents' energy consumption, for example with the help of new services, are included in the Action Plan. The actions related to adapting to climate change are not presented in this Plan.

We can make Helsinki carbon-neutral through cooperation. The City of Helsinki is responsible for some of the actions, but

most of the actions depend on the choices of the Helsinki residents, businesses and other organisations. The City organisation can influence these choices through enabling, encouraging and using various steering measures. To achieve its objective, Helsinki needs the Finnish government to make consistent decisions that reduce emissions. For example, reducing traffic emissions in Helsinki by 69 per cent from 2005 to 2035 requires that the national objective of reducing emissions by 50 per cent is realised by 2030. Similarly, stopping the use of coal and making energy re-fittings to the existing building stock require action both from the state and the residents of Helsinki. The City of Helsinki heavily supports the national emissions reduction objectives with objectives of its own. The City organisation must cooperate closely with various actors, such as the six largest cities in Finland, the cities in the Helsinki metropolitan area, the municipalities in the Helsinki region and the residents. The businesses and residents see the Helsinki metropolitan area as an entity. The climate objectives of the cities in the area are consistent with each other, and it is beneficial in terms of the cities' cooperating to achieve the objectives.

The Carbon-neutral Helsinki 2035 Action Plan focuses on the emissions created within the City borders and the emissions reduction actions that the City organisation is able to promote with its steering measures and ownership. The Action Plan also presents actions the City uses to foster the creation of new services and solutions for the residents and businesses to reduce their emissions. This will also create smart and clean growth and business. The abbreviations and terms used in the Action Plan are listed in Appendix 1.

## 1.1 Structure of the Action Plan

The Carbon-neutral Helsinki 2035 Action Plan, the development programme of Helen and the continuation of the latter will allow the City to reach its emissions reduction goals (Figure 1). Helen Ltd's development programme includes actions in centralised energy production, while the Carbon-neutral Helsinki 2035 Action Plan includes actions in areas other than centralised energy production.

The Carbon-neutral Helsinki 2035 Action Plan includes all strategic actions that are key for Helsinki's climate objectives. Each action is assigned an actor in charge and given an estimate of the costs, time span and complexity of the implementation.

A constantly updated online monitoring tool that supports the work in practice will be an integral part of the Action Plan. The monitoring tool will contain both the key actions and additional actions that will be described in details, with impact assessments included (Chapter 9.2). The actors in charge of the actions will see to it that the monitoring tool includes up-to-date information on the progress of the actions. With to the monitoring tool, the actions can be tracked and directed after the Action Plan has been approved.

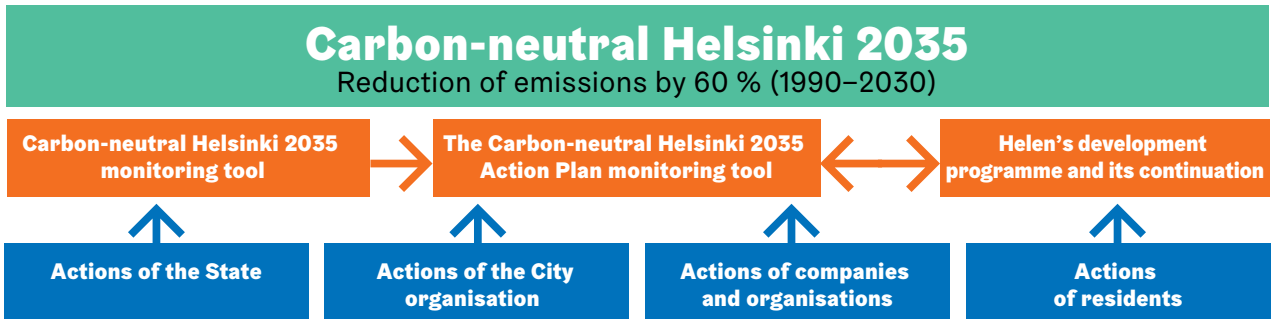



**Figure 1. The structure of the Carbon-neutral Helsinki 2035 Action Plan.**

This will also enable the City to engage its residents according to the principles of Helsinki's engagement and interaction model and open policy practice (Chapter 9.2). The City will aim to engage experts, in particular, to keep the data used in monitoring accurate and up-to-date. The monitoring tool is available at www.stadinilmasto.fi. There is a separate plan for communication and interaction regarding the Action Plan.

## 1.2 Helsinki's climate objectives and the role of the City

**Table 1. Helsinki's climate objectives**

| Decision of the Council | Objective | Target year |
|---|---|---|
| 2002 (no longer applicable) | 0 % (emissions will not increase from 1990) | 1990–2010 |
| 2008 (no longer applicable) | -20 % | 1990–2020 |
| 2013 | -30 % | 1990–2020 |
| 2013 (no longer applicable) | Carbon-neutrality | 2050 |
| 2017 | -60 % | 1990–2030 |
| 2017 | Carbon-neutrality (-80 % from 1990) | 2035 |

Helsinki first set its objectives for greenhouse gas emissions in a sustainable development programme in 2002. Then, the objective was to keep the emissions in 2010 at the same level as in 1990. This objective was reached, and the City Council has since made the climate objectives significantly more ambitious (Table 1).

In 2008, emission objectives were set for Helen. To achieve the objectives, the City Council decided on 2 December 2015 that the Hanasaari B power plant would be closed down by the end of 2024. Helen has produced a development programme to be observed until 2024, and the programme presents the substitution of the district heating produced by the Hanasaari coal plant with other energy sources (see Chapter 5). It was decided that the substitutive production will be implemented in a decentralised manner, which requires significant plot and space solutions of the City.

Helen is preparing policies to continue its development programme. Helen is likely to meet the objectives set for its heating production by 2030, and it is aiming to reduce its greenhouse gas emissions by 40 per cent by 2025. To meet the carbon-neutrality objective for 2035, the use of fossil fuels needs to be reduced in Helen's heating production. Helen Ltd's objective is to stop using coal entirely in the 2030s, at the latest. If the state prohibits the use of coal for energy by 2030 or earlier, the fuel used in the Salmisaari cogeneration plant would need to be changed in an accelerated manner and at greater cost. The state would need to reimburse the costs to the operator.

The City organisation itself only produces under 10 per cent of the emissions within the City borders, which means that a carbon-neutral Helsinki can only be reached with close cooperation between the City organisation and residents. The emissions of the City organisation are produced by the energy consumption of City-owned buildings, the fuel consumption of vehicles and the electricity consumption of outdoor lighting. In addition to reducing its own emissions, the City organisation also has many opportunities to influence the emissions produced by residents as the City is largely involved in residents' everyday lives. The City can promote a carbon-neutral Helsinki with various steering measures. The City can

also enable, encourage and regulate emissions reductions, for example in the following manners:

- **through collaboration with companies**
- **by offering test platforms for new low-emission trials**
- **by steering operations through land use planning and plot assignments**
- **through traffic planning, such as the promotion of bicycling and walking**
- **by directing construction**
- **through communication and interaction**
- **through education**
- **by promoting public transport**
- **by supporting low-emission vehicles**
- **through procurements and investments.**

## 1.3 The premise of the Action Plan and the related preparations

The objective of the Helsinki City Strategy 2017–2021 is to promote modern climate responsibility in Helsinki. According to the Strategy, "Helsinki takes its own responsibility for the prevention of climate change seriously and ambitiously. Helsinki sets the goal of reducing emissions by 60 per cent by 2030, and brings forward its target of carbon-neutrality to 2035 instead of 2050, as earlier. Helsinki is preparing for a possible decision by the State to forbid the use of coal in energy production. Here, Helsinki will need consistent State support to develop solutions to compensate for this. The carbon-neutrality goal is set in a way that corresponds to general practice in Finland."

The strategy also includes the objective that a scheduled Action Plan for implementing emissions reductions be drawn up before the end of February 2018. On 6 November 2017, Head of the City Executive Office Sami Sarvilinna appointed a work group for the emissions reduction programme, tasked with preparing an Action Plan for the implementation of emissions reductions in accordance with the City Strategy 2017–2021. The term of the work group ended on 28 February 2018. The work group convened three times.

The Carbon-neutral Helsinki 2035 Action Plan is based on the report of the climate work group appointed by former Mayor Jussi Pajunen, which included suggestion for Helsinki's new climate objectives for 2030 (Helsinki climate work group 2017a). The report, which was completed in winter 2017, also presented updates to Helsinki's carbon-neutrality objective. In turn, Helen's development programme is responsible for the actions regarding centralised energy production.

The Action Plan has been prepared, based on the objectives in the City Strategy, as openly and transparently as possible and in accordance with Helsinki's engagement and interaction model (Figure 2). Everyone interested in the process has been able to follow the preparation in real time. Since the start of the preparation, it has been possible to present comments and suggestions in workshops and online.

During the preparation, nine workshops were organised, with around 300 expert participants from companies, research centres and organisations. An open-to-all event was organised in Laituri. Invitations to the events were sent openly to various organisations. The event targeted at residents was marketed on social media.

The implementation of the Action Plan should also follow the same principles of open participation and further promote the engagement of Helsinki residents to encourage them to commit to the Action Plan and support its implementation. Many persons both from the City organisation (the abbreviations used are presented in Appendix 1) and interest groups have participated in the creation of the Action Plan.

- **The work group for the emissions reduction programme** acted as a steering group for the project: president Raimo K. Saarinen, secretar-

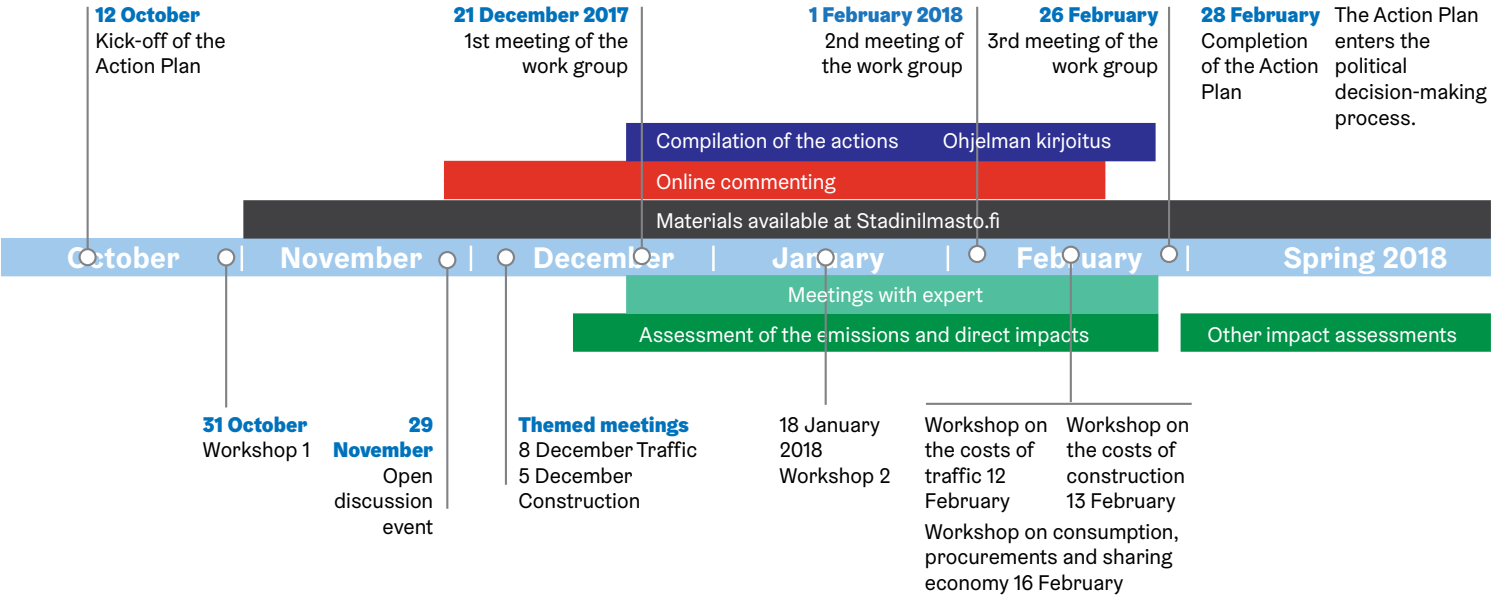
ies Jari Viinanen and Saara Kanto (the names of the members are available in the appendix).

- The preparation group organised the events, workshops and meetings and was responsible for the compilation of the actions, the writing of the Plan and the practical arrangements for consultation: Jari Viinanen, Petteri Huuska, Sonja-Maria Ignatius, Mira Jarkko and Auni Haapala from the climate team of Environmental Services and Saara Kanto from the City Executive Office.
- The text and the descriptions of the actions have been written by various experts
  - **Antti Venho, Suvi Haaparanta, Johanna af Hällström, Markus Lukin, Mia Malin, Auni Haapala** (City of Helsinki/Environmental Services)
  - **Rauno Tolonen** and **Jouni Kivirinne** (Helen Ltd)
  - **Johannes Lounasheimo** (HSY)
  - **Marja Piimies** (City Of Helsinki/Detailed Planning)
  - **Ari Piispanen** (Port of Helsinki Ltd)
  - **Jouni Tuomisto** (The National Institute for Health and Welfare)
  - **Katri Kuusinen** (City Of Helsinki/Built Assets Management)

• **Workshops and events:** at least 300 participants from the City, the Climate Partners companies, interest groups, organisations and from among the residents.

• **Open participation:** The materials on the Stadin Ilmasto (Helsinki Climate) website www.stadinilmasto.fi have been openly available and open for continuous commenting.

**Figure 2. The schedule for the preparation of the Action Plan and the essential events.**




## 1.4 Restrictions of the Action Plan

The most important restriction in the Action Plan is that the development of emissions and the progress of the climate objectives will be monitored only regarding the greenhouse gas emissions in the geographical area of Helsinki. The most significant sources of emissions are the heating of buildings and traffic, including the emissions from the harbours. Electricity is calculated as average national electricity, the emissions from which are calculated based on the estimated electricity consumption of the residents. Additionally, the emissions from machinery, waste management and agriculture are estimated.

The true carbon footprint of a Helsinki resident is twice as large as the amount of emissions produced in the Helsinki area. The true carbon footprint includes the emissions from the products and services consumed

by residents, such as the food, construction materials, product parts, goods, services and travel services produced outside Helsinki. Helsinki's carbon-neutrality objective does not take indirect emissions from consumption into account since there are no suitable tools available for the assessment and monitoring of indirect emissions and since the City of Helsinki is often unable to influence indirect emissions effectively. Furthermore, the calculation of the emissions produced should be agreed on to ensure that emissions are not calculated twice. Because of the above-mentioned reasons, the Carbon-neutral Helsinki 2035 Action Plan primarily focuses on emissions produced inside the borders of Helsinki. However, the Action Plan also includes actions to reduce the emissions from the consumption habits of residents.

The second important restriction is that the actions of centralised energy production (in practice, those of Helen – fuel choices, investments on power plants) are not included in the Plan. Helen will reduce emissions according to the objectives of the City through its own development programme. However, the development programme includes various actions targeted at energy consumers in Helsinki, which will help the City reach its objective of carbon-neutrality. Helen is included in the Action Plan through these actions. Examples of these actions include the demand response of electricity and heating, as well as the energy efficiency and heat loss projects for properties.

The third restriction is that the objectives related to the adaptation to climate change and preparation for risks are not included in the Action Plan. Adaptation is handled in a separate plan.

## Defining carbon-neutrality

Carbon-neutrality means that the greenhouse gas emissions produced in the Helsinki area are equal to or lower than the greenhouse gases sequestered in the Helsinki area in the long term. This is when the emissions and the carbon sinks are in balance; in other words, the net emissions are at zero. It is a general policy in Finland that carbon-neutrality can be reached by reducing 80 per cent of the emissions in the city area and then using compensation, implementing the remaining emissions reductions elsewhere.

## Example

**"What does 'emissions from residents' mean in practice?"**
Typically, carbon dioxide emissions are measured in tonnes, kilotonnes (million kilograms) or megatonnes (billion kilograms). Other emissions produced by humans, the most significant ones being methane ($CH_4$) and nitrous oxide ($N_2O$), are converted into carbon dioxide equivalents (abbreviated $CO_2e$) so that the combined global warming effect of the greenhouse gases can be examined for the time span agreed on (typically 100 years). If a kilotonne of carbon dioxide were frozen into gas ice, its volume would be 640 $m^3$, and it would fill a quarter of a full-sized Olympic swimming pool. You would need 30 lorries to transport it (33 tonnes per lorry). The amount of carbon dioxide produced by the residents of Helsinki in 1990 (3,600 kt $CO_2e$) would take more space than 21 Finnish Parliament Houses (the Parliament House is 108,000 $m^3$) in gas ice form. When released into the atmosphere, the volume of one year's carbon dioxide emissions in gas from is 1,800 million $m^3$ (density of 2 kg/$m^3$). This amount would form a layer just under 10 metres thick that would cover Helsinki in its entirety (214 $km^2$).

# Carbon-neutrality means that the emissions produced in the Helsinki area are equal to or lower than the emissions sequestered in the Helsinki area.

# 2 Helsinki's climate actions in 1990–2017

## 2.1 Development of greenhouse gas emissions

The progress of Helsinki's climate objectives is monitored by following the development of greenhouse gas emissions (Figure 3). HSY calculates the emissions annually and compares them to the emission level in 1990. The emission sectors are district heating, oil heating, electric heating, consumption electricity, traffic, industry and machinery, waste management and agriculture. In 2016, Helsinki's greenhouse gas emissions amounted to approximately 2.7 million tonnes of carbon dioxide equivalents, which equals 4.3 tonnes of carbon dioxide equivalents per capita. The total emissions were 23 per cent lower and emissions per capita were 40 per cent lower than in 1990. Nowadays, a little over 50 per cent of emissions is produced by the heating of buildings, 25 per cent is produced by traffic and approximately 15 per cent is produced by consumption electricity.

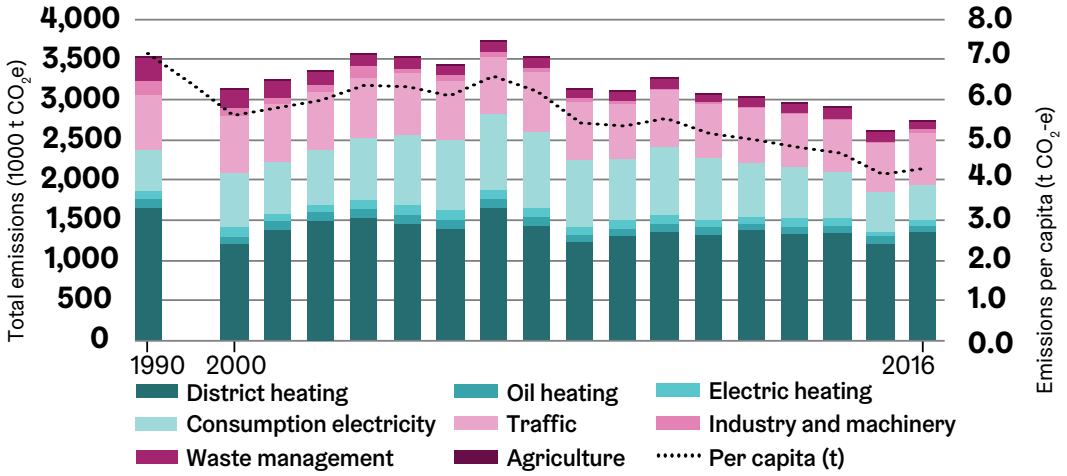



**Figure 3. Development of Helsinki's greenhouse gas emissions by each emission sector in 1990–2016. (HSY 2017)**

## 2.2 Reasons for the decrease in emissions since 1990

Helsinki's emissions in the year of comparison, 2015, were 26 per cent lower than in 1990. The decrease in emissions is caused by the following factors:

**Reference period of 1990–2005**

- the use of natural gas as the main fuel in district heating instead of coal
- the commissioning of the Vuosaari A and B power plants
- improved energy-efficiency as the cogeneration of electricity and heating has increased
- the structural change and improved energy-efficiency in industry
- the recovery and utilisation of gases produced in waste management
- improved energy-efficiency of vehicles in operation.

**Reference period of 2005–2016**

- the emissions in the electricity production in Finland are lower (nuclear power, cogeneration, renewable fuels, purchase of low-emission electricity from other Nordic countries)
- the Katri Vala heat pump plant and the adoption of district cooling
- the continued structural change in industry
- improved energy-efficiency of vehicles in operation and the use of biofuels.

Helsinki's greenhouse gas emissions have clearly decreased from 1990. Nevertheless, the energy consumption (electricity and heating) has increased as the building stock has grown, and the reduction in the specific consumption of buildings was not able to cancel out this development until 2007. Since then, the overall consumption of the building stock has not grown; instead, the energy efficiency of buildings has improved in parallel with the growth of the building stock. Increased tourism has also increased the emissions from the ship traffic in Helsinki compared to 1990.

# 3 Greenhouse gas emission forecasts for Helsinki for 2030 and 2035

The BAU (business as usual) scenario for Helsinki's greenhouse gas emissions for 2030 and 2035 describes the development of climate change mitigation in Helsinki based on the current political measures and actions already decided on (Figure 4). Active measures are needed for the BAU scenario to be realised. It involves shutting down the Hanasaari B power plant and substituting its production with other energy sources and solutions, as per Helen's development programme. Moderate future estimates were also sought from the base scenarios presented in the energy and climate strategy 2016 of the Ministry of Economic Affairs and Employment, as well as VTT's models.

The premises of the BAU scenario are compiled in Table 2. In the BAU scenario, Helsinki's greenhouse gas emissions will be 51 per cent lower in 2030 and 52 per cent lower in 2035 compared to 1990 (Figures 5 and 6). However, Helsinki's objective to become carbon-neutral requires a reduction of 80 per cent (Figure 4). The intermediate goal is a reduction of 60 per cent by 2030. In addition to implementation of the current policy measures and actions already decided on (the BAU scenario), more actions are needed to reach the objectives. These additional actions are included in the target scenarios for 2030 and 2035.

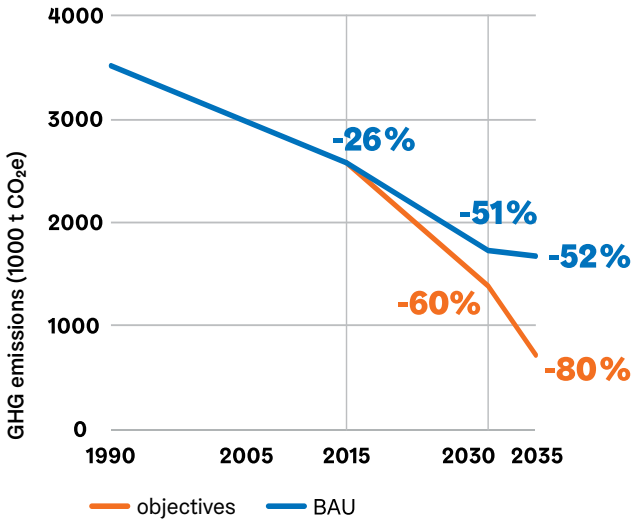



**Figure 4. Helsinki's emissions reduction objectives for 2030 and 2035, and the development estimated using current decisions (BAU). (HSY 2017)**

A target scenario of 80-per-cent emissions reductions has been calculated for 2035; in this scenario, carbon-neutrality is reached (Figure 6, Table 2). In this scenario, it is assumed that Helen will stop using coal as fuel and use of coal will end in the whole of Finland. In addition to this, the scenario includes calculations for many other factors that affect energy efficiency and emissions related to transport. These calculations allow us estimate the scale of the changes required to reach carbon-neutrality, the need for additional actions and the various sectors' contribution to the required emissions reductions.

## 3.1 Population and urban development

In both the BAU scenario and the target scenario, the City will continue to grow rapidly. By 2035, the population will grow to nearly 770,000, and more than 100,000 new jobs will be created. The proportion of jobs in the service sector will continue to grow as the proportion of jobs in industry decreases.

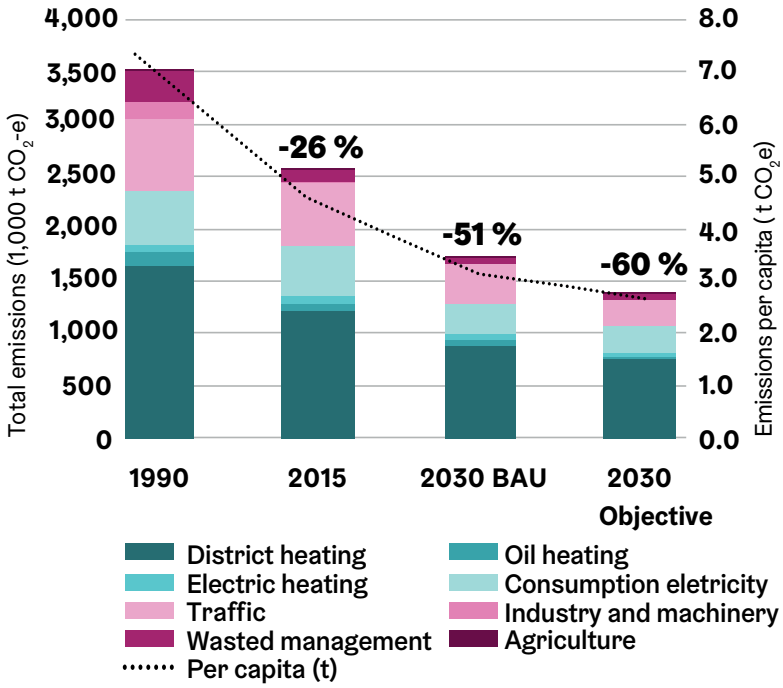



Figure 5. The development of Helsinki's emissions from 1990 to 2015, the BAU scenario for 2030 and the target scenario for 2030. (HSY 2017)

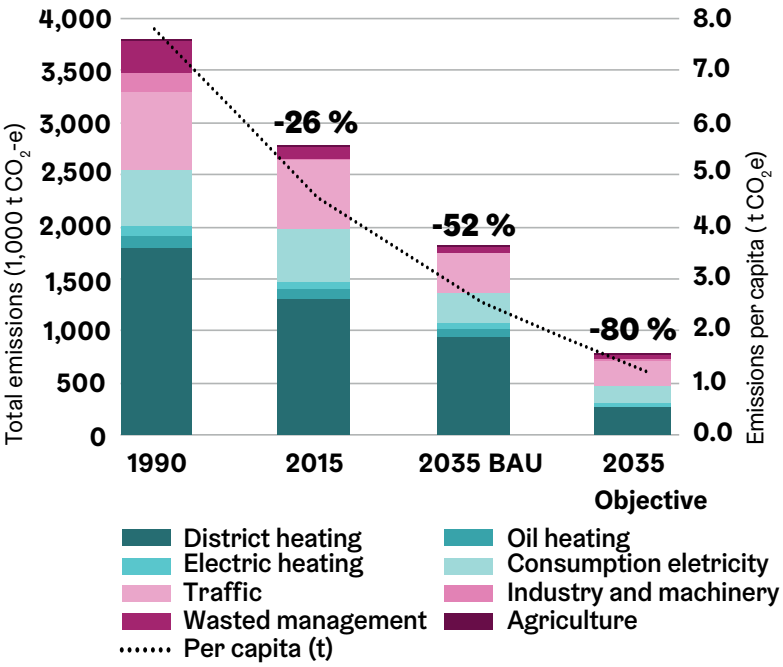



Figure 6. The development of Helsinki's emissions from 1990 to 2015, the BAU scenario for 2035 and the target scenario for 2035. (HSY 2017)

## 3.2 Development of traffic and the related background assumptions

In the BAU scenario, emissions from traffic in 2030 will be nearly 50 per cent lower than in 1990. This estimate is based on the assumptions that rail traffic will grow and public transport will become carbon-neutral, the use of biofuels will grow significantly, and the energy efficiency of vehicles will improve. Distance travelled per capita by car will remain at the same level as now, which means that mileage in the City will follow the population growth. The proportions of cycling and walking as transport modes will also remain the same. The estimated proportion of electric cars will be 14 per cent.

To achieve the emissions reduction objectives, emissions from traffic should be reduced significantly more than in the BAU scenario: by approximately 60 per cent by 2030 and by almost 70 per cent by 2035. The actions related to traffic will be covered in Chapter 4.1.

## 3.3 Development of construction and the related background assumptions

Approximately 11 million floor square metres' worth of new buildings will have been completed in Helsinki by 2030, and this number will grow to approximately 14 million by 2035. The total floor area in Helsinki will equal over 60 million square metres. The amount of greenhouse gas emissions is significantly affected by how energy-efficient the design and implementation of the new buildings are. However, it is even more significant to reduce the consumption of heating energy in the existing building stock.

In the BAU scenario, the energy classes of new buildings will be at the current level, and the energy consumption of the existing building stock will decrease slightly each year. The emissions from heating will be reduced by a little less than a third, along with the changes in energy production and the means of heating.

On the one hand, global warming will reduce the need for heating by approximately 0.5 per cent annually, which will help reduce the emissions from heating. On the other hand, the need for cooling buildings will slightly increase. To achieve the climate objectives, the energy efficiency of the existing building stock would need to improve by almost 2 per cent each year. This requires significant contributions to energy-efficient repair construction, separate investments and other energy-saving measures. New buildings should also reach nearly zero-energy levels. In addition to this, low-emission production of district heating and increased use of geothermal heating will be required, and use of oil heating needs to be gradually stopped. With these actions, the greenhouse gas emissions of buildings will be reduced by approximately 80 per cent from the current level, as required by the objective of carbon-neutrality. The emissions reduction actions related to construction and buildings are described in Chapter 4.3.

## 3.4 Development of energy production and the related background assumptions

The BAU scenario and the target scenario for 2030 include the Hanasaari coal plant being shut down and replaced with mostly bio-based fuels. Carbon-neutrality, meaning an emissions reduction of 80 per cent, requires that the use of coal be stopped altogether, which would mean that other solutions would be needed to replace the current production in Salmisaari. The target scenario for 2035 includes an assumption that emission-free sources of energy will make up 70 per cent of heating production. For the scenario to become reality, significant urban space solutions are required. The use of natural gas still produces greenhouse gas emissions that will need to be compensated for, as required by the objective of carbon-neutrality.

In the monitoring and scenario calculations of Helsinki's greenhouse gas emissions, the consumption electricity is assumed to be average Finnish electricity. According to the scenarios of the Ministry of Economic Affairs and Employment, the emission factor of electricity will decrease significantly by 2030 and 2035 (the BAU scenario), and as coal is removed from the fuel selection, the emissions of consumption electricity and heating electricity will decrease further (target scenario for 2035) (Ministry of Economic Affairs and Employment 2017). Furthermore, the target scenario of 80 per cent reductions includes major decentralised production of local and renewable electricity. When Helen's development programme is realised – in practice, if coal is replaced with emission-free energy sources – the emission factor of district heating produced in Helsinki will decrease from the current level of 190 g/kWh to 49 g/kWh. Helen's development programme and the related actions are described in more detail in Chapter 5.

**Table 2. Assumptions used in the scenarios.**

| BAU-SCENARIO (-52 %) | TARGET SCENARIO (-80 %) |
|---|---|
| Electricity consumption +8 % | Electricity consumption +0 % |
| 0.2 % of electricity from solar panels | 15% of electricity from solar panels |
| New buildings in the current energy class | New buildings consuming significantly less than the ones currently built |
| Energy efficiency of the old building stock ↗ | Energy efficiency of the old building stock ↗↗ |
| Heat consumption +7 % | Heat consumption -19 % |
| Geothermal heating ↗↗, district heating ↗, electric heating ↘,oil heating ↘ | Geothermal heating ↗↗↗, End to oil heating |
| Hanasaari B will be closed down, and the substitute production will have access to sufficient urban space solutions. | In 2035, 70 % of district heating will be emission-free and Helen will be climate-neutral by 2050. |
| Rail traffic ↗↗, buses ↘, freight traffic ↗ | Rail traffic ↗↗↗ |
| Car, bicycle and pedestrian traffic per capita will remain the same | Car traffic ↘↘, bicycle and pedestrian traffic ↗↗ |
| Electric cars (incl. plug-in) 14 % | Electric cars (incl. plug-in) 30 % |
| The emissions from ship traffic will remain the same | Carbon-neutral Port by 2035 |

| COMMON ELEMENTS IN BOTH SCENARIOS |
|---|
| +140,000 residents (rapid-growth population forecast) |
| +14 million m$^2$ of new floor area |
| The emission factor of electricity will decrease |
| Transport ordered by HSL will be carbon-neutral |
| The proportion of biofuels in transport will be 30 % |
| Fuel consumption of vehicles ↘ |
| Global warming will reduce heating needs by 10 % |

## 3.5 A summary of BAU forecasts and scenarios up to 2035

On the basic trajectory of climate emissions (the BAU scenario), Helsinki's greenhouse gas emissions will decrease significantly, but not sufficiently considering the City's climate objectives (Figure 4, Table 2). Reaching carbon-neutrality by 2035 will require massive additional contributions and actions in all emission sectors, in addition to the BAU development, which is positive, as such, and the implementation of the climate actions already decided on. The target scenario illustrates the scale of the changes required to reach carbon-neutrality (Table 2).

Helsinki's emissions were approximately 3.5 million t $CO_2e$ in 1990 and approximately 2.6 million t $CO_2e$ in 2015. The objective of carbon-neutrality, meaning a 80-per-cent reduction in emissions, requires that the annual emissions must be approximately 700,000 tonnes in 2035 (Figure 7). The objective for 2030 will be reached once the emissions are at 1.4 million tonnes. This means that the emissions need to be reduced by approximately 1.2 million tonnes by 2030 and by almost 2 million tonnes by 2035, compared to the current level.

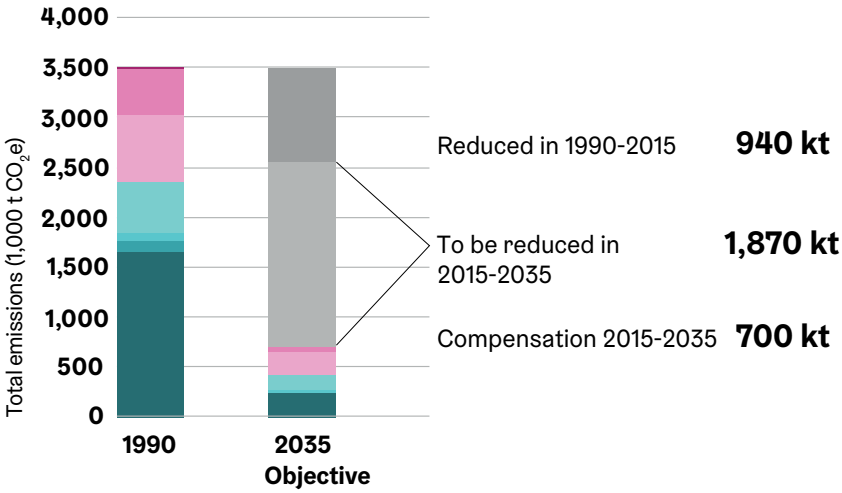



**Figure 7. Emission reduction required to reach carbon-neutrality by 2035. (HSY 2017)**

The estimated proportions of the various sectors and actions of the emissions reductions required for the 80-per-cent reduction are presented in Figure 8.

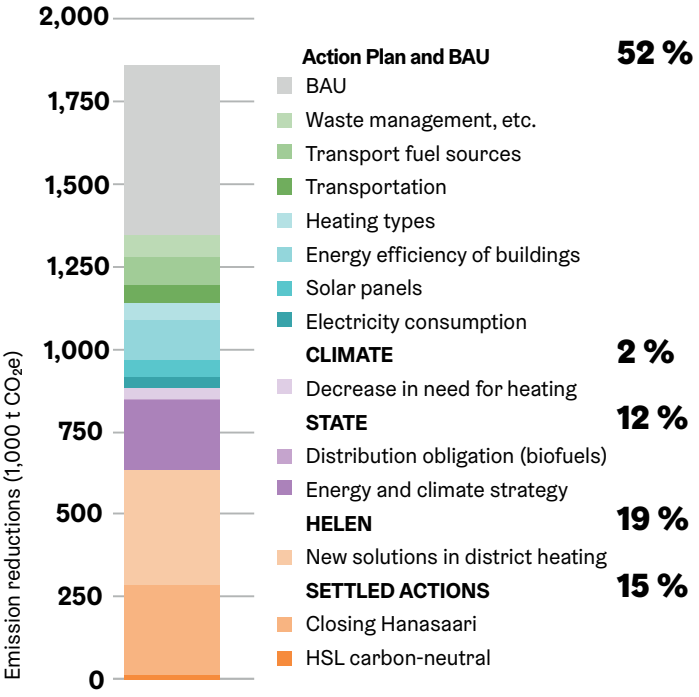



**Figure 8. Emission reduction required to reach carbon-neutrality by 2035. In the calculation principle used, the impact of the energy efficiency actions for buildings has been calculated first, the changes in heating methods second, modernisations in energy production third, and the reduction in the need for heating caused by global warming fourth. The proportion of traffic amounts to 377 kt $CO_2e$ and that of buildings amounts to 576 kt $CO_2e$, including the related BAU actions (Table 2). (HSY 2017)**

# 4 The necessary actions for making Helsinki carbon-neutral

In the BAU scenario, the emissions in Helsinki will decrease by 52 per cent by 2035, meaning that additional measures are required to reach carbon-neutrality, meaning an emissions reduction of 80 per cent. In this chapter, we present the action entities with which the development of emissions will meet the objective of carbon-neutrality.

The actions required to achieve the emissions reduction goal are defined for different sectors. The Plan includes a description of the current state, the objectives and the key emissions reduction actions for each sector. The sectors are the following:

- **traffic**
- **construction and use of buildings**
- **consumption, procurements, sharing economy and circular economy**
- **Smart & Clean growth**
- **Helen's development programme**
- **carbon sinks and compensation for emissions**
- **communications and engagement**
- **coordination, monitoring and assessment of climate work.**

Each sector includes both individual actions and entities comprising multiple actions. The experts who participated in the preparation of the Action Plan have scheduled each action and estimated the complexity and approximate costs of the actions (Table 3). Gaia Consulting Ltd and WSP Finland Ltd have estimated emissions and costs for traffic, construction and use of buildings in more detail.

Appendix 4 and Figure 9 present the proportion of the key action entities in traffic, construction and use of buildings in the total emissions reductions of the Action Plan. Furthermore, Appendix 5 includes a summary of the costs and benefits related to the implementation of the key action entities, as well as an explanation of the assumptions used for the calculations. The appendix also includes further information on the current status of the actions. In future processes, the impact assessments will be specified, and other impacts will be introduced in addition to the costs and emissions, such as the benefits brought about by the actions, health effects, other emissions reductions and green jobs. These details will be presented in the separate monitoring tool at a later date (see Chapter 9).

| Schedule | Complexity | Cost estimate |
|---|---|---|
| Council term (2017–2021) | Decision by the City of Helsinki | Low costs or to be carried out as official work |
| Next council term (2021–2025) | Decision by the City of Helsinki, requires further clarification | Requires resources |
| Later (2025–2035) | Cannot be decided on solely by the City of Helsinki | Significant costs |

Table 3. Assessment of the actions from the perspective of the City.

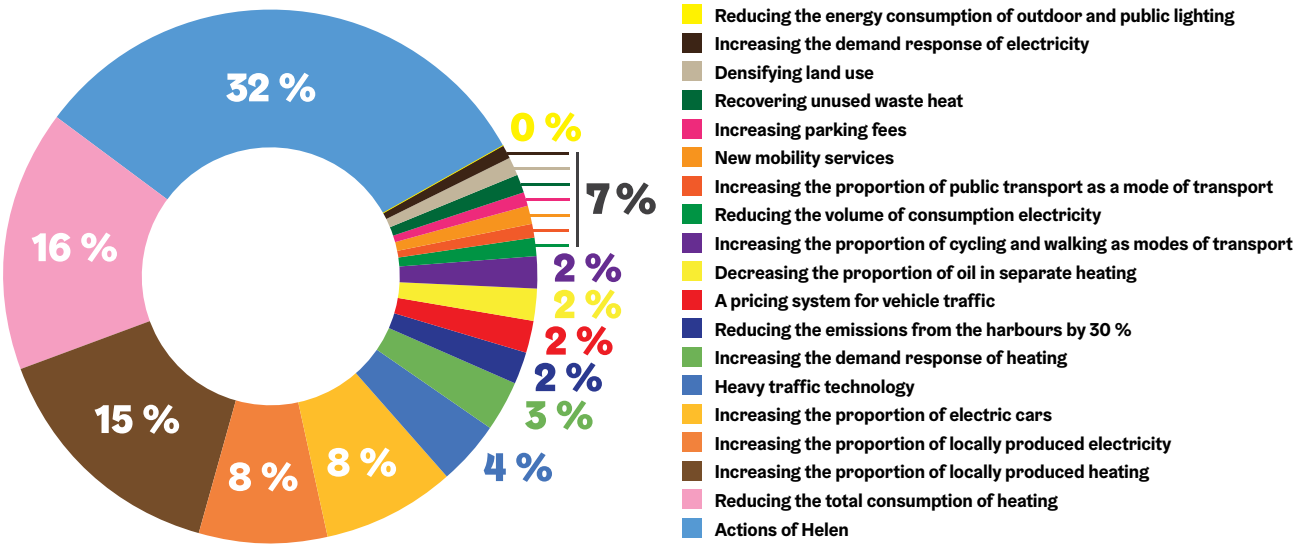



**Figure 9. The calculated proportions of the emissions reductions of the key action entities, including the pricing of vehicle traffic. For construction and use of buildings, the calculations use the current emission factor. The proportions are only indicative and target-oriented, and thus neither individual actions nor their impact are taken into account within the action entities.**

(Source: Traffic model studies, WSP Finland Ltd 2018, and Construction and use of buildings, Gaia Consulting Ltd 2018)

## 4.1 Traffic

According to the City Strategy, "Traffic emissions will be reduced across the city's transport system by promoting both cycling and pedestrianism and by raising the proportion of e-vehicles and buses and rail transport. Helsinki paves the way for a strong surge in the number of e-vehicles by enabling the market-driven construction of a public charging infrastructure."

Helsinki's carbon-neutrality objective (emissions reduction of 80 % in 1990–2035) has been set in such a way that the emissions from traffic must be reduced by 69 per cent from 2005 to 2035. The goal set by the Finnish Government is to reduce traffic emissions by 50 per cent from 2005 to 2030 at national level. Considering this goal, Helsinki is reducing traffic emissions more rapidly than required by the national goal. As a city constantly growing denser and that has good public transport connections, Helsinki has good conditions for reducing emissions. The distribution of the emissions from traffic is presented in Figure 10.

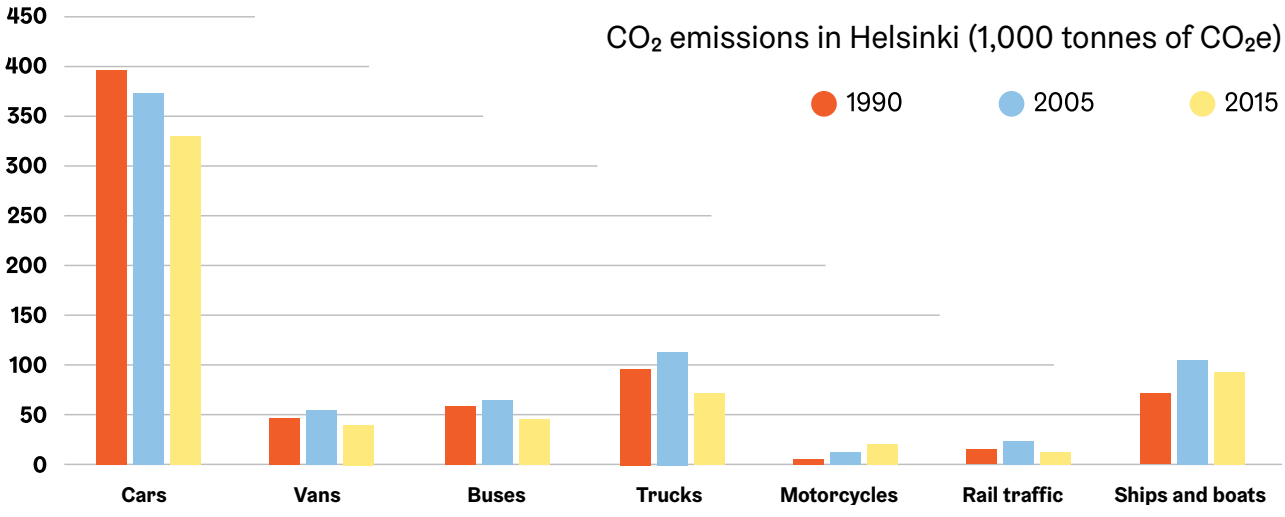



**Figure 10. The $CO_2$ emissions from traffic in Helsinki. (WSP Finland Ltd 2018)**

## The causes of emissions from traffic and how to influence them

The greenhouse gas emissions from traffic can be reduced by influencing the following:

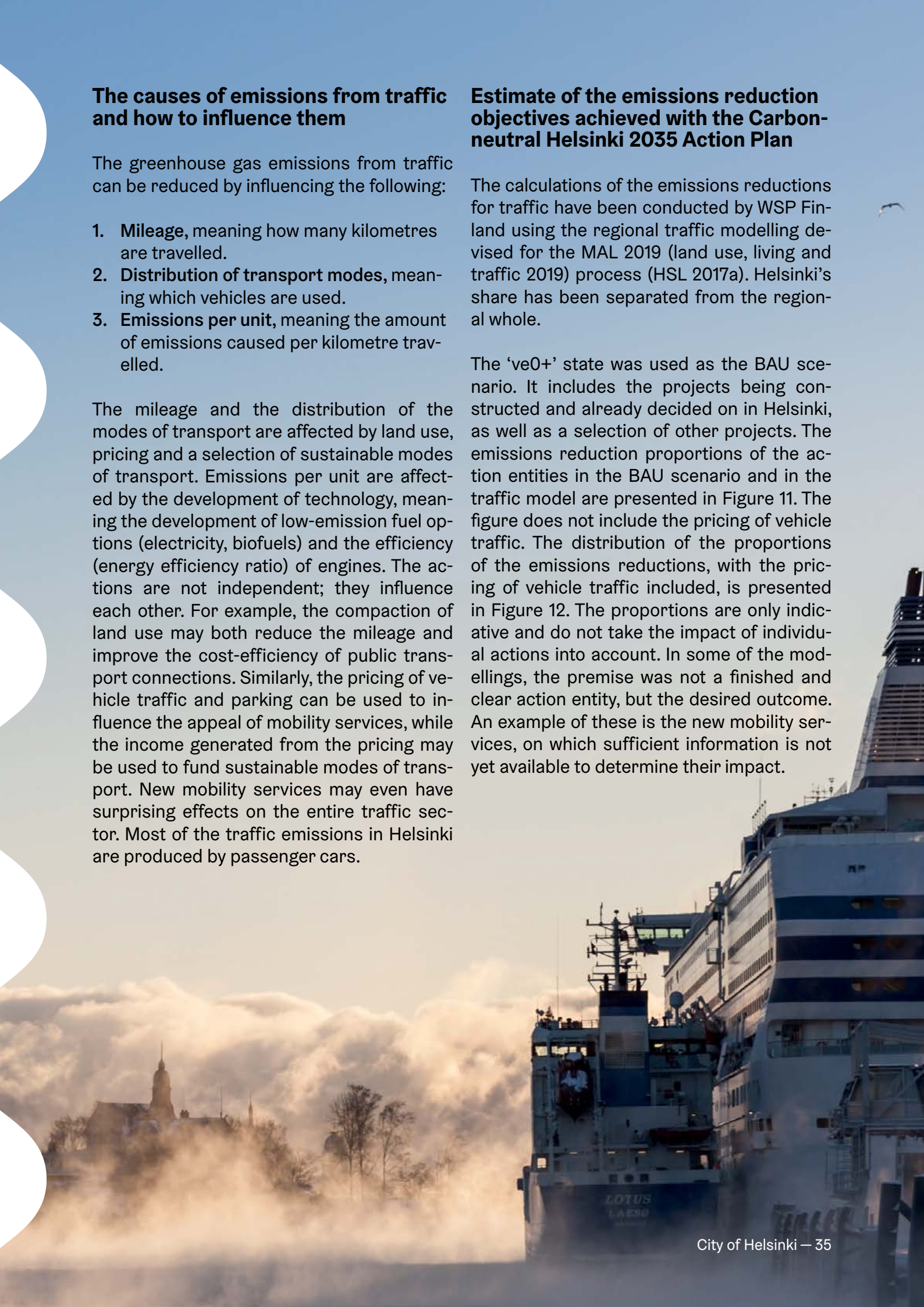
1. **Mileage,** meaning how many kilometres are travelled.
2. **Distribution of transport modes,** meaning which vehicles are used.
3. **Emissions per unit,** meaning the amount of emissions caused per kilometre travelled.

The mileage and the distribution of the modes of transport are affected by land use, pricing and a selection of sustainable modes of transport. Emissions per unit are affected by the development of technology, meaning the development of low-emission fuel options (electricity, biofuels) and the efficiency (energy efficiency ratio) of engines. The actions are not independent; they influence each other. For example, the compaction of land use may both reduce the mileage and improve the cost-efficiency of public transport connections. Similarly, the pricing of vehicle traffic and parking can be used to influence the appeal of mobility services, while the income generated from the pricing may be used to fund sustainable modes of transport. New mobility services may even have surprising effects on the entire traffic sector. Most of the traffic emissions in Helsinki are produced by passenger cars.

## Estimate of the emissions reduction objectives achieved with the Carbon-neutral Helsinki 2035 Action Plan

The calculations of the emissions reductions for traffic have been conducted by WSP Finland using the regional traffic modelling devised for the MAL 2019 (land use, living and traffic 2019) process (HSL 2017a). Helsinki's share has been separated from the regional whole.

The 've0+' state was used as the BAU scenario. It includes the projects being constructed and already decided on in Helsinki, as well as a selection of other projects. The emissions reduction proportions of the action entities in the BAU scenario and in the traffic model are presented in Figure 11. The figure does not include the pricing of vehicle traffic. The distribution of the proportions of the emissions reductions, with the pricing of vehicle traffic included, is presented in Figure 12. The proportions are only indicative and do not take the impact of individual actions into account. In some of the modellings, the premise was not a finished and clear action entity, but the desired outcome. An example of these is the new mobility services, on which sufficient information is not yet available to determine their impact.



Figures 11 and 12 must not be seen as alternative means of implementation. In both cases, the emissions reduction is based on the reduction of vehicle traffic. The figures present different means of reducing mileage and the necessary actions, with their effects. In Figure 12, the pricing of vehicle traffic is used to reduce vehicle traffic, and, as a result, the proportion of cycling and public transport will grow. In Figure 11, the appeal of cycling and public transport will be increased in a way that will reduce vehicle traffic and help reach the same outcome.

In Figure 11, the potential distribution of emissions reductions in traffic is presented without the pricing of vehicle traffic. When

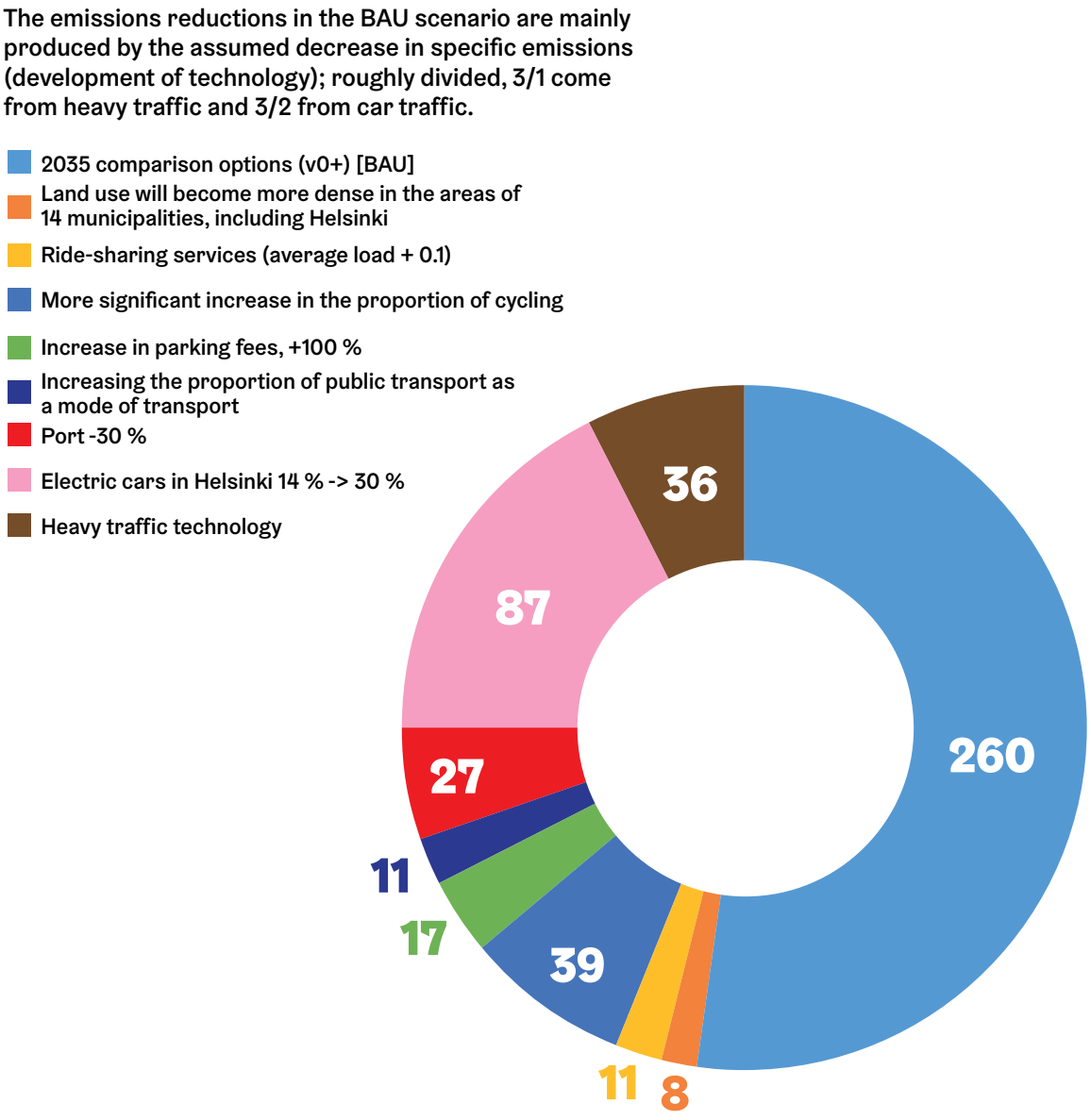



Figure 11. The emissions reduction proportions (kt $CO_2$) of the action entities included the traffic model study do not contain the pricing of vehicle traffic. The proportions are only indicative and target-oriented, and thus neither individual actions nor their impact are taken into account within the action entities. (WSP Finland Ltd 2018)

comparing Figures 11 and 12, it can be noted that the emissions reductions from the proportion of public transport as a transport mode will not change. Achieving significant growth in the proportion of transport mode will be challenging. Even maintaining the current proportion will require work. The examined increase in the service level of public transport (which was simulated in model using a 25-per-cent reduction in ticket price) only produced a third of the emissions reductions achieved through the pricing of vehicle traffic. A more substantial change to the public transport system was also proposed, but it was not considered realistic. The easiest way to increase the use of public transport would be the pricing of vehicle traffic.

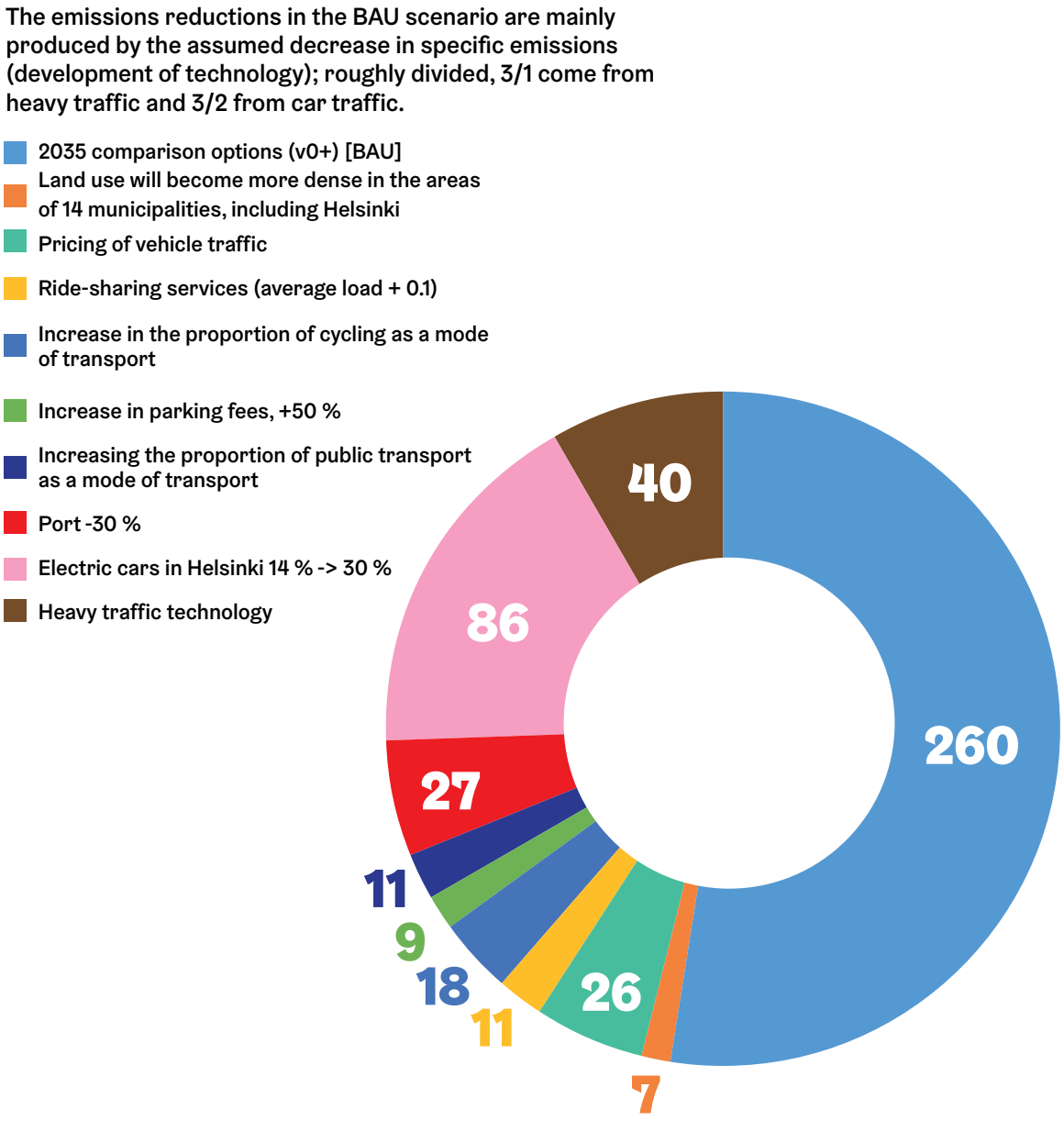



Figure 12. The emissions reduction proprotions (kt $CO_2$) of the action entities included the traffic model study, complemented with the pricing of vehicle traffic. The proportions are only indicative and target-oriented, and thus neither individual actions nor their impact are taken into account within the action entities. (WSP Finland Ltd 2018)

With the model analyses made, the calculated status where the emissions reduction objective for 2035 is realised can be reached. However, this will require a significant number of actions that the City needs to take both by itself and in cooperation with others. In this case, all emissions reduction actions defined will be included. In addition to this, vehicle technology, meaning low-emission vehicles, need to develop at the predicted speed to ensure that the emission level in 2035 is sufficiently low. To achieve the emissions reduction objectives, both restrictions and incentives need to be used. They support each other as the restricted elements can be replaced with other alternatives, perhaps even better ones.

The action entities seen as the most important are the development of low-emission vehicle technology and the renewal of the car population ('Electric cars in Helsinki: 14% -> 30%'), the reduction of the Port's emissions, the pricing of vehicle traffic and the reduction of emissions from heavy traffic ('Heavy traffic technology'). The pricing of vehicle traffic is an effective action in terms of emissions reductions. It is also a great example of an action that can be used to support the renewal of the vehicle population: the fees for low-emission vehicles could be lower than those for other vehicles, following the current parking policy. The most effective means would be direct restrictions on vehicle traffic.

## Traffic and transportation planning in Helsinki

The most popular means of transport among Helsinki residents within Helsinki in 2017 was walking, with 35 per cent of journeys made by foot. The second-most popular means of transport was public transport (34 per cent). The proportion of journeys made by cars was 22 per cent, whilst 9 per cent were made by cycling. Both the proportion and volume of passenger car traffic in the centre of Helsinki have been on the decrease since the start of the millennium: At the calculation line, at the border of the Helsinki peninsula, the proportion of cars has decreased from approximately 37 per cent to approximately 30 per cent since the start of the millennium. Similarly, the proportion of public transport has increased from approximately 63 per cent to approximately 70 per cent. At the cross-section line, the proportion of cars is higher than at the border of the peninsula, but the development of the transport modes has been similar to the development at the border: in 2007, the proportion cars accounted for was 84 per cent and the corresponding proportion for public transport was 16 per cent, while in 2017 car transport accounted for 79 per cent and public transport 21 per cent. At the border of the City, the volume of traffic has been experiencing an almost constant increase since the 1970s. The number of registered cars in Helsinki has also been on a steady increase ever since the 1970s, apart from the drop at the start of the 1990s. Regardless, the trend in car ownership has slowed down during the 2010s: in 2010, there were 395 passenger cars per 1,000 residents. In 2017, the corresponding number was 411. The ownership of cars in operation has been on a slight decrease throughout the ten-year monitoring period.

In aiming for a carbon-neutral Helsinki by 2035, traffic planning has a significant role. The transport system of the Helsinki region is planned in close collaboration with the cities and municipalities of the region, the State and the interest groups, as a part of the MAL 2019 plan for the land use, living and traffic of the Helsinki region. The binding target level set for the MAL 2019 plan is the following: the greenhouse gas emissions produced by traffic will be reduced at least by 50 per cent from 2005 to 2030. The plan will present the actions with which the target can be reached in the region.

Helsinki has many separate strategies and programmes used to direct the develop-

ment of sustainable urban transport and to meet the emissions reduction objectives set. The Helsinki's City Strategy of 2017–2021 steers the operations of the entire City for the duration of the Council term. One of the focuses of the Strategy is the promotion of sustainable transport in Helsinki. The new city plan is a long-term development plan for strategic land use and traffic, which will tie traffic and land use planning together. One of the objectives of the city plan is to make Helsinki a network city for rail traffic. In this objective, sustainable transport plays a central role. Individual development programmes and detailed actions have been prepared for the various modes of transport. These individual plans support and steer traffic planning, help reduce the emissions from traffic and promote sustainable transport. In the assessment of traffic projects, the impact that the project in question has on the distribution, volume, smoothness and emissions of transport modes will be analysed.

### 4.1.1 Using sustainable means of transport

Sustainable modes of transport typically include walking, cycling and public transport. To promote pedestrian traffic, it is important to design the city structure in such as way that housing, jobs, recreational areas and services are located close to each other and in an environment where walking is possible. Pedestrian traffic can also be increased by improving traffic safety.

Cycling is an emission-free mode of transport that makes the City more pleasant, improves the functionality of the transport system, saves street space and creates health benefits. The proportion of cycling as a mode of transport can be increased by increasing the appeal of cycling in the residents' everyday lives. This can be achieved by improving on the basic requirements for cycling, meaning smoothness, effortlessness and safety. In other words, it is vital to invest in connected and high-quality cycling paths and safe bicycle parking. When developing cycling, attention needs to be paid to the safety of cycling for children and young people, which will enable them to cycle to their school, day care centre or hobbies. As the community structure of Helsinki has spread wide, and the range of a bicycle is often not sufficient for all journeys made within the City, cycling needs to be developed simultaneously with public transport. At the same time, the popularity of electric bicycles and the fast trunk routes for cycling will also increase the appeal of cycling on longer journeys in the coming years. Improving the 'BIKE and RIDE' conditions at rail stations and at the stops of the future light rail system will also improve the conditions for cycling.

Even though public transport produces emissions, its effectiveness compared to cars is beyond compare when measured by emissions per person-kilometre travelled. Public transport also enables the cost-efficient use of modern and ecological technologies: for example, the trams and the underground trains in Helsinki have long used green electricity, while the availability and price of electric cars and the lack of charging infrastructure are still restricting the sales of electric cars. For emissions reductions, it is essential that the proportion of passenger cars using fossil fuels decreases and the proportion of cycling and other sustainable transport modes increases. The appeal of public transport compared to the use of cars can be increased by raising the service level of public transport (lines and routes, intervals, smooth exchanges, price, comfort). Furthermore, with the pricing of vehicle traffic, increasing the service level of public transport is absolutely necessary. In this case, the income from the pricing of vehicle traffic should be directed towards the improvements to the other modes of transport. The abbreviations used in the Action Plan are listed in Appendix 1.

**Key actions related to modes of transport (29 kt $CO_2e$).**
(Includes the increase in the proportion of public transport (11 kt) and the increase in the proportion of cycling (18 kt) from Figure 11.)

**1. The services offered in traffic nodes and the smoothness of the traffic connections will be improved.**

- The action plan devised in connection with HSL's Solmu project will be implemented.
- The number of signposts and mobile applications will be increased to make the travel chain easy and quick to perceive in real time.
- The regional action plan for park-and-ride services (HSL's publication 8/2017) in Helsinki will be implemented.

**Parties responsible:** HSL, Land Use and City Structure / Traffic and Street Planning, Land Use and City Structure / Detailed Planning.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Significant costs.

**2. The target network for bicycle traffic in the inner city will be completed by 2025.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council terms 2017–2021 and 2021–2025.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs.

**3. The Baana network for bicycle traffic will be completed by 2030.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council terms until 2030.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs.

**4. The cycling lane network with high-level winter maintenance will be expanded.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Buildings and Public Areas / Maintenance.
**Time span:** Council terms 2017–2021 and 2021–2025.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs.

**5. A pleasant and safe environment for pedestrians will be promoted, for example by implementing the development programme for traffic safety.**

**Parties responsible:** Land Use and City Structure / Detailed Planning, Land Use and City Structure / Traffic and Street Planning.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**6. Services for bicycling (city bikes, bike hubs, bike parking, etc.) and the related communications will be developed. The ability to carry bicycles in heavy train traffic will be developed and the capacity for this will be increased.**

**Parties responsible:** HKL, Land Use and City Structure / Traffic and Street Planning, HSL, Ilmastoinfo.
**Time span:** Continuous
**Complexity:** Decision by the City of Helsinki. Cost estimate: Requires resources
**Cost estimate:** Requires resources

**7. The development programme for tram traffic in Helsinki will be implemented. The objectives for the speed, flow, reliability and disturbance level of tram traffic will be achieved.**

**Parties responsible:** HSL, Land Use and City Structure / Traffic and Street Planning, HKL
**Time span:** 10–15 years / continuous
**Complexity:** Cannot be decided on solely by the City of Helsinki
**Cost estimate:** Requires resources

**8. The service level of public transport and the coverage of the rail network will be improved.**

- By ensuring sufficient passenger demand through simultaneous planning of land use and traffic investments (such as complementary construction).
- By strengthening the efficient trunk network of public transport.

**Parties responsible:** HSL, Land Use and City Structure / Traffic and Street Planning, HKL.
**Time span:** Continuous
**Complexity:** Cannot be decided on solely by the City of Helsinki
**Cost estimate:** Significant costs

**9. The promotion programme for cycling and the development programme for bicycle parking will be implemented.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, HSL, HKL.
**Time span:** Continuous
**Complexity:** Decision by the City of Helsinki
**Cost estimate:** Requires resources

## 4.1.2 Pricing of transport

The 'pricing of transport' entity consists of the pricing of parking and public transport and a potential pricing system for vehicle traffic. From the perspective of emissions reductions, the pricing of transport is estimated to be both the most effective and the most cost-efficient action in the traffic sector (Gaia Consulting Ltd 2014; Siemens 2016). The pricing of transport has also been found to be the most effective measure for decreasing the negative effects traffic has on air quality, and, consequently, on the health of residents. Because of the above-mentioned factors, it is one of the spearhead actions in Helsinki's air protection plan (The Air Protection Plan of the City of Helsinki 2017–2024).

Realising the pricing of transport does not require any investment decisions on the part of individual consumers. However, things such as the adoption of road tolls cannot be decided on solely by the City of Helsinki; instead they require regional collaboration and cooperation with the state. Road tolls have been studied during the preparation of the HLJ 2015 plan (The Transport System Plan of the Helsinki Region). According to the MAL agreement on land use, living and traffic for 2016–2019, the preparation of a road toll, which will affect the traffic demand will be continued in collaboration with the region and the state.

The pricing of transport also involves other benefits, in addition to emissions reductions: the congestion in the vehicle traffic network will be reduced, as will other negative effects on humans, such as noise. In addition to this, the income from the pricing can be directed back into the development of the transport system. The direction and significance of the potential road tolls have been assessed as being somewhat uneven from the perspective of business, in particular, and the toll system would require further development (HSL 2016c). Similarly, the allocation of the effects on various user groups and areas may also be uneven. The effects the pricing of transport would have on the appeal of the city centre and the distribution of jobs in the centre need to be examined.
There are many technical solutions for the implementation of the pricing system for vehicle traffic, of which the pricing model based on gate zones was examined in more detail during the work on HLJ 2015 (HSL 2016c). The investment and use costs of the system were estimated at around 20–25 million euros a year, and with a socio-economically optimised toll, the net profit was estimated to be 80 million euros a year. However, in this Action Plan, the emissions reductions reached through road tolls have been calculated with a toll that is higher than the optimal socio-economic level. In this case, the net profit would be approximately 160–170 million euros a year. In particular when studying a toll higher than the optimal socio-economic level, the broad business impacts would need to assessed so that the results could be taken into account when deciding on a trial. The direct costs and income presented would be apply across the entire region, and Helsinki's proportion was not estimated individually.

The adoption of a pricing system for vehicle traffic would require changes to legislation. It is necessary to agree on factors such as the level of the road tolls, the zones and the procedure with which income will be allocated to the development of the region's transport system in such a way that ensures the procedure does not decrease the region's average long-term traffic funding from the state. The pricing system for vehicle traffic would enable the creation of incentives for low-emission vehicles and business transport, among other things. For example, road tolls were adopted in Stockholm with a three-year trial in 2006. The estimate for the implementation schedule is approximately 3–5 years from the decision being made on the trial.

Based on the emission calculation, the City's carbon-neutrality objective in the traffic sector would require a decision on starting the trial for the pricing of vehicle traffic in the 2020s and the adoption of the pricing system before 2035. During the current Council term, the development of technology related to emissions reductions in traffic will be monitored, and the examination of the pricing system in connection with the MAL planning will be continued so that the trial may be started within the estimated schedule. If the pricing system for vehicle traffic is not adopted, the emissions reductions must be covered with other actions.

**Key actions related to the pricing of transport (35 kt $CO_2e$).**
(Includes the pricing of vehicle traffic (26 kt) and the increase of parking fees (9 kt) from Figure 11.)

**10. A pricing system for vehicle traffic (a road toll or congestion tax):**

- Necessary additional surveys conducted primarily together with the State and the municipalities in the region, helping the City prepare for the start of the trial. We will examine the allocation of road tolls for the development of the region's transport system as a part of the shared investment package of the State and the municipalities, which covers multiple terms of government. The requirement for the pricing is that the income from road tolls be allocated for the development of the region's transport system.

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Executive Office; regional, economic and administrative steering measures will be examined as a part of the MAL 2019 planning.
**Time span:** Examined in council term 2017–2021, potential trial in the 2020s
**Complexity:** Cannot be decided on solely by the City of Helsinki
**Cost estimate:** Requires resources

**11. The current parking policy will continue until 2021 and, afterwards, the parking fees will be raised further to reduce CO2 emissions. The impact on business will be studied before making the decision.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**12. Parking fees will be scaled more heavily from the perspective of emissions and the promotion of the joint use of vehicles.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Services and Permits / Environmental Services, Executive Office.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**13. The parking fee zones will be expanded.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

## Example

Congestion tax has been used in Stockholm since it started as a trial in 2006 In 2007, the tax were made permanent. The income generated is used to fund the city's transport investments. The tax has also significantly reduced traffic volumes during rush hours. Stockholm and the State of Sweden have agreed that the income generated will be returned to the City of Stockholm.
en.wikipedia.org/wiki/Stockholm_congestion_tax.

## 4.1.3 The growing city structure

The design of the city will attempt to make jobs and hobbies more accessible without a passenger car. On average, journeys made by car are approximately 5–6 times as long as journeys made by foot or bicycle. This is why the goal of the City is to have a more diverse and mixed community structure where housing, services and jobs are more mixed and more accessible. The jobs in the city area are disturbing their environment less than before, and a solid city structure will promote the adoption of sustainable modes of transport.

Emissions can be reduced when new forms of land use utilise the existing infrastructure. In Helsinki, the objective is, in accordance with the MAL agreement and the AM programme (the implementation programme for housing and the related land use in Helsinki) to develop at least 600,000 floor square metres' worth of detailed plans for housing production, mainly in the service area of rail traffic. Of this floor area, complementary construction accounts for 240,000 floor square metres. The objective of Helsinki is to build 6,000 (7,000 from 2019) apartments, 55 per cent of which will be reasonably priced (the proportion of ARA rental apartments will be 25 per cent and the proportion of 'intermediate' apartments will be 30 per cent). Reasonably priced apartments in accessible areas may reduce the need for commuting and promote sustainable transport modes.

**Key actions related to the growing city structure (7 kt $CO_2$e).**
**(Includes the more dense land use in 14 municipalities, also in Helsinki (7 kt), from Figure 11).**

**14. The use of public transport and other sustainable means of travel will be promoted by complementing the community structure of the City.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Land Use and City Structure / Detailed Planning.
**Time span:** Continuous; to be continued as a part of MAL 2019 planning.
**Complexity:** Continuous.
**Cost estimate:** Low costs / to be carried out as official work.

**15. The parking norms will be updated to better support sustainable transport both in the design of new areas and in the complementary construction of existing areas.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Council term 2017–2021.
**Cost estimate:** Low costs / to be carried out as official work.

**16. The creation of blocks and areas that focus on bicycle and pedestrian traffic will be encouraged through land use planning.**

**Parties responsible:** Land Use and City Structure / Detailed Planning, Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Continuous.
**Cost estimate:** Low costs / to be carried out as official work.

## 4.1.4 Changes in vehicle technology

As technology develops, vehicles' emissions per unit may also decrease. The vehicles' emissions per unit can be reduced by advancing the upgrading of the vehicle population and by directing the upgrades towards low-emission choices. The EU's strict legislation related to the emission criteria for vehicles offers good support for the promotion of low-emission vehicle technology, including in Helsinki. The City will be able to encourage residents to use new low-emission vehicles, for example by lowering the parking fees for these vehicles and, in the future, by lowering the potential congestion taxes for the vehicles. The growing popularity of ride-sharing will increase the usage of cars and reduce their service lives, which will accelerate the renewal of the vehicle population. In the emissions reductions of heavy traffic and machinery, the tendering criteria are key. A potential emission-based environmental zone can also be used to reduce the emissions from heavy traffic.

As electric cars and biofuels become more popular, sufficient charging and distribution infrastructures are required. A functional environmental zone also requires easy access to electricity and biofuels. The City can reduce emissions by using environmental criteria for its own equipment and the equipment and machinery services procured by it. The City's construction and maintenance use heavy logistics in which the reduction of emissions and the increased usage of low-emission power are important.

The City's construction company, Stara, will move to using biofuels in machinery by 2020. HKL is also moving to biofuels as it uses Stara's fuel distribution points for refuelling. The procurements for HKL's transport services are made based on Stara's framework agreement, which takes the environmental criteria for the transport fleet into account.

**Key actions related to the changes in vehicle technology (126 kt $CO_2e$).**
**(Includes the proportion of electric cars in Helsinki, 30% (86 kt), and the technology for heavy traffic (40 kt) from Figure 11)**

**17. The environmental zone will be developed:**

- Assessments will be carried out for expanding the current environmental zone, including CO2 emissions in the criteria and applying the requirements to different types of vehicles (council term 2017–2021).
- A $CO_2$ emissions based environmental zone will be ready for introduction based on the assessment. (council term 2021–2025).

**Parties responsible:** Services and Permits / Environmental Services, HSY, HSL, Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council terms 2017–2021 and 2021–2025.
**Complexity:** Decision by the City of Helsinki, requires further clarification
**Cost estimate:** Low costs / to be carried out as official work.

**18. Market-based construction of public charging infrastructure for electric cars will be made possible. Implemented as per the recommendations of the electric traffic working group.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Buildings and Public Areas / Maintenance, Housing Production
**Time span:** until 2035.
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** Significant costs.

**19. The City of Helsinki will develop and tighten the environmental criteria (incl. alternative fuel sources, emission classes) in all competitive bidding processes for delivery services, heavy delivery services and utility vehicle and machinery services, as well as in competitive bidding processes for contract work including any of the above-mentioned services. Once the procurement process is completed, the client will monitor the environmental criteria. An environmental bonus system will be introduced into the competitive bidding processes for delivery and utility vehicle and machinery services as well as into competitive bidding processes for contract work including the above-mentioned services will be researched (cf. HSL).**

**Parties responsible:** Buildings and Public Areas/ Maintenance, Services and Permits / Environmental Services, Stara construction service, HKL, HSL, HSY, Social Services and Health Care Division, Education Division, Culture and Leisure Division, Services and Permits/Environmental Services.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki, in cooperation with HSL regarding public transport (HKL), and HSY regarding deliveries and utility vehicles and machinery.
**Cost estimate:** Low costs / to be carried out as official work; use of vehicles that run on alternative fuels is more expensive.

**20. The environmental criteria will be applied to procurement of the City's own vehicles and leasing vehicles. The fleets of Stara and HKL will only use vehicles that run on biofuels or renewable electricity by 2020.**

**Parties responsible:** Stara Logistics, Urban Environment Division, HKL (HSL), (HSY), Social Services and Health Care Division, Education Division, Culture and Leisure Division, Services and Permits / Environmental services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki, in cooperation with HSL regarding public transport (HKL).
**Cost estimate:** Low costs / to be carried out as official work.

**21. The City of Helsinki will have an active role in developing city logistics and incentives to encourage low-emissions delivery traffic**

- The introduction of a parking ID system for delivery traffic, implementing environmental criteria-based price categories for the parking ID system and expanding the network of loading and unloading points for delivery traffic will be researched.

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, City Executive Office, Buildings and Public Areas.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**22. HSL will continue to pursue its objectives; for example, 10 % of the bus traffic ordered by HSL will be operated using electric buses by 2022, with an increase to 30 % by 2025; and 90 % of the traffic ordered by HSL will be run on biofuels (renewable next-generation biodiesel and biogas) by 2020.**

**Parties responsible:** HSL
**Time span:** Council terms 2017–2021 and 2021–2025.
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Requires resources.

**23. The charging infrastructure for buses will be expanded as part of the bus traffic competitive bidding programme.**

**Parties responsible:** HSL, HKL, Helen and Helen Electricity Networks.
**Time span:** Continuous.
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Requires resources.

### 4.1.5 Reducing the emissions from the harbours

For the harbour operations, it is expected that the emissions from traffic will decrease based on policy measures, meaning the objectives of the government and Helsinki. The government's objective is to reduce the emissions from traffic by 50 per cent from 2005 to 2030. Helsinki's objective is to reduce the emissions from traffic by 69 per cent from 2005 by 2035 in the entire City area. The emissions for ship traffic have been calculated for a ship's journey from the water border controlled by The Port of Helsinki, as specified in the Harbour Code, to the harbour, for the ship's stay in the harbour, and from the ship's journey from the harbour to the water border controlled by The Port of Helsinki. The emissions from wheeled traffic and machinery have been calculated for the portion of time the vehicle or machine moves about in the land area controlled by the Port, as specified in the Harbour Code.

The Port of Helsinki has only a few machines and vehicles of its own, and the Port's opportunities to affect the emissions from the machinery and operations of operators are restricted. The Port of Helsinki can mostly just present its recommendations and wishes to the operators. The situation is also affected by the competition between harbours and the restrictions set by technology.

The Port of Helsinki has offered heavy-capacity shore power for the passenger and car ferries of Viking Line at Katajanokka since 2012. In addition to this, the South Harbour has one and Vuosaari Harbour has nine light-capacity shore power connections. As for the expansion of the West Harbour, an investigation into the offering of shore power is ongoing. The increase in heavy-capacity shore power connection (capacity of several megawatts) will involve costs of at least a million euros per berth. The risk involved is that the vessels using the berth will change, and the shore power connection will be left unused as the vessels' capacity to receive shore power varies. So far, the technical issues include the lack of a shore power connection in vessels and the lack of a uniform connection standard. The short visit times of other vessels in the harbour also make connecting to shore power impractical. The use of shore power only reduces the emissions from vessels when they are docked in the harbour. Based on the current emission calculation method, most of the emissions from ship traffic come from the journey from the harbour to the water border controlled by the Port of Helsinki, as specified by the Harbour Code, and vice versa. In this case, the percentual emissions reductions from the use of shore power, compared to the current calculated level, will only have a minor effect.

The environmentally motivated discount on the harbour fee has been adopted, in an experimental manner, in the 2018 price list of the Port of Helsinki. One of the criteria for the discount is a low emission level (vessels using biogas or LNG or shore power while docked). The level of the discount depends on the ESI (Environmental Ship Index) points or the CSI (Clean Shipping Index) emission level. The discount may also be granted for investments or innovations that improve the energy efficiency or reduce the emissions of the vessel. In this case, the application for a discount must include a plan or presentation on the changes and a calculation or measurement of the effects.

To improve the energy efficiency or to reduce the emissions per freight unit, larger freight vessels are needed. As vessels become larger, the number of visits in relation to the volume of freight will decrease. In container ships, the growth trend of vessels has already been noticeable in Vuosaari Harbour for the last few years. For roro and ropax vessels, the trend is that existing vessels are elongated to increase the transport capacity. In addition to this, the new roro

and ropax vessels entering into operation are longer than in the past. These changes require the channel leading to Vuosaari Harbour and the marine traffic area of the Harbour to be sufficiently deep, and the jetties of the Harbour to be sufficiently long to dock the vessels safely. The costs for the Port of Helsinki will be in the region of 10 million euros. The channel requires a significant investment from the State (the Finnish Transport Infrastructure Agency) (approximately 30 million euros).

The actions of the Port of Helsinki are compiled under the action 'Carbon-neutral harbour'. In this action, carbon-neutrality – a zero-emission level by 2035 – concerns the emissions from the Port of Helsinki's operations in the harbour areas. The Carbon-neutral Port by 2035 plan presented here will also be used to steer the emissions of other actors.

### Examples

The Port of Stockholm offers shipping companies an opportunity to receive a subsidy of one million SEK per ship for installing a shore power connection.
www.portsofstockholm.com/siteassets/prislistor/sh-prices-and-terms-2018-version-2018_2.pdf

Vancouver encourages shipping companies to create environmental programmes and certifications, for which the companies may receive a discount on the harbour fees. The discount may be as high as 47 %. The Gold certified shipping companies receive the highest discounts.
www.portvancouver.com/wp-content/uploads/2015/05/4747-PMV-Eco-Action-Program-Brochure-Online.pdf

**Key actions related to reducing the emissions from the Port operations (27 kt $CO_2e$).**
(Includes the emissions from the harbours (27 kt) from Figure 11)

**24. The Port of Helsinki will create the Carbon-neutral Port by 2035 Action Plan which will include the following types of actions:**

- Energy reviews performed every four years in accordance with the legislation on energy efficiency. In the reviews, the energy consumption profile of the company is examined in terms of electricity and heating, and new opportunities for saving energy are identified.
- Using environmental criteria in the upgrading of the machinery and vehicle fleet of the Port. Enabling the bunkering of low-emission fuels (such as biogas and LNG) in various parts of the Port through surveys, negotiations with the authorities (Trafi) and instructions.
- Advancing the use of shore power with requirement outlines and increasing the number of shore power connections, if necessary.
- Potential support for shipping companies taking environmental action, such as discounted port taxes. Enabling the visits and docking of more energy-efficient and low-emission ships per freight unit in Vuosaari Harbour.

**Parties responsible:** Port of Helsinki Ltd
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
Cost estimate: To be carried out as official work / implementation requires resources.

**25. The traffic of the West Harbour will be made smoother between the Harbour and the Länsiväylä.**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning, Executive Office / Area construction, Executive Office / Economic Development and The Port of Helsinki Ltd.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

## 4.1.6 New mobility services and steering of mobility

New mobility services introduced in addition to or as a part of public transport can improve the smoothness of the City's traffic and the energy efficiency of transport. With these developments, the greenhouse gas emissions per person-kilometre travelled will decrease. These types of services include ride sharing, car sharing and peer-to-peer renting services, public transport on demand and, at a more general level, Mobility as a Service (MaaS) packages. In MaaS, the user is offered the entire travel chain from door to door by flexibly combining different transport modes through a single centralised interface, for example with a single ticket or a monthly fee. In the future, robot cars and automated traffic will also be included in the selection of mobility services. There have already been trials related to them in Helsinki. Innovative low-carbon mobility services have been tested at the rail stations and the areas of Kalasatama and Jätkäsaari, for example, and the City will need to further develop its role as a test platform. Additionally, the advancing route and journey planner services and dynamic traffic control systems based on real-time data will support the energy efficiency of transport. Services that reduce the need for transport, such as the opportunities for remote work and local hobbies, online shops and remote health care services, will reduce the emissions from transport.

With new mobility services, it should be noted that there is still very little information available on their effect on transport. According to the preliminary report of the Finnish Transport Infrastructure Agency (Finnish Transport Agency 2016), assessing the potential of new mobility services in terms of emissions reductions is currently difficult, and further studies are needed.

**Key actions related to new mobility services and the steering of mobility (11 kt $CO_2e$) (Includes ride-sharing services from Figure 11 (11 kt))**

**26. The City will act as a testing platform for smart mobility services and adopt more functional solutions.**

**Parties responsible:** Urban Environment Division + other divisions, Land Use and City Structure / Traffic and Street Planning, Executive Office / Economic Development, HSL, HKL, Forum Virium, Services and Permits / Environmental Services, S&C Foundation.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**27. The City will support the introduction of different mobility services:**

- Continuing to make data more open and developing the marketing of open data.
- Examining the additional measures with which the City could help make new mobility services more common and prepare for their impact.
- Examining the allocation of ride-sharing services for areas with a low public transport service level.
- Examining the development of rides paid for by the City as a part of ride-sharing services.

**Parties responsible:** Land Use and City Structure, Buildings and Public Areas, Executive Office, HSL (open ticket-selling interface for public transport, pilots of mobility services), Forum Virium.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the city of Helsinki, requires further clarification.
**Cost estimate:** Requires resources.

**28. The Smart Transport in Helsinki Action Plan will be prepared (update to the Action Plan decided on in 2013).**

**Parties responsible:** Land Use and City Structure / Traffic and Street Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**29. The City will campaign and communicate to promote sustainable means of transport.**

**Parties responsible:** Urban Environment Division / communications, HSL.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki and HSL.
**Cost estimate:** Requires resources.

**30. Mobility plans and other smart transport plans will be implemented for the City organisation, subsidiary communities and companies. The City and HSL, together with entrepreneurs, will survey the needs of companies and the opportunities for reducing traffic and making it more efficient.**

**Parties responsible:** HSL, Executive Office / Economic Development, Services and Permits / Environmental Services.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## Mobility management

means the promotion of sustainable transport modes through informative guidance and the coordination and development of services. Typical measures include guidance services related to sustainable transport, various advertisement campaigns and mobility plans customised for organisations. A key objective is to get various actors to influence the transport habits of their employees or customers. Mobility management is also strongly connected to the planning, implementation and maintenance of properties. Mobility management is a cost-efficient and easily acceptable way of reducing the emissions from transport.

The mobility plans of organisations, such as companies, will set the boundaries, operating principles and objectives for the development and monitoring of the mobility of companies. With planning and incentives, the journeys made by an employee alone in their own car can be reduced by 20–30 per cent, on average.

## 4.1.7 Assessment of traffic emissions and costs

The volume of greenhouse gas emissions from traffic in Helsinki amounted to approximately 600,000 tonnes ($CO_2e$) in 2015 (HSY 2017). The volume has decreased in the past years: in 2005, the volume of emissions was 18 per cent higher. For traffic, the objective is to reduce $CO_2$ emissions by 69 per cent from 2005 to 2035, which would mean a reduction of 496,000 tonnes ($CO_2e$) in greenhouse gas emissions (HSY 2017).

The impacts of the emissions reductions in traffic were analysed with the HELMET 3.0 model system, created by HSL and covering the entre employment area of the Helsinki region (HSL 2016a and 2016b). The employment area of the Helsinki region means the large area that covers the Helsinki metropolitan area, the rest of the Uusimaa region and the Riihimäki region. The initial data for the model included the population and employment data of the region, data on people's mobility habits based on research and a description of the transport system. In the model, the land use in Helsinki in 2035 was based on the data in the city plan. For the other areas, the land use data was interpolated based on the data for 2030 and 2050. This data was based on the data produced by the MAL process (ve0+ on 9 January 2018). The HELMET model has been documented carefully, and the calculations made can be repeated (HSL 2016a and 2016b). The projects included in the network options 0 and 0+ for 2030 have been added to the current traffic networks to analyse the year 2035 (the view of the projects is based on the date of analysis). The network options are based on the definitions made in the MAL 2019 planning dated 6 November 2017.

The traffic-related emissions reduction actions analysed included an increase in the proportion of cycling, an increase of the service level of public transport, the pricing of vehicle traffic, the changes to the parking

policy, new mobility services and the opportunities created by the development of technology (the increase of the electric car stock and the decrease of the specific emissions from heavy traffic).

In some of the model analyses, the premise was not a finished and clear action entity, but the desired outcome. The practical actions presented in the analyses will not be sufficient to reach carbon-neutrality, and additional emissions reduction actions will be needed for the coming years. The emission and cost assessment was carried out by WSP Finland Ltd.

## Summary of the results of the traffic emissions assessment

According to the report, the emissions reduction goal for traffic emissions for 2035 can be reached. However, this will require a significant number of actions that the City needs to take both by itself and in cooperation with others. To achieve the objectives and reduce emissions, all action entities analysed will be necessary. For comparison, if the pricing system for vehicle traffic were not an available action, the emissions reductions would need to be covered with actions from the other sectors, such as construction and use of buildings.

To achieve the emissions reduction objective for 2035, vehicle technology needs to develop at the predicted speed, at the minimum. Approximately half of the emissions reductions by 2035 will come from the predicted decrease in the specific emissions of vehicles. This is based on the developments in vehicle and fuel technologies that are predicted to happen in any case (the BAU scenario). In the BAU scenario, electric cars (all-electric cars and chargeable hybrids) will account for approximately 7 per cent of all cars in Finland (VTT, ALIISA car stock model). In the Helsinki region, this percentage is expected to reach 14 per cent (HSY). In addition to this, transport ordered by HSL will be carbon-neutral.

To achieve the objective, the proportion of electric cars that is higher than the proportion in the BAU scenario was also analysed (approximately 30 % of the entire car stock in Helsinki) as the emissions reductions required by the objective would be very difficult to achieve through other means in the transport system. Achieving a higher number of electric cars can be estimated to be easier in cities than in rural areas as the market-based implementation of charging opportunities is presumably easier in cities.

Based on modelling, the most effective methods for reducing the emissions from traffic are the pricing of vehicle traffic, the minimising of the specific emissions of heavy traffic and the significant growth of the electric car stock. These are actions that will either reduce the mileage of car traffic or the emissions per unit from cars. The pricing of vehicle traffic is also a great example of an action that can be used to support the renewal of the vehicle population: the fees for low-emission vehicles could be lower than those for other vehicles.

The actions analysed have many economic effects. The most easily identifiable effects are the direct costs caused by the implementation of the actions. Some measures, such as the pricing of traffic and the raises to parking fees, will also generate income for the City organisation, in addition to costs. Many plans and programmes related to traffic define the required costs and their distribution amongst various actors.

## Summary of the economic impact of emissions reduction actions for traffic

The traffic-related actions analysed have many economic effects. The most easily identifiable effects are the costs caused by the implementation of the actions. The costs are affect various parties, and the distribu-

tion of costs between parties is not always clear. Most projects related to transport are also implemented for reasons other than climate change. An example of these reasons is the development of public transport. Some measures, such as the pricing system for vehicle traffic and the raises to parking fees, will also generate income for the City organisation, in addition to costs.

A significant number of actions are already included in the development programmes and plans prepared in the past, such as the development programme for cycling, and the BAU scenario requires the implementation of these older actions, as such. Some of the actions may not require investments; instead, they can be implemented in connection with ordinary official work (for example: the complementing of the community structure in city planning to promote the use of public transport and other sustainable modes of transport). The detailed content of some of the actions cannot yet be defined.

At this stage, a single-value cost estimate cannot be presented for the traffic-related emissions reduction actions. It is easiest to estimate the costs and cost-efficiency of actions that have already been implemented and for which calculation methods for the emissions reductions already exist. An example of such an action is the adoption of renewable fuels.

The implementation of actions, in particular in the existing development programmes and plans, does not depend on funding as the budgeting of the City (such as the investment programme) has already prepared for the necessary resources. The implementation of the actions, particularly in densely constructed areas, requires that the statutory engagement opportunities are secured and the varying interests of different actors are harmonised, which may take time.

In addition to direct cost effects, the actions will also have indirect economic effects. These effects include the health benefits gained from the decrease in local traffic emissions and the increase in bicycling and walking. Calculation and valuation methods are not yet available for all of these effects – despite their importance or great significance.

## Increasing the proportion of cycling as a mode of transport

To increase the proportion of cycling among the different modes of transport, a diverse selection of measures is required, including influencing, building infrastructure and high-quality maintenance. If the City wants to increase the volume of cycling, essential routes need to have sufficient space for cyclists.

In the 2014 development programme for bicycling, an annual funding level of 20 million euros was presented (until ca. 2025), of which approximately 18 million euros were proposed to be used on infrastructural investments (approximately 50 per cent of the sum is needed for the expansion of the Baana network). The remaining 2 million euros would be spent on the implementation of cycling-related services, communications, monitoring and the implementation of other matters.

In Helsinki, the 10-year investment programme included in the budget for 2018 includes direct appropriations of approximately 11–20 million euros for working on the pedestrian and cycling paths of the City. In addition to this, the paths for walking and cycling will be implemented in connection with new construction using the budgetary appropriations allocated to the implementation of project areas and that are specific to the ‘major districts’. Cycling is also promoted through means such as the development of the city bike system, implemented within the framework of HKL’s investment programme (approximately 0.7–1.3 million euros a year).

## Raising the service level of public transport

Improvements to the service level of public transport are affected by various factors. The service level can be affected by establishing or constructing new rail connections, and the service level can be improved through line planning, for example by making the lines faster, shortening the intervals and improving the connections and conditions at interchange stations. Additionally, campaigns and marketing projects that influence people's habits can also be implemented to expand the clientele of public transport. The actions can be implemented in various ways and at various cost levels.

According to HSL's 2017 development programme for interchange stations (the Solmu project), the costs of the improving the interchange stations were 0.5–1.4 million euros in 2016–2020. Of these costs, the City of Helsinki's share (including the City's direct share, HKL's share and half of HSL's share) equals approximately 0.4–1 million euros. However, it should be noted that the cost estimate is only indicative as the costs have not been estimated for all action presented.
The development programme for tram traffic, approved by the Urban Environment Division in November 2017 (Helsinki Urban Environment Division 2017), describes the principles for improving the rail infrastructure and the operation of the tram traffic in the City centre. The programme's main focus is on the area of the existing tram network in the inner city. Future light rail solutions will be implemented as separate entities, although the development needs of the inner city sections used by them have been taken into account. It is estimated in the development programme that the costs of the improvements to the rail infrastructure will amount to approximately 60 million euros, at current value and within a time span of 15 years. This equals an annual cost of approximately 4–5 million euros.

The implementation of the development programme is estimated to produce approximately 4–4.5 millions of euros' worth of annual savings in the operating costs of tram traffic after the programme has been realised (calculated based on the operating level of autumn 2017; if the lines are operating at a higher level, the savings will be higher).

The actions based on the development programme for the tram network can be implemented in the 10-year investments plan of HKL, within the approximately 70 million euros allocated for the changes and modernisations of the tramways in 2018–2027 (the budget of Helsinki for 2018 is included here as an appendix).

The full extent of the 10-year investment programme of HKL is approximately 1.3 billion euros, which can be expected to be allocated to the improvement of the service level of public transport. As for the investments made by HKL, it should be noted that allocation of costs (operation, investments) caused to the City by the organisation and development of public transport follows the basic agreement with HSL and the agreement on the cost reimbursement of public transport infrastructure. The City will pay the costs of organising and developing public transport within the payment share of HSL and as direct subsidies for HKL. The payment share of HSL can be estimated at approximately 200 million euros per year while the subsidies for HKL can be estimated at approximately 20–25 million euros per year.

As a part of HSL's planning, minor line changes and improvements to existing lines will be implemented annually. The City prepares for the necessary traffic arrangements caused by these with an annual sum of approximately 6–10 million euros, within the framework of the budgetary appropriation directed towards the development of the investment programme for public transport and the traffic arrangements.

# An increase in the proportion of electric cars and the development of heavy traffic vehicle technology are estimated as the most significant actions in the traffic sector.

In addition to the costs caused, it should be noted that, when implemented, the acceleration projects for public transport produce indirect benefits, such as the time and service level benefits for the passengers, in addition to the direct operational savings.

## Influencing the volume of vehicle traffic

The investment and usage costs for a pricing system based on gate zones, as examined during the preparation of HLJ 2015 (HSL 2016c), were estimated to be approximately 20–25 million euros a year. With a socio-economically optimised toll, the net profit was estimated to be 80 million euros a year. In this Action Plan, the emissions reductions achieved through road tolls have been calculated with toll that is higher than the optimal socio-economic level. In this case, the net profit would be approximately 160–170 million euros a year. The direct costs and income presented would be apply

across the entire region, and Helsinki's proportion was not estimated individually.
The adoption of a pricing system for vehicle traffic would require changes to legislation. Similarly, it is necessary to agree on the level of the road tolls, the zones and the procedure by which income will be allocated to the development of the region's transport system in such a way that the procedure does not decrease the region's average long-term traffic funding from the state.

In this Action Plan, vehicle traffic pricing that is higher than the optimal socio-economic level is presented in order to achieve sufficient emissions reductions. In this case, the direction, significance and allocation of the negative effects for different user groups and areas have been estimated to be somewhat uneven from the perspective of business, in particular, which is why the system requires further development. Reduced congestion and pollutants, as well as faster journeys, will compensate for the disadvantages.

## Parking policy

According to the Helsinki City Strategy 2017–2021, "the City curbs the costs of construction and densifies the city structure by gradually moving – without risking its competitiveness and accessibility – towards an areal and market-driven parking system, starting in the new housing developments." It can be estimated that this will lead to a more flexible number of parking spaces.

The increase to parking fees and the expansions to the parking fee zones is possible. Due to zone changes, the parking income of the City grew by 6.5 million euros from 2016 to 2017. Raising the parking fees and expanding the zones will not involve costly development of infrastructure or similar costs, with the exception of traffic signs (and the potential parking meters). In the zone changes mentioned above, the costs of the signs and the installation was estimated to be approximately 100,000 euros per new zone. A programme for the increase to the resident parking fees has been developed, and it will continue until 2021.

The actions related to pricing of parking need to be assessed in terms of positive and negative effects on the operating conditions of businesses, and, thus, the location of jobs. At the same time, companies are clearly concentrating their presence in the vicinity of the stations for heavy rail traffic. Of the jobs in companies located in the metropolitan area, 57 per cent are located a maximum of one kilometre away from a heavy train traffic station (local trains and the metro), and almost a third of the companies' personnel live less than a kilometre away from a station (2013). As many as 46 per cent of the companies' personnel are based less than 600 metres away from a station. Companies in Helsinki and the metropolitan area have commendably located to areas that are easily accessible by foot, bicycle or public transport. (HSY 2015)

## Mobility services

Actions related to mobility services are complex. The mobility service industry is still developing, which is why accurate definitions for the actions are not yet possible. The role and tasks of the City in this developing industry are also at a formative stage. In general, it can be said that in user-oriented services, the City and HSL will mainly act as platforms (enablers), and companies will produce the services being offered. The costs of the services are market-determined. The City may accrue costs from pilot projects, among others. The costs will be defined case by case.

The advantages and savings will mainly benefit consumers, who will save in fuel costs, and, when giving up their own cars, in the capital and insurance expenses for cars.

## Heavy traffic technology

The City has limited opportunities to influence the renewal of the vehicle stock in the City. In the procurements for the City's own vehicles, the prioritisation of low-emission vehicles is essential. The prices of chargeable hybrid machines are currently 1.5–2 times higher than those of regular machines. Biofuels are also slightly more expensive than ordinary fuels. For example, the additional cost of biofuels would cost Stara approximately 150,000 euros annually (20 per cent increase).

## Passenger traffic technology

“Building one charging station for electric buses costs approximately €350,000, and the total investment for constructing the necessary number of charging stations is estimated at approximately €12m during 2018–2021. Helsinki’s share of the costs would be approximately 4 million euros.” (HSL 2017b).

The prices of electric buses are currently much higher than those of diesel buses (1.5–2 times as much), but as the market develops, the prices can be expected to decrease. However, it is possible that with an extended contract term of 10 years, and considering the affordability of operating energy, the resulting changes in the level of costs may be small in the long run (HSL 2017b).

Approximately one million euros (+ VAT) a year have been spent on the environmental bonuses of HSL’s bus traffic. According to HSL’s operation and economy plan for 2018–2020, Helsinki’s municipal share of the environmental bonuses is approximately 870,000 euros per year.

In the environmental bonus model, the proposals for emissions reduction actions will be auctioned, which leads to the most energy efficient proposals being implemented. In the environmental bonus competition for bus traffic in 2018, 975,000 euros’ (+ VAT) worth of actions, which will reduce greenhouse gas emissions ($CO_2e$) by 15,000 tonnes in 2018 (in the entire region covered by HSL), were approved.

The bus traffic ordered by HSL will switch to exclusively using renewable fuels by 2020. The inclusion of key actors, such as HSL and Stara, in the BioSata project allows for rapid adoption of biofuels.

According to the report of the electric traffic working group (2016), the cost of the charging stations for cars was approximately 6,000 euros per charging stations; the true implementation price of the charging stations was estimated as approximately 10,000–15,000 euros per charging station.

## Mobility-related steering and communications

It is difficult to separate the emissions reductions enabled by individual actions. Communications are required to lay the groundwork for the changes and improve their acceptability. At the moment, communications and the steering of mobility are conducted by Ilmastoinfo (a part of HSY) and HSL. The communications conducted through both HSY and HSL are funded through municipal allocations. Ilmastoinfo also receives funding from the payments of the companies in the EcoCompass initiative and the EU’s project funding. The municipal allocation for Ilmastoinfo amounts to 408,000 euros per year, of which approximately 50 per cent comes from Helsinki. Only a portion of this allocation is spent on mobility guidance, campaigns and similar

purposes. Cost estimates for the mobility guidance and campaigning conducted by HSL do not exist.

### 4.1.8 Effectiveness of traffic-related actions

Commissioned by the City of Helsinki, Motiva Oy prepared the Low-emission report in autumn 2018. In the report, the effectiveness of traffic-related actions were analysed (Motiva Oy 2018). The focus of the analysis was on vehicle technology and its development. The 30-per-cent proportion of electric cars used in the calculations of the Action Plan may well be possible in Helsinki, according to the latest forecasts, as may the emissions reduction goal for heavy traffic fleets, as long as high-quality renewable fuels are available at a reasonable price. To reach the desired emissions reductions (-69 per cent) of traffic through the actions, all actions described in the Action Plan will need to succeed. The greatest risk is that many of the impacts are based on significant changes in the habits of residents of both Helsinki and the neighbouring regions, not only on matters that can be decided on solely by the City of Helsinki.

The Action Plan is affected by the development forecasts for automobile technology. The reduction of greenhouse gases and harmful exhaust gases requires a combination of technologies (driving forces). For example, increasing the volume of all-electric vehicle is not sufficient; instead, the entire selection of sustainable transport modes is required. Smooth travel chains reduce the use of private passengers cars and improve the internal and external accessibility of the municipality, but they can only be implemented through collaboration with other municipalities. The carbon dioxide emissions from electric cars are affected by the development of the energy production structure.

The following action proposals in the report were selected for further examination:

- **Studying the benefits of parking for low-emission cars (for example: the City's sports facilities, collaboration with other actors, such as shopping centres).**
- **Helsinki's own additions to the scrapping bonus and alternative subsidies for the purchases of electric bicycles (meaning a subsidy that can also be spent on a bicycle instead of a new car).**
- **Allowing low-emission cars to use the bus lane at specific times, provided that public transport is not significantly delayed.**
- **If congestion taxes are examined, the examination should include discounts or exemptions granted for low-emission cars.**
- **Examining 'super blocks' in which specific areas or streets would be reserved exclusively for low-emission cars.**
- **Parking fee discounts for low-emission cars in City-owned rental apartment buildings and properties.**

## 4.2 Construction and use of buildings

### Description of the status quo

According to the City Strategy: "The energy efficiency of buildings will be improved both in the construction of new and the renovation of old buildings. Helsinki's energy efficiency norms are more ambitious than the national minimum level. Helsinki strives to combine renewable energy sources with energy efficiency in an optimal way, both in individual buildings and in areas."

The heating of buildings causes more than half of Helsinki's emissions. At the moment, heating is still mainly produced with fossil fuels, which produces a great volume of emissions. The less buildings use heating, the less heating will need to produced. Approximately 90 per cent of the properties in Helsinki are part of the district heating network. Moving towards carbon-neutral energy production in a cost-efficient manner will need to be supported by Helsinki residents reducing the need for heating in their buildings. There are three key measures with which this objective can be achieved. In buildings, energy efficiency can be improved, energy can be produced on-site and heat wasted through air and water can be actively recovered. To achieve the emissions reductions optimally in terms of costs and the effects for residents, it is important to look at the energy system as a whole and not from the perspective of an individual property or area. For example, the property-specific solutions do not always support the total energy efficiency of the whole energy system.

It is important to improve energy efficiency in both existing buildings and new buildings to be constructed in the future. In the old city structures, particularly in suburbs, heat pumps can be used to recover significant volumes of heat being released from the buildings. The building stock of the 60s–90s is a significant source of heat waste since the buildings rarely include heat recovery systems as a part of the ventilation system; instead the used warm air is let out through exhaust air ducts. In these buildings, it is possible to recover heat with mechanical recovery systems for supply and exhaust air or with exhaust air heat pumps (EAHP). Adding heat recovery functions to a ventilation system is expensive and requires a long repayment period if the ventilation system needs to be replaced fully or mostly. However, upgrading the ventilation will also improve the indoor air quality of buildings. A less expensive solution is to recover heat with exhaust air heat pumps, but they do not improve the service level of the buildings and they increase energy consumption. However, the volume of district heating energy conserved with EAHP solutions is around three times as high as the increase in electricity consumption.

Energy efficiency renovations that require investments are best scheduled so that they are performed in connection with the modernisation of the building. If the modernisation is planned and implemented optimally, the energy efficiency of the building can be improved significantly. For example, the weatherproofing of the building can be improved or the windows replaced with more energy efficient ones during facade renovations. During plumbing renovations, essential energy efficiency renovations include the optimisation of ventilation, the installation of a heat recovery system and the optimisation of the heating system.

Energy efficiency can also be improved without repair construction as long as the technical systems of the buildings, such as heating, ventilation and electrical systems, have been adjusted correctly and are controlled when necessary. With regular inspections and automatic control, it can be ensured that the building only consumes the amount of energy it needs and that the usage con-

ditions (such as indoor temperature, indoor air quality, air humidity) are suitable. Energy savings can be achieved by reducing the consumption of warm water, for example with the help of water-conserving fixtures or apartment-specific or user-specific metering. As buildings become more energy efficient and consume less heat, the proportion of the energy used for heating domestic water of all heating consumption will grow. Reducing the consumption of electricity is more challenging than reducing that of heating as buildings have many systems running on electricity, and even more individual appliances using electricity. The fragmented nature of consumption requires several separate energy conservation measures specific to different system and appliances, since the electricity consumption of a building cannot usually be controlled in a centralised manner. Even though the energy efficiency of many electrical appliances has improved significantly, the diversity and number of appliances available have increased both at home and in services.

Of the building stock in Helsinki, over 90 per cent of buildings are connected to the district heating network. The proportion of separate heating is approximately 10 per cent, and according to statistics, this proportion is divided nearly evenly between electric heating (49 per cent of the floor square metres heated separately) and oil heating (47 per cent). Oil heating accounts for approximately 5 per cent of the heating emissions in Helsinki buildings, and it is mainly used in privately-owned detached houses. Most users who have stopped using oil heating have moved to district heating or geothermal heating, and this trend will likely continue. However, not all changes to heating methods are registered in statistics, which is why the number of oil-heated buildings may seem higher than what it is in reality. The energy and climate strategy (Ministry of Economic Affairs and Employment 2016) assumes that the proportion of oil heating in separate heating will drop to 40 per cent in existing commercial and service buildings, and the use of oil in residential buildings will end by 2050. The objective of the Finnish Government is to reduce the use of imported oil for domestic needs by 50 per cent in the 2020s. This objective also supports the phasing out of oil heating.

Currently, the climate objectives often only examine the effects buildings have on energy consumption when they are being used. The lifecycle emissions of buildings, including factors such as the manufacturing of building materials in another municipality, are currently not included in the emission calculations of Helsinki. The proportion of construction materials in the lifecycle impacts of buildings grows as the energy efficiency of buildings is improved, meaning that the emissions from the use of buildings are reduced. The above-mentioned puts pressure on cities to develop methods to also estimate the lifecycle emissions in the cities' emission calculations. For example, wooden construction produced significantly fewer greenhouse gas emissions than concrete construction. The City can reduce the lifecycle emissions of construction through its procurements. It is essential that the opportunities to influence lifecycle emissions during the procurement processes are identified and education on this matter is increased.

## Opportunities to reduce the emissions from construction and use of buildings

In the Carbon-neutral Helsinki 2035 Action Plan, the calculation of emissions is based on the expectation that the construction and use of buildings will adhere to the energy and climate strategy of Finland and that Helen will implement its own development programme. These actions mainly affect the emission factors of electricity and district heating, which will be significant reduced. The estimate of the emissions reduction impact and the costs was drawn up by Gaia Consulting.

As the emission factor of the energy form being compared is reduced, the emissions reductions achieved through the actions will also decrease, and more significant actions are required to achieve the corresponding emissions reductions. As Helen implements its development programme, the price of district heating can be expected to increase from the current level. However, in this analysis, the price was raised only based on inflation.

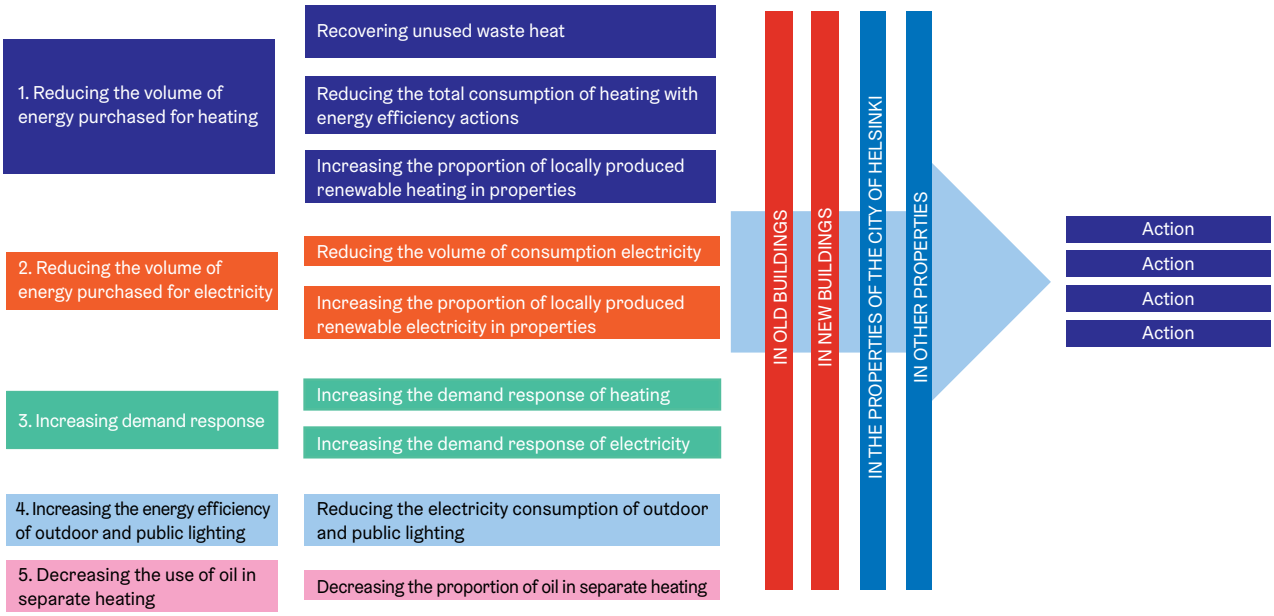
The emission factors used in the calculation were provided by HSY, and for district heating, they are based on the estimate in Helen's preliminary scenario regarding the distribution of fuels in 2035 (renewable and emissions-free fuels accounting for 70 per cent and natural gas accounting for 30 per cent). The rapid-growth forecast for Helsinki was used when calculating the development of the population and employment. The developments of technology, such as improvements to the coefficient of efficiency of heat pumps and solar panels, were not taken into account in the calculations.

In the Action Plan, the action entities are distributed differently to in the calculation of Gaia Consulting due to the practical implementation of the actions (Figure 13). In the monitoring tool, the actions can be grouped in different ways for different reporting and calculation needs.

The report by Gaia Consulting includes the distribution of emissions reductions and the corresponding costs by the age of building stock and the parties responsible (Figure 14). Helsinki's building stock will grow and be renewed significantly by 2035, but since the new building stock will be energy efficient, the majority of the emissions reduction potential concerns the old building stock (81 per cent of the whole, meaning 322 kt $CO_2e/a$ in 2035). The proportion of the potential owned by the City of Helsinki is approximately 11 per cent, meaning 45 kt $CO_2e/a$.

Figure 15 illustrates the estimate by Gaia Consulting regarding the emissions reduction potential of the actions in 2035. According to the estimate, renovations at the basic

**Figure 13. Grouping of the actions used in the calculations (Gaia Consulting Ltd 2018).**



level can help achieve a proportion of 42 per cent of the emissions reductions, while the Action Plan helps achieve a proportion of 58 per cent. The emissions reduction impact of the Action Plan has been calculated using the 2015 emission factor for electricity and heating, which is a good way to illustrate the emissions reduction impact of the actions in the coming years. For comparison, Figure 17 (page 85) illustrates the impact using the 2035 emission factor.

**Figure 14. Emission reduction potential by building stock and the responsible party in 2035** (Gaia Consulting Ltd 2018).

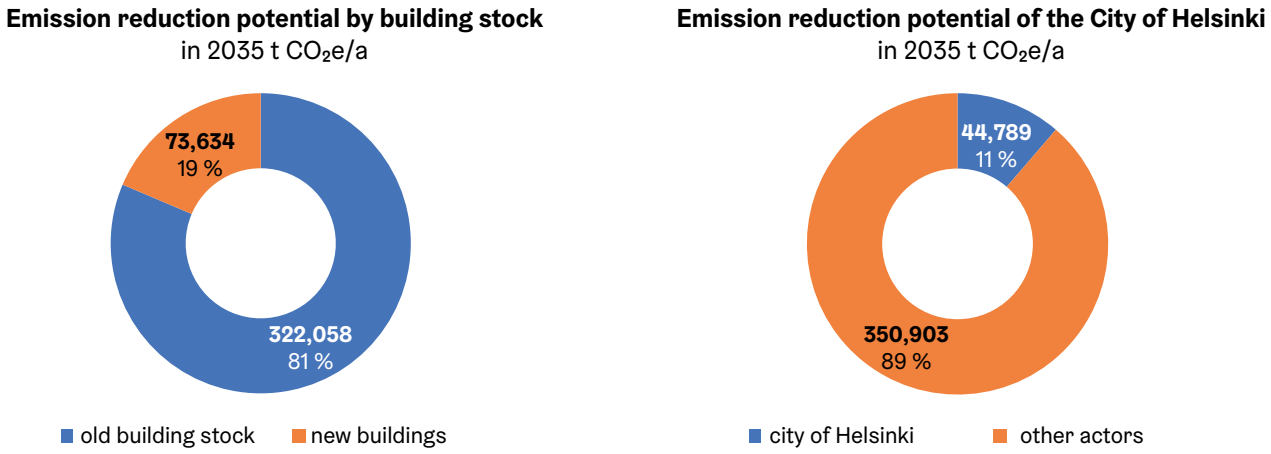
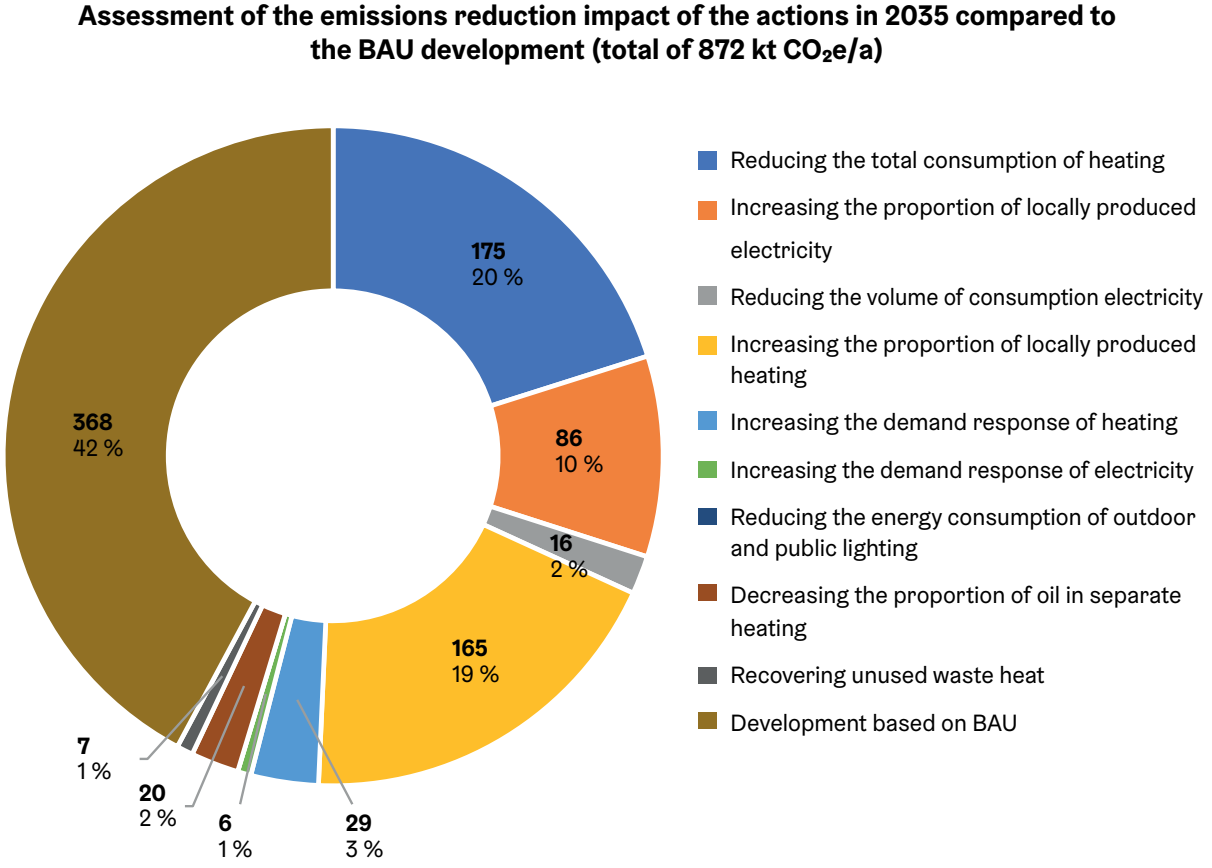



**Figure 15. The combined technical and economic emissions reduction potential of the Action Plan and the basic level of repair construction in the sector of construction and use of buildings compared to a situation where the actions would not be implemented. The 2015 emission factor was used in the calculations.** (Gaia Consulting Ltd 2018)



## 4.2.1 Residential and service buildings and outdoor lighting owned by the City

In its own construction of office buildings and housing, Helsinki has strived for improvement in energy efficiency that is more rapid than the national level. In its implementation plan for housing and land use, Helsinki has defined the energy efficiency conditions for the City's plot conveyances to be stricter than required by the national regulations. In the planning instructions of Helsinki Housing Production Department (ATT), the E value objective for the previous year was 115 kWh/m². In the construction of office buildings, the City strives to fulfil the requirements for near-zero energy construction this year, although the requirements will come into effect for private construction of office buildings only in 2020.

### Service buildings

The City of Helsinki owns approximately 16 per cent of the service buildings in the City area, and its proportion of the energy consumption is approximately at the same level.

Steered by the previous advisory board for conserving energy, the City of Helsinki has developed the energy conservation in its building stock since 1974. An energy conservation work group will start in the new City organisation in 2018. The energy efficiency agreements (KETS) made between the municipalities and the Ministry of Economic Affairs and Employment are used to implement the actions required by the national energy and climate strategy. Since the energy conservation agreement made in 1993, Helsinki has conducted energy surveys in over 80 per cent of the service building stock of the City, and approximately 50 per cent of the economically viable energy conservation actions proposed in the surveys have been implemented. The specific heating consumption of buildings is constantly decreasing. The electricity consumption has not increased in the last few years, either, despite the growing number of electrical appliances.

In the energy efficiency agreement of the last contract period, 2008–2016, Helsinki achieved the energy conservation objective of 9 per cent through measures such as low-energy construction, energy renovation during modernisations and separate energy conservation actions and investments. The current energy efficiency agreement for 2017–2025 was signed in October 2016, and its instructive minimum objective for energy conservation is 7.5 per cent from 2015. The new agreement encompasses the energy consumption of service buildings, street and outdoor lighting, vehicles and machines owned by the City, common areas and public transport.

Since 2018, the City of Helsinki has committed to the planning and implementation of new office buildings following its own near-zero-energy requirements that are stricter than the national requirements. Similarly, the City is committed to applying the near-zero energy instructions to the modernisation of buildings, with the characteristics and cost efficiency of each buildings taken into consideration. In near-zero construction, the improvements to energy efficiency are based on measures such as structural solutions, weatherproofing, the management of building services engineering systems, appliance-specific consumption and power demand levels, the recovery of heat and the use of renewable energy. Earlier in this decade, the construction of office buildings has been implemented as low-energy construction.

In the existing building stock, energy consumption is monitored at a hourly level, and property-specific target levels have been set for each building. Energy efficiency is constantly improved through various means both in daily property management and by implementing economically viable separate

investments, for example in ventilation control or the renovation of the lighting.

As the efficiency of facilities is improved, the usage period of a building is extended, the utilisation rate will increase, the number of users will grow and, depending on the purpose, the number of electrical appliances may also grow. The energy consumption of an individual building may increase as the space utilisation is improved and empty spaces are taken into use, but the energy efficiency of the building may be improved in spite of this. Measuring energy efficiency requires new kinds of parameters in addition to the traditional parameters of total consumption and specific consumption. The abbreviations used in the Action Plan are listed in Appendix 1.

### Key actions related to the service buildings of the City

**31. The status of the actions identified in the energy surveys of the last years will be examined and both the unimplemented and feasible actions will be projected. The documentation of the survey implementation will also be developed.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Maintenance, Construction Contracting.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**32. The most significant sources of heat loss in the City's service building stock (in particular, sports halls and apartment buildings) and the opportunities for heat recovery will be identified. The viable projects will be implemented.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Heka housing, Buildings and Public Areas / Construction Contracting, Culture and Leisure Division, Services and Permits / Environmental Services, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** Requires human resources, service procurements and investments.

**33. The cost effects of energy consumption and energy savings will be better allocated for the actors affecting the energy consumption of facilities.**

- These actors include building maintenance, users and evening users.
- We will attempt to develop a method that encourages all actors to conserve energy.

**Parties responsible:** Buildings and Public Areas / Premises Services, Built Assets Management, Maintenance.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs.

**34. The consumption monitoring of office buildings will be developed towards the monitoring of energy- efficiency by adding the condition and usage data of the buildings into the energy consumption data.**

- All properties owned by the City or that offer City services will be connected to the new monitoring system, and all buildings owned by the City or its subsidiary communities and premises used by the City and rented from elsewhere will be eligible to join.

**Time span:** Council term 2017–2021, continuous.
**Parties responsible:** Buildings and Public Areas / Built Assets Management, Construction Contracting, Maintenance, Executive Office, Helen.
**Complexity:** Decision by the City of Helsinki and its subsidiaries.
**Cost estimate:** Requires human resources and the procurement of services.

**35. Demand response of electricity and heating will be piloted in the City's premises in different types of service building. Based on the pilots, the potential of demand response in the premises and the need for investments will be estimated, and a plan will be made for the extent and schedule of the adoption of these changes.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Helen.
**Time span:** The pilots and the assessment of the potential during council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires human resources, service procurements and investments.

**36. Property-specific or regional opportunities for storing energy (electricity and heat) will be examined, as will the cost effects of these opportunities. Based on the results, objectives will be set for using the storage to increase the demand response level and as reserve power, and an operating plan will be prepared.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Helen, Executive Office / Area Construction.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**37. A target programme for using renewable energy in the City's construction projects and existing buildings will be prepared, and the progress of the programme will be monitored.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, in collaboration with Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**38. The City will constantly develop its criteria and methods for procurements in construction and maintenance so that they will take City's ambitious goals into account in terms of things such as energy efficiency, lifecycle $CO_2$ emissions and environmental impacts.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Construction Contracting, Maintenance, Environmental Services, Urban Environment Division / procurements.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**39. The commitment and competence of the actors responsible for construction and maintenance will be strengthened in terms of the low emission levels, energy efficiency and lifecycle impacts of the construction projects and existing buildings and in terms of the environmental criteria used in procurements.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Construction Contracting, Maintenance, Land Use and City Structure, Services and Permits / Environmental Services, Administrative and Support Services / procurements, Operational Development, Stara Construction, HKL.
**Time span:** 2018–2019
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**40. Policies, objectives and procedures will be set for facility projects with conflicting interests related to energy efficiency and the utilisation of renewable energy, i.e. costs, profitability, protection values, architectonic solutions and the cityscape.**

**Parties responsible:** Buildings and Public Areas, Land Use and City Structure, Services and Permits, City Museum.
**Time span:** Current council term, 2017–2021.
**Complexity:** Decision by the City of Helsinki apart from the protection decisions made by the Finnish Heritage Agency.
**Cost estimate:** Requires resources.

**41. The project planning and cost calculations for facility projects will be developed from the perspective of energy efficiency and emissions reductions to ensure that the maximum prices set in project decisions will not impede the implementation of cost-efficient solutions.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management.
**Time span:** 2018
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**42. The lifecycle emissions from the City's construction and infrastructure projects will be minimised.**

- The City will contribute to and participate in the preparation of tools, calculation methods and national databases for initial data for the estimation of lifecycle emissions, together with the Ministry of the Environment, Ministry of Transport and Communication, the Finnish Transport Infrastructure Agency, the Confederation of Finnish Construction Industries and GBC Finland.
- A report will be drawn up on the current state of lifecycle emissions in the City's infrastructure and construction projects, on the opportunities to reduce emissions and on the necessary steering measures for projects and the inspection of alternatives in pre-construction.

- An emissions reduction objective and procurement criteria will be set for the lifecycle emissions of buildings and infrastructure projects, categorised by the project type.
- The tools for calculating lifecycle emissions will be piloted in the construction projects in all stages of the planning and construction processes. The effects the pilots have on land use and project planning will be reported.

**Parties responsible:** Executive Office / neighbourhood construction, Urban Environment / Fingo, Buildings and Public Areas / Built Assets Management (mass coordinator) / Construction Contracting, Heka Housing, Land Use and City Structure.
**Time span:** The calculation method will be harmonised during this Council term (2018–2021), the report and the goal-setting will be done in future terms.
**Complexity:** Requires the creation of a national, harmonised calculation method, at the minimum, otherwise decided by the City of Helsinki alone.
**Cost estimate:** Requires resources.

**43. The City will pilot energy-plus construction, examine the cost effects and challenges of such construction, and, based on the former, prepare a plan for moving gradually towards energy-plus construction while discussing the matter with innovative actors in the construction industry.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Executive Office, Land Use and City Structure, Helen.
**Time span:** The pilot will start during this Council term (2017–2021), and the plan will be prepared during the next Council term.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## Circular economy in construction projects

The City of Helsinki conducts pilots of various methods used to control the environmental impact of buildings throughout their lifecycle, starting from the design stage. The methods being piloted are various environmental classifications, the Level(s) indicators of the European Commission and the City's own models for lifecycle objectives and the environmental documentation of construction sites. There are other tools and models on the market, as well. The lifecycle carbon footprint of a building is a part of the environmental impact of the buildings. The calculation of the carbon footprint will be included in the national steering methods for housing construction by 2025, and the Ministry of the Environment will publish the first version of the calculation model in November 2018. Environmental classification tools and lifecycle objectives also include the assessment and steering of other environmental matters.

With lifecycle assessment (LCA), construction methods and techniques can be developed in a low-emission direction even though the impact assessments become increasingly uncertain the longer the lifecycle is. It will also make the emissions from material production chains visible and encourage the use of recycled, renewable and sustainably produced materials. Lifecycle assessment also supports the objectives of circular economy effectively since the use of recycled materials is encouraged, the emissions from the maintenance and replacement of materials are minimised and the processes at the end of lifecycles are made visible.

The emissions from construction sites can form a significant part of the emissions from construction and traffic. The foundation conditions affect the carbon footprint of the construction stage. The stabilisation of the ground, the movement of landmasses and pile driving all increase the emissions from construction. In infrastructure construction, for instance, the subgrade reinforcements may account for up to 80 per cent of the emissions in the implementation of the construction project. Different measures for subgrade reinforcement, such as loading berms, mass and pillar stabilising and mass exchange cover most of the emissions from construction, and the emission impacts of the different measures and methods are also at different levels. The City of Helsinki

will aim to offer information about the emissions reduction opportunities in pre-construction during the zoning and planning of projects.

The use of landmasses in construction projects will reduce the emissions and costs caused by the transport of the masses. The development programme for the use of excavated earth, which has been implemented in Helsinki from 2014 onwards and which aims for utilisation locations to be found for all excavated and quarried landmasses. With better control over the landmasses and the utilisation of the masses, annual savings of 5–10 million euros have been achieved in Helsinki alone. In three years, the actions in the development programme for excavated earth have saved Helsinki approximately 32 million euros, 4.5 million litres of fuel and 11,311 tonnes of carbon dioxide emissions.

In addition to this, the emissions from the transport related to the machinery and the construction sites make up a significant portion of the emissions in the City area. According to the estimate of the City of Oslo, the greenhouse gas emissions from the machinery at construction sites may account for as much as 25 per cent of all traffic emissions.

### Key actions related to circular economy in construction projects

**44. The obstacles and opportunities related to increasing the proportion of recycled materials in housing construction, infrastructural construction and maintenance. Actions and instructions for this will be prepared.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Premises Services, Construction Contracting, Land Use and City Structure, Heka Housing.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** Requires resources.

**45. The principles of using excavated earth, rock material and demolition material in groundwork and the related action plan (2018–2021) will be put into practice as a part of the procedures following the resource planning system. The principles will apply to the key processes of the Urban Environment Division: the land acquisition and area management of the City, the general planning of land use, zoning, pre-construction and the planning and construction of infrastructure and buildings. The City will participate in the development and adoption of the regional landmass tool using geographical information (SeutuMaisa).**

**Parties responsible:** Buildings and Public Areas / Built Assets Management / Construction Contracting / Maintenance, Land Use and City Structure, Heka Housing, HSY, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**46. Emission-free construction sites will be piloted in the City's own construction projects, and a model and criteria for all sites will be adopted based on the experiences from the pilot. The model and the criteria will be included in the environmental document for infrastructure and housing construction projects, as well as in the environmental plan of the site. The actors having construction projects within the City will be steered to use the model and the criteria.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management / Construction Contracting / Maintenance, Environmental Services, Land Use and City Structure, Heka Housing, HSY, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## Examples

Stockholm piloted energy-plus construction in the first block of the Royal Seaport, aiming for carbon neutrality. The design competition was won by the city's own housing production department.
www.byggnorden.se/fastighet/stockholmshem-bygger-stockholms-forsta-plusenergihus

Statsbygg, a construction contractor owned by the State of Norway, uses the calculations of a lifecycle carbon footprint in all of its projects throughout the entire construction and planning process (selection of a plot, setting of objectives, comparison of planning and competition alternatives, verification of savings). Some Finnish cities, such as Porvoo, Vaasa and Tampere, have used the EN-15978 carbon footprint in their plot conveyance competitions, for example in the Senaatti and ATT architecture/contract competitions.

The City of Oslo has piloted emission-free construction sites at six locations. Market dialogue with companies has had a central role as it has been used to create common criteria for tendering.
https://www.oslo.kommune.no/english/politics-and-administration/smart-oslo/projects/zero-emission-construction-sites/#gref

## City-owned residential buildings

The City of Helsinki owns a total of ca. 60,000 apartments, of which Heka Housing owns approximately 48,000 apartments, HASO owns 3,400 apartments, the Auroranlinna housing cooperative owns 2,300 apartments, and the remaining approximately 7,000 are owned by Helsingin Asuntohankinta and other parties. Heka is the largest company that owns Arava rental apartments in Finland. The Heka Group includes five regional companies, in addition to the parent company. Heka monitors the monthly energy consumption of the housing locations.
Previously, the housing companies of Helsinki committed to the energy efficiency agreement of the housing property industry (VAETS), the aim of which was to improve energy efficiency by 7 per cent between 2010 and 2016. Heka is also committed to the new VAETS agreement period for 2017–2025, in which the energy efficiency objective is 7.5 per cent. In Heka's housing locations, measures such as the balancing of the heating networks, changes to the control characteristics and the replacement of radiator valves have been taken. Similarly, the pumps of the water-circulating radiator network have been replaced with more energy efficient alternatives. Flow limiters have been installed and leaking taps and sanitary fittings have been replaced and repaired to influence the water consumption. Heka has piloted exhaust air heat pumps, solar panels and the demand response of heating in its apartment buildings stock in the last few years. Heka also made the energy consumption data of its properties available to be used in the open 3D city information model of the City in February 2018.

### Key actions related to City-owned residential buildings

**47. Solutions for the recovery of the heat from exhaust air and sewage will be implemented: locations being renovated will use either mechanical input and removal with heat recovery or an EAHP. EAHP projects will be implemented without renovations in buildings where it is economically viable (repayment period of under 15 years).**

**Parties responsible:** ATT Housing Production, Heka Housing, HASO, Auroranlinna, in collaboration with Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs; repayment period of under 15 years.

**48. Great energy efficiency will be sought in the renovations of the City's own housing production, and actions for making the buildings more energy efficient will be implemented where they are viable in terms of lifecycle costs.**

**Parties responsible:** ATT Housing Production, Heka Housing, HASO, Auroranlinna, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Significant costs; lifecycle costs have been taken into account.

**49. The renovations and separate measures for improving energy efficiency will be planned and implemented according to the long-term maintenance plans. The plan must also include annual maintenance and repair-type measures (heat exchangers, adjustments to radiator valves, reduction of water consumption).**

**Parties responsible:** ATT Housing Production, Heka Housing, HASO, Auroranlinna.
**Time span:** Council term 2017–2021; plan finished by the end of 2018. Annual monitoring through binding objectives in the budget / other objectives.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**50. Heka's old property automation systems will be upgraded to improve energy efficiency. Remote reading and measuring of water consumption will be made possible in collaboration with HSY.**

**Parties responsible:** Heka Housing, Auroranlinna, HASO, Buildings and Public Areas, HSY.
**Time span:** Starts during council term 2017–2021.
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Requires resources.

**51. The City will investigate the utilisation of renewable energy in its own building stock and that of its subsidiaries. The objective is to find cost-efficient (repayment period of 10–15 years) targets to be repaired in terms of local heating and electricity production. Based on the investigation, a scheduled implementation plan will be prepared.**

- During the investigation, the results of the local heating production trials and the impact thereof will be analysed.

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Heka Housing, Executive Office / Financial and Planning Services, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**52. Heka will pilot the use of geothermal/marine heating and expand the use thereof based on the experiences.**

**Parties responsible:** Heka Housing, in collaboration with Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**53. General and common guidelines to support renovations will be prepared. Descriptions of technical concept solutions will be prepared for different types of projects: buildings of different ages and types, renovations of different types; lifecycle calculations, such as MOBO, will be used here. The concepts will be updated based on the development of solutions and prices. The concept solution will include the following, in addition to the technical renovation solutions:**

- Target level for energy conservation or the E value
- The implementation measures for heat recovery from ventilation and sewage
- Adoption of renewable energy, such as solar panels
- Demolition will be examined for unprotected locations where the price of the renovation would be close to the price of a new building.

**Parties responsible:** Heka Housing, ATT Housing Production, Auroranlinna, HASO, Buildings and Public Areas / Built Assets Management.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs.

## Outdoor lighting

The public outdoor lighting network of the City area contained 86,100 lighting points in 2015. The electricity consumption of outdoor lighting amounts to 48.5 GWh, which equals 3 per cent of the energy consumption of the City. The consumption was reduced by 2 per cent from the previous year. Compared to 1997, the total electricity consumption of outdoor lighting has decreased by 26 per cent while the energy consumption of the lighting points has decreased by 39 per cent. During this period, the number of lighting points has increased by 21 per cent.

The renovations of outdoor lighting are steered by the Commission Regulation 245/2009 of the EU (18 March 2009), which defines the energy efficiency requirements for the light fixtures used in outdoor lighting. Based on the regulations, the Public Works Department, together with Helsingin Energia (Helen), prepared an Action Plan for the improvement of energy efficiency in 2010. The plan consists of three parts: upgrading old light fixtures to meet the requirements of the regulations, adopting a new control system for outdoor lighting and the monitoring of the development of LED lights and the adoption thereof. In the new energy efficiency agreement, street lighting is set an instructive energy conservation objective of 7.5 per cent for 2017–2025.

According to the report by Gaia Consulting, replacing street and outdoor lighting with energy efficient LED lighting will only create minor emissions reductions compared to the whole (less than 1 % of the full potential). This action is weak in terms of cost-efficiency compared to the other actions.

**Key actions related to outdoor lighting**

**54. The City will upgrade street lighting to use LED light sources, according to plan, and also use smart lighting control.**

**Parties responsible:** Buildings and Public Areas / Maintenance, Built Assets Management.
**Time span:** Council term 2017-2021 + next terms.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Acceleration of the plan would increase the costs.

## 4.2.2 Energy-efficient land use and city structure

Land use planning can be used to promote sustainable construction in the City far into the future. In practice, the City's neutrality objective for 2035 means that the city structure being currently planned must largely be carbon-neutral or enable the achievement of carbon-neutrality.

### Detailed planning

Helsinki strives to combine renewable energy sources with energy efficiency in an optimal way, both in individual buildings and in areas. In detailed planning, the main lines are decided on, and it is ensured that a diverse selection of methods will be extensively available in the next stages of the planning process, such as plot conveyance, more detailed planning and other further stages.

With detailed planning, an energy efficient city structure and a low-carbon lifestyle are promoted. The city centres, sub-centres and station areas are complemented with additional construction, and the housing, jobs and services will be directed towards areas with good public transport connections. The viability of the planned rail connections will be ensured by constructing station areas efficiently, whereby it will be possible to significantly reduce the energy consumed and greenhouse emissions produced by traffic and transport. The concept of low-carbon station districts (LCD Low Carbon District) can be used in the planning. Helsinki is involved in the development of the LCD concept. The planning of city blocks can be used to influence factors such as the location and direction of buildings, as well as route and parking space reservations that favour cycling. Also included are the prevention of the buildings overheating and the themes of preventing the heat island phenomenon. Green masses play a significant role in this.

With detailed planning, we can promote energy efficient construction methods and construction where the level of energy efficiency is higher than the national level, with regional characteristics taken into account. Detailed planning is also used to promote the production of renewable energy, for example through regional or plot-specific pilots.

Detailed planning can also promote changes towards climate-neutral energy production as required by the centralised energy production. Helsinki has created principles for the location of wind power in connection with work on the city plan. In the principles, the potential areas for industrial wind power were planned in the outer archipelago and Vuosaari. With the location principles, Helsinki enabled the further planning of industrial wind plants on solid ground, in optimal wind conditions, for the first time. The impact of this decision will be assessed and monitored. Best practices and development projects will be adopted in future locations. The city plan allows the City to achieve the objectives in various ways.

The most significant changes cannot be achieved through detailed planning alone; instead, multiprofessional and cross-organisational collaboration is required to set and achieve project-specific objectives. For example, multi-level development projects similar to the Smart Kalasatama project will create many opportunities for collaboration between the organisations of the City and the private sector.

In important city planning projects, the most significant ways of influencing lifecycle greenhouse gas emissions, specific to each area, will be identified at the start of the project. These ways of affecting lifecycle emissions may include the following:

- **traffic solutions**
- **processing of contaminated earth**
- **foundation engineering methods**
- **mass balance**
- **energy solutions analysed from the perspective of the local actors, in collaboration with the energy solution provider**
- **conservation or addition of vegetation**
- **service network solutions**
- **construction methods**
- **large-scale recycling of materials**
- **wooden construction and the use of timber as a construction material.**

Based on the conclusions, shared climate objectives will be set for the planning and implementation of the area. During the project, whether the realisation of the objectives can be steered with detailed planning and which matters should be steered through other means shall be determined. When defining the means, it will be ensured that new innovations and methods can be enabled during the construction planning and the construction proper, and also after the area has been completed.

To support its own strategy, the City can set ambitious objectives during the planning to reduce emissions and act as a pioneer. The reform of the Land Use and Construction Act is about to start. The operating environment is affected by things such as digitalisation, climate politics and energy matters, the differentiation of the regional structures and the changes in the population, the growth of urban regions and urbanisation and the changes in mobility (Ministry of the Environment 2018). “The more effective direction of current steering methods towards the mitigation of climate change and the reduction of greenhouse gas emissions will be key when the land use sector is required to achieve more emissions reductions. The most significant solutions related to emissions reductions concern the community structure and functionality of urban regions,” states the Ministry of the Environment 2018.

Land use also needs to be prepared to respond to quick changes in demand. Meanwhile, people's requirements for the quality of their habitat and their sensitivity to changes in the habitat have increased. As a long-term document, the detailed plan must withstand time and potential pressure for change. It is important that the plan be flexible in case the regulations change, and that it will enable the use of different trials and new technologies to achieve the objectives.

### Key actions related to detailed planning

**55. Detailed planning will be used to promote the use of renewable energy and property-specific, regional and centralised production of renewable energy in a meaningful manner. Detailed planning will take the location principles for wind power into account. Detailed planning will be used to pilot regional or plot-specific development projects, the impacts of which will be assessed and monitored. The best ideas will be used in future locations.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. The actions will raise the costs of construction, but more cost-efficient solutions can be found with comprehensive planning.

**56. Detailed planning will be used to facilitate further planning to make the energy efficiency of construction projects exceed the national level, while also taking regional characteristics into account. Regional planning principles will be prepared as the basis for changes in city planning. The principles will be used to analyse additional construction on plots, which can support the energy efficient renovations in the existing buildings.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. The actions will raise the costs of construction, but more cost-efficient solutions can be found with comprehensive planning.

**57. Detailed planning will be used to steer construction where it can be used to influence the energy consumption habits of people. Such matters include shared spaces, lighting conditions, etc.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. The actions will raise the costs of construction, but more cost-efficient solutions can be found with comprehensive planning.

**58. By developing the regulations on land use planning, the selection of methods that support carbon-neutrality can be expanded. The regulation collection for land use planning will include regulations which are related to the use and production of renewable energy and energy efficiency, which cannot be expected to become outdated soon and which will facilitate flexibility regarding plot conveyance and the further planning and implementation stages, as well as various trials and new technologies to help achieve the objectives.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. The actions will raise the costs of construction, but more cost-efficient solutions can be found with comprehensive planning.

## Examples

In San Francisco, solar panels on new buildings are mandatory.
www.theguardian.com/environment/2016/apr/21/san-francisco-adopts-law-requiring-solar-panels-on-all-new-buildings

In France, the installation of green roofs or solar panels in commercial zones is required by law.
www.theguardian.com/world/2015/mar/20/france-decrees-new-rooftops-must-be-covered-in-plants-or-solar-panels

## Plot conveyance

The City of Helsinki is the most significant land owner in the area. Roughly 60 per cent of all construction occurs on plots conveyed by the City. Plots are conveyed through both selling and renting. The City uses plot conveyance to actively promote the objectives of its housing-related and economic policies, as well as other strategic objectives. Plot conveyance is also used to support the regional land use objectives set in the detailed plans for different areas. The City has used a slightly stricter requirement for emissions reductions in apartment buildings than to the norm (Class $C_{2013}$ E value < 120 kWh/m²).

With the terms and conditions of plot conveyance, the City can influence the energy efficiency and the lifecycle emissions of construction and steer the projects on plots conveyed by the City towards carbon-neutral construction. Since all plots and construction projects are different, the terms and conditions and steering methods of plot conveyance must be clear, predictable and flexible. This way, different planning and implementation solutions are allowed and no one is forced to use solutions that are in conflict with the official regulations regarding construction. The requirements for energy efficiency and renewable energy set in plot conveyance must not form unreasonable costs or impede the implementation of projects. The requirements must also be in balance with the other objectives related to plot conveyance.

The City can also use plot conveyance to encourage actors in the construction industry to use and develop energy efficient solutions. This can be done by allocating plots for actors who independently commit to the development and implementation of energy efficient projects, for example. Innovations that improve energy efficiency and eco-efficiency can also be encouraged through various plot conveyance competitions where energy efficiency and eco-efficiency and the related innovations are used as a key assessment criterion.

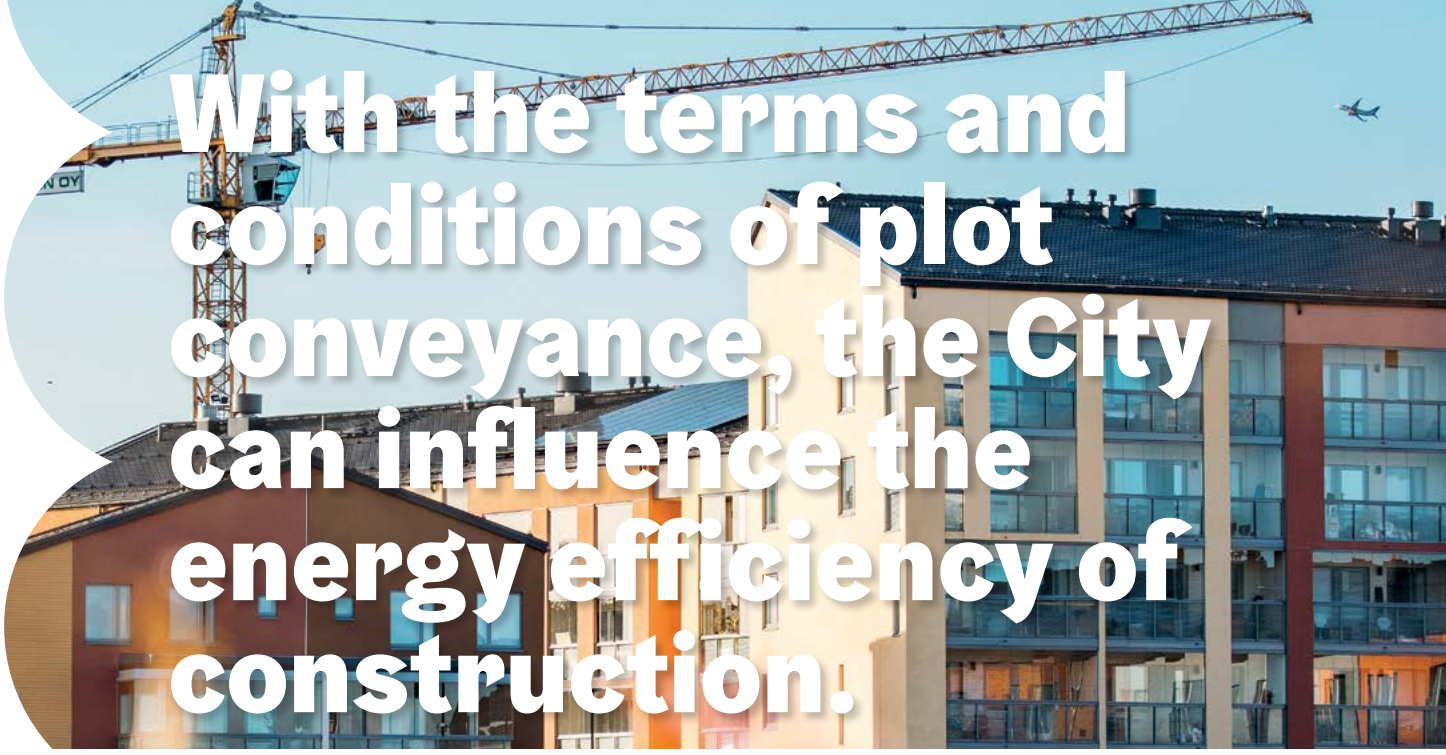
### Key actions related to plot conveyance

**59. The City's conditions for plot conveyance will include energy efficiency requirements that are stricter than the requirements at national level. The development needs and opportunities for the requirements will be actively assessed as the national requirements advance and as experience is gained from pilots and other projects. The requirements for energy efficiency will promote energy conservation and the production of renewable energy for buildings.**

**Parties responsible:** Land Use and City Structure / Land Property Development and Plots.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work as a part of the plot conveyance process. If the requirements are developed based on the current model, the monitoring of the terms and conditions will need to be increased. This will probably increase the costs of construction.

**The City will collect experiences of the effects of the smart energy solutions required in plot conveyance, and the solutions will be gradually adopted for all plot conveyance conditions, when possible.**

**Parties responsible:** Land Use and City Structure / Land Property Development and Plots.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. Collecting the experiences and potentially developing the conditions requires expertise we do not currently possess. Increasing the number of conditions and expanding them will also increase the need for guidance and supervision. This will very likely increase the costs of construction.



# With the terms and conditions of plot conveyance, the City can influence the energy efficiency of construction.

**61. In plot conveyance competitions based on quality, the criteria will include the carbon footprint and eco-efficiency of the construction project.**

**Parties responsible:** Land Use and City Structure / Land Property Development and Plots.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**62. The City will implement plot conveyance competitions that aim particularly at carbon-neutrality, the experiences from which will be analysed. The experiences gathered will be used when developing the terms and conditions for plot conveyance.**

- The opportunities to include other objectives in the competitions to promote and support Smart & Clean solutions will be explored.

**Parties responsible:** Land Use and City Structure / Land Property Development and Plots.
**Time span:** Pilots during the current council term (2017–2021); experiences to be included by 2035.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources. Resources are required for the definition of the competitions' assessment criteria, the assessment of the proposals and the analysis of the experiences gained. Requires expert competence.

## Building Control Services

According to the City Strategy, the energy efficiency of buildings will be improved both in the construction of new and the renovation of old buildings. Energy efficient solutions are proactively promoted in the planning stages of construction projects. The City will develop the proactive guidance for building renovation projects by including tools based on open data (Helsinki Energy and Climate Atlas 2018). The realisation of the minimum requirements set in the national energy regulations is a precondition for receiving a building permit, but with the preliminary guidance of Building Control, projects can be steered to aim for a higher level. The requirement for high energy efficiency is included in the City's terms and conditions of the conveyance of plots for apartment buildings and in the regulations related to some of the new detailed plans.

According to the Building Code approved by the Helsinki City Council in 2010, a permit is not required for the installation of a solar collector, solar panel or air source heat pump. The Land Use and Construction Act was amended in 2017 to include the provision that projects that affect the environment or the cityscape significantly require a permit (Land Use and Construction Act,

Section 126 a). Buildings protected based on legislation or the city plan have been deemed significant for the cityscape of Helsinki, which allows the City the ensure the competence of the designers and the quality of the plans.

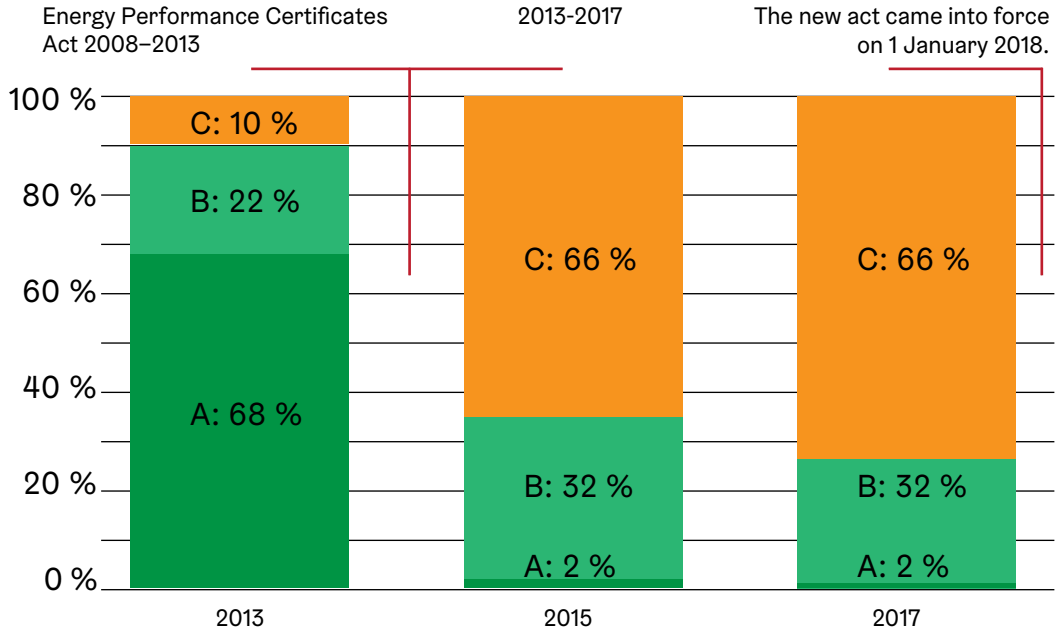
The energy classification (from A to G) for construction objects has been based on the reference value for energy efficiency (the E value) since 2013. Building Control Services have supported low-energy housing construction projects for several years by granting a permit fee discount of 20–30 per cent. In 2017, the discount was granted for 54 projects which included 116 housing buildings in total. The regulations for 'nearly-zero energy constructions' entered into force at the start of 2018, based on which new construction projects generally need to be at energy efficiency class B in order to receive a building permit (Figure 16).

**Figure 16. The energy efficiency classifications of new buildings in Helsinki in 2013–2017. (Environmental Services / Construction Control 2018)**

The energy regulations for the repairs and changes to buildings came into effect in 2013 (Decree of the Ministry of the Environment 4/13). According to the regulations, the improvement of energy efficiency needs to be taken into account in the planning of all regulated construction projects. The energy efficiency of buildings must be improved when economically, functionally and technically possible.

According to the Land-Use and Building Act (Section 117 g): "the energy regulations for repair construction do not need to be applied to buildings that are protected based on the Act on the Protection of Architectural Heritage (498/2010), a protection decree set out in the city plan or by being accepted as World Heritage site based on a general agreement on the protection of world cultural or natural heritage (SopS 19/1987) as a part of a specific environment or due to the building's architectural or historical value where its character or appearance would change in an unacceptable manner because of the adherence to the minimum requirements."

Energy efficiency classifications of the new housing construction projects in Helsinki. The method for calculating the classifications was changed in 2013 (the E value); new changes in 2018.



Key actions related to building control

**63. Pre-emptive guidance for housing companies (for example, in the project planning stage) will be developed to promote energy-efficient renovations and the use of renewable energy sources.**

- The implementation instructions for the geothermal heating project, prepared jointly by the building control authorities of the TOP11 cities, will be taken into use (www.pksrava.fi, the instructions published in spring 2018). Additionally, the opportunity to exempt geothermal heating projects from building control licence fees will be explored.

**Parties responsible:** Services and Permits / Building Control, Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**64. Operation models and good examples for energy-efficient solutions in the renovation of protected buildings will be prepared.**

- In the preliminary negotiations for permit projects, the parties will be instructed on the many means through which the energy efficiency of the buildings can be improved. The examples will be used to highlight the professional planning of protected buildings and the skilled implementation that will take the long lifecycle into account.

**Parties responsible:** Services and Permits / Building Control.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**65. The City will examine how climate objectives can be taken into account when updating the building code.**

**Parties responsible:** Administrative and Support Services / legal department, Land Use and City Structure.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**66. A road map or service path will be prepared for the development of building control in all stages of a construction project to enable energy-efficient construction.**

- The Buildings and Public Areas Division will work on the development in its own processes; for example: the environmental management model.

**Parties responsible:** Services and Permits / Building Control, Buildings and Public Areas, Land Use and City Structure / Strategic Urban Planning.
**Time span:** Pilots during the current council term (2017–2021).
Experiences to be included by 2035.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## 4.2.3 Energy renaissance

The resources of the City of Helsinki to reduce the emissions from privately owned buildings have been quite scarce compared to the high level of the emissions reduction potential in privately owned building stock. With renovations, the energy consumption of buildings can be reduced by 15 per cent by 2030, and an equal percentage can be achieved by moving to geothermal heating. By 2030, 5 per cent of the consumption in the City area can be covered with solar power in a manner that is technically and economically viable (Pöyry 2015).

The national energy guidance is coordinated by Motiva, whose website includes excellent guides on energy conservation and renewable energy utilisation in buildings. Guidance that aims for the improvement of energy efficiency has been primarily offered through projects, such as the metropolitan area's energy guidance project directed at consumers (the ASIAA project). Since the project ended, the energy guidance services have been moved to HSY's Ilmastoinfo service, which offers services and campaigns for both consumers and housing coopera-

tives. Housing cooperatives are offered Energy Expert training, themed events and individual energy guidance, to name just a few services. An energy guidance officer can be invited to the meeting of a cooperative to support the discussion on energy matters. In addition to this, the Solar Power for Homes campaign helps property owners and designers with planning and choosing good solar energy solutions that fit the urban environment.

Energy guidance has also been provided at the information events organised by Building Control Services (Tellinki) as a part of other guidance. Helen also provides energy guidance at the Energy Gallery, by phone and on its website. The Corporate Responsibility Unit of Built Assets Management also communicates with schoolchildren on energy-related matters. The resources for guidance related to the improvement of energy efficiency have been scarce, and the operations have not been coordinated comprehensively in the City.

The improvement of the energy efficiency of the existing buildings and the increase in renewable energy in connection with modernisations are collectively referred to as the energy renaissance. The improvement of energy efficiency is at its easiest and most cost efficient when the actions are scheduled to take place in connection with modernisation. Privately owned housing cooperatives consume approximately half of the energy in the building stock in Helsinki. At the moment, they lack sufficient incentives to take energy matters into account when planning modernisation. The housing cooperatives also lack sufficient competence to assess the energy efficiency and viability of the solutions on the market. Without sufficient support, the energy efficiency potential of modernisation cannot be realised. Guidance is most effective when it includes incentives, such as renovation subsidies, which have no longer been offered to actors other than companies and service properties in the last years. At the moment the subsidies for the modernisation of privately owned housing buildings consist only of the elevator subsidy, of which the state funds 50 per cent and the City funds 10 per cent.

In the modernisation of the City's properties, energy efficient construction is strived for. The planning instruction for both housing and service building construction emphasises energy efficient construction.

To enhance its operations, the City should start a development programme that would realise the energy renaissance in modernisation. Within the framework of this programme, the most promising areas for increasing energy efficiency in Helsinki will be identified, the owners and residents of the area's real estate can be activated to improve their energy efficiency and the area-specific, shared modernisation projects can be facilitated.
Most of the apartment buildings constructed in 1950–1980 will need to be modernised in the coming years. Modernisation offers an opportunity to improve the energy efficiency of buildings cost efficiently. The proposed energy renaissance action will be implemented by modernising suburbs and blocks as joint projects, which will lower the total costs of the modernisation.

Currently, modernisation is performed based on the needs of individual housing cooperatives and their owners. Typically, each modernisation project is tendered as an individual project, which reduces the potential to utilise regional synergies. In addition to this, the varying skill levels of the clients prevent energy efficiency actions being implemented during the projects. The City can act as an independent and reliable facilitator of joint projects.

Decision-makers on housing cooperatives require more information on the improvement of energy efficiency and systematic property maintenance. Basic understanding of applicable energy measures and the

combination thereof in modernisation help the boards and managers of housing cooperatives make energy-smart decisions. With small adjustments, such as the adjustment of the temperatures in shared spaces to meet the recommendation, significant and rapid energy conservation can be achieved profitably. Good examples encourage housing cooperatives to implement the actions.

The City can support investment in modernisation through the granting of additional construction permits and complementary construction permits for rented plots. The City has experience of similar project operations based on the Suburban Renaissance project, among others. The City can also develop best concepts for the renovations and modernisations with regard to the total energy consumption of the buildings. Through the conceptisation of the renovations, collaboration between various design and planning disciplines can be ensured.

### Key actions related to the energy renaissance

**67. An energy renaissance programme will be prepared to support the renovation of neighbourhoods and the existing private building stock energy-efficiently.**

**Parties responsible:** Services and Permits / Environmental Services, Land Use and City Structure, Services and Permits / Building Control, Executive Office / neighbourhood construction, in collaboration with Helen.
**Time span:** Council terms of 2017–2021 (planning), 2022–2035 (implementation).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**68. The City will investigate ending oil heating by 2035 and increasing the use of renewable energy and the energy efficiency in electrically heated buildings.**

- A pilot area will be selected. There, best options will be examined together with the residents.

**Parties responsible**: Services and Permits / Environmental Services, Services and Permits / Building Control, Ilmastoinfo.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**69. The 3D model (the Energy and Climate Atlas) will be developed in the energy efficiency guidance for residents. Energy tools for the assessment of the costs and potential improvements in buildings' energy consumption will be developed.**

**Parties responsible:** Services and Permits / Environmental Services, Executive Office / 3D.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**70. The energy-related competences of the decision-makers in housing cooperatives will be improved.**

- Decision-makers of housing cooperatives will receive training on the improvement of energy-efficiency, the use of renewable energy and systematic maintenance.
- Case presentations on the opportunities to improve energy efficiency in housing cooperatives will be prepared.

**Parties responsible:** HSY / Ilmastoinfo, Services and Permits / Environmental Services.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

### 4.2.4 New energy solutions

New energy solutions include solutions related to the demand response of electricity and heating and the storage of energy, among others. For example, as solar power becomes more common, various solutions for the storage and demand response of electricity will be increasingly important to secure the balance of the electricity network and the sufficiency of production in all conditions as the production of renewable energy fluctuates.

The demand response of district heating means that heating consumption and the timing of the demand for heating output are adjusted, compared to traditional heating demand, without decreasing the service quality experienced by customers. The premise for examining the demand response in district heating is that district heating will be of no practical use unless it leads to significant benefits in some part of the system, meaning distinct financial savings, either through investments or usage operations, which can be distributed between the heating company and its clients Another requirement for the implementation of demand response is that the additional

**The recovery of wasted and recycled heat is one of the most significant ways to improve energy efficacy.**

value should be distributed evenly between the actors participating in the production, in proportion to the actors' contribution to the production. (Valor 2015)

The recovery of wasted and recycled heat is one of the moat significant ways to improve energy efficacy. At the moment, 140 GWh of waste heat is recovered in a year in the building stock of Helsinki. This amount is constantly growing as the demand for cooling in the building stock and different condensation methods is increasing. Helen will increase and develop the recovery of wasted and recycled heat from locations in need of condensers through district heating and cooling.

The objective of the City of Helsinki is to secure the more extensive utilisation of renewable energy in the future, which is why the obstacles for the utilisation need to be removed and the operation processes need to become smoother. Currently, the location of the thermal wells on plots for apartment buildings that are quite small compared to their need for heating and the wells bending away from their planned location have been identified as problems in the drilling of thermal wells. The City will monitor the development of the drilling technology in collaboration with actors in this sector.

**71. Helen Ltd will implement emissions reduction actions based on its own development programme and decisions. The actions include:**

- Continuing the inspection of the measurements of the properties' district heating connections and changing the tariffs for properties to match the more accurate measurements.
- Opportunities for monitoring energy consumption (cf. Sävel+) will be developed by offering the client an open interface when updating the client data system.
- The cost and incentive effects of a hourly tariff for district heating will be examined in terms of its potential to improve the reasonable use of energy and support the creation of economically viable energy conservation business.

**Parties responsible:** Helen.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work, requires resources.

**72. The opportunities to acquire renewable district heating will be identified in the City organisation, as will the cost effects thereof. The acquisition will be scheduled. A plan will be created for the acquisition of renewable district heating and on the date when its proportion will reach 100 per cent of all district heating.**

**Parties responsible:** Executive Office / HANK, Environmental Services. Collaboration with: Buildings and Public Areas, Built Assets Management, Maintenance, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources, since renewable district heating is more expensive than that produced with fossil fuels.

**73. The City will acquire renewable/emission-free electricity. Purchasing units will prepare a scheduled plan for the switch to renewable electricity.**

**Parties responsible:** Units purchasing electricity.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources since renewable electricity is slightly more expensive than that produced with fossil fuels.

**74. The primary measurement of water consumption will be automated and made hour-based and remotely readable. HSY recommends consumption-based invoicing.**

**Parties responsible:** HSY.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City.
**Cost estimate:** Requires resources.

**75. The City will encourage all properties in the City area to take action to improve energy efficiency and energy consumption. A data model will be created, which will allow interested parties to see the 'energy wellness' of their own property, compared to a reference group. The model will not violate privacy or the protection of property. The results produced by the data model will provide guidance on the acquisition of inspections or surveys, as needed.**

**Parties responsible:** Energy conservation work group, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Requires further clarification.
**Cost estimate:** €200,000.

**76. Two-way district heating in the City properties will be investigated, piloted and adopted.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Helen.
**Time span:** Council term 2017–2021.
Complexity: Requires further clarification.
**Cost estimate:** Requires resources.

**77. The technical, economical and emission-related impacts of a hybrid heating system, combining a heat pump and district heating, will be studied at the level of individual properties and the entire energy system. The functionality and afore-mentioned impacts of existing hybrid systems will be verified. Based on the results of the study, recommendations will be created for the connections and implementation of the hybrid systems to ensure that the functions are energy-efficient and cost-efficient.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Heka Housing, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** €150,000.

**78. The land-use needs of centralised and regional production of renewable energy will be taken into account.**

**Parties responsible:** Helen, Land Use and City Structure / Detailed Planning, Strategic Urban Planning.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**79. The most significant potential heat waste locations will be identified, and actions to utilise this heat waste will be planned. The impact the utilisation of sewage heating in properties will have on the water treatment plant will be analysed.**

**Parties responsible:** Services and Permits / Environmental Services, HSY, Helen, Buildings and Public Areas / Built Assets Management.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** To be carried out as official work.

**80. The space allocation requirements of the geothermal wells will be assessed as a part of the preparation of the Underground Master Plan. The City will be an active mediator between constructors and Helen as regional energy options and hybrid solutions are examined, which will promote the adoption of such solutions.**

**Parties responsible:** Executive Office / neighbourhood construction, Land Use and City Structure / Geo, Technical and Economic Planning / Strategic Urban Planning / Land Use and City Structure, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**81. The areas suitable for geo-energy will be surveyed (survey for geothermal heating potential).**

**Parties responsible:** Executive Office / neighbourhood construction, Land Use and City Structure / Geo, Strategic Urban Planning / Technical and Economic Planning.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as consultation work.

**82. Opportunities to recover and utilise the landfill gases of closed landfills in the Helsinki area will be examined further, with the help of surveys and reports made in the past.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, Infra, Helen.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

## Examples

The utility company of Tampere piloted a two-way district heating network, which allows for case-specific analysis and various connection solutions for heat pumps.
www.kiinteistolehti.fi/kaukolampojarjestelma-ja-poistoilmalampopumput-ne-yhteen-soppii/

Fortum will open its district heating network to all heating suppliers, including housing cooperatives and offices, at prices agreed on (Fortum's press release 7 March 2018).
www.fortum.fi/media/2018/03/fortum-avaa-ensimmaisena-suomessa-kaukolampoverkkonsa-kaikille-puhtaan-energian

### 4.2.5 Funding and incentives

Many investments in energy efficiency are profitable but are still left unimplemented due to many obstacles. The repayment periods for energy efficiency actions are long, the savings involve uncertainty and may only benefit the future residents. In the ownership model in housing cooperatives in particular, energy effective investments with long repayment periods are often left unimplemented. The repayment periods for typical energy efficiency actions are presented in Table 4.

There are many ways to solve the challenges related to funding (Gaia 2014). For example, the energy efficiency and ESCO services are service businesses where an external energy service company implements investments and actions in the client company to make the use of energy more efficient and conserve energy. The costs of the service, including the energy efficiency investment, are paid for with savings enabled by the reduced energy costs. The service includes a guarantee on the energy conservation to be achieved.

To raise residents' awareness of the funding instruments available, the City will survey the funding alternatives and inform the residents of these (for example, private funding channels and state subsidies).

**Key actions related to funding and incentives**

**83. When meeting with financial institutions, the City will tell them about the opportunity to spread information, e.g. about energy renovation loans, via the information page on energy efficiency.**

**Parties responsible:** Executive Office / Financial and Planning Division
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**Table 4. Calculated savings in a typical apartment building location constructed in the 70s–80s in Merihaka. The original heat recovery systems is used in Merihaka, which often makes the savings higher than in other buildings from the same era located elsewhere in Helsinki.** (VTT 2017)

| | **Merihaka's energy renovation package** | | | | |
|---|---|---|---|---|---|
| | **Technical solution** | **Conserved heat, kWh/m²/year** | **Conserved electricity, kWh/m²/year** | **Repayment period, 0 % interest** | **Cost €/m²** |
| **Oversheath** | Thermal insulation in the outer walls<br>Renewal of windows | 13<br>23 | | 62<br>11 | 48<br>15 |
| **HVAC** | Heat recovery<br>Smart thermostat | 25<br>9 | | 12<br>4 | 18<br>2 |
| **Water** | Water-saving taps<br>Recovery of heat from sewage | 6<br>20 | | 28<br>10 | 10<br>13 |
| **Electricity** | Solar panels on the roof | | 3 | 13 | 4 |
| **Total, heating** | | 96 | | | 105 |
| **Total, electricity** | | | | | 4 |
| **Total, energy** | | 99 | 3 | 17 | 110 |
| **Heat consumption, before (kWh/m²)** | | **165** | | | |
| **Heat consumption, after the improvements (kWh/m²)** | | **69** | | | |

**84. The City will survey the financial obstacles of energy efficiency projects (such as the restrictions of the ARA funding).**

**Parties responsible:** Executive Office / Financial and Planning Division, Buildings and Public Areas / Built Assets Management, Heka / ATT Housing Production.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work; project work.

**85. The means of adopting new funding and procurement models will be monitored, the procedures of other cities will be benchmarked, and suitable procedures will be taken into use.**

**Parties responsible:** Executive Office / Economic Development, Buildings and Public Areas / Built Assets Management.
**Time span:** Council term 2017–2021, continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**86. The usability of the ESCO project in the Helsinki Group will be piloted in a chosen subsidiary community.**

**Parties responsible:** Executive Office / Financial and Planning Division, Buildings and Public Areas / Built Assets Management, a subsidiary community.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**87. The City will negotiate with the State to receive support for the energy renovations of housing cooperatives and for increasing the proportion of renewable energy, including the replacement of oil vessels. The potential support measures to be offered by the City will be identified. A presentation will be prepared in collaboration with six large cities.**

**Parties responsible:** Executive Office / Financial and Planning Division
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

## Examples

Norway has prohibited the use of oil heating as a heat source from 2020 onwards. The prohibition is softened with an investment subsidy of 40 % granted to households that stop using oil heating. The Climate and Environment Ministry of Norway states that the prohibition will be applied to both old and new buildings and both private and public buildings. Exceptions are made only for recreational buildings not in the vicinity of an electric network. www.oslo.kommune.no/getfile.php/13166797/Content/English/Politics%20and%20administration/Green%20Oslo/Plans%20and%20programmes/Climate%20and%20Energy%20Strategy%20Oslo.pdf

In Estonia, modernisation subsidies that are dependent on the energy efficiency improvements are granted through the Kred-EX system, in addition to affordable loans and guarantees. The most extensive subsidy for housing companies is as much as 40% of the full price of the modernisation if energy efficiency is significantly improved. http://kredex.ee/en/apartment-association/toetused/rekonstrueerimise-toetus/

In San Antonio, the city funds the city organisation's economically viable investments in energy efficiency with revolving funds. www.harcresearch.org/sites/default/files/Project_Documents/Case%20Study%20%231%20San%20Antonio's%20Revolving%20Loan%20Fund%20Best%20Practices%20Final.pdf

The City of Oslo has an energy efficiency fund used to grant funding for the reduction of the heating consumption of buildings, the energy efficiency of technical appliances, the improvement of the energy efficiency of fireplaces and the abandonment of oil heating. For example, the funding for the renovation of 1–4 apartments amounts to 20 % of the costs. The funding is collected through an additional fee of 0.01 NOK/kWh on the electricity bill. www.razemdlaklimatu.eu/images/2016/20160926/prezentacje/Fundusz_klimatyczno-energetyczny_miasta_Oslo.pdf

The City of Gothenburg launched a green bond programme in 2013, in which organisations were offered more than 200 million euros' worth of projects related to renewable energy, waste management and transport. www.siemens.fi/pool/cc/brochures/sustainability/helsinki-cypt-report---mar-2016.pdf

## 4.2.6 Assessment of the emissions and costs of construction and use of buildings

Gaia Consulting assessed the emissions and costs for the construction sector of the Carbon-neutral Helsinki 2035 Action Plan. In it, the emissions reduction potential (t $CO_2e$/a) and cost efficiency (€/t $CO_2e$) of the planned actions were analysed. The calculation focused on the actions taken during the use and maintenance of buildings. Emissions produced during the construction and the carbon sink potential of the construction were calculated as a separate entity and not included in the total emissions reduction objective.

The emissions reduction potential of construction and use of buildings is greatly affected by the energy policy of Finland and Helsinki and the fuels used. In the assessment process, it was assumed that the industry will adhere to the energy and climate strategies of Finland and that Helen will implement its own development programme. The actions in question will significantly affect the emission factors for electricity and Helsinki district heating, which were received directly from HSY for this assessment. For district heating, they are based on the estimate in Helen's preliminary scenario regarding the distribution of fuels in 2035 ($CO_2$-free fuels accounting for 70 per cent and natural gas accounting for 30 per cent), assuming that the preconditions set by the City Strategy will be realised.

The rapid-growth forecast for Helsinki was used when calculating the development of the population and employment. The current level was used for calculating the development of technology, for example the coefficient of efficiency of heat pumps and solar panels.

It was calculated in this assessment that 81 per cent of the emissions reduction potential is allocated to the old building stock while 11 per cent is allocated to the buildings controlled by the City of Helsinki.

### Summary of the results of the emissions assessment

In the report by Gaia Consulting, it is stated that the base level of repair construction should be sufficient for maintaining the total energy consumption of buildings at the current level, which means that the improvement of the buildings' energy efficiency would be sufficient to compensate for the additional construction required by the pop-

**Table 5. Assessment of the technical and economic potential of the energy efficiency actions and renewable energy in 2035.** (Gaia Consulting Ltd 2018)

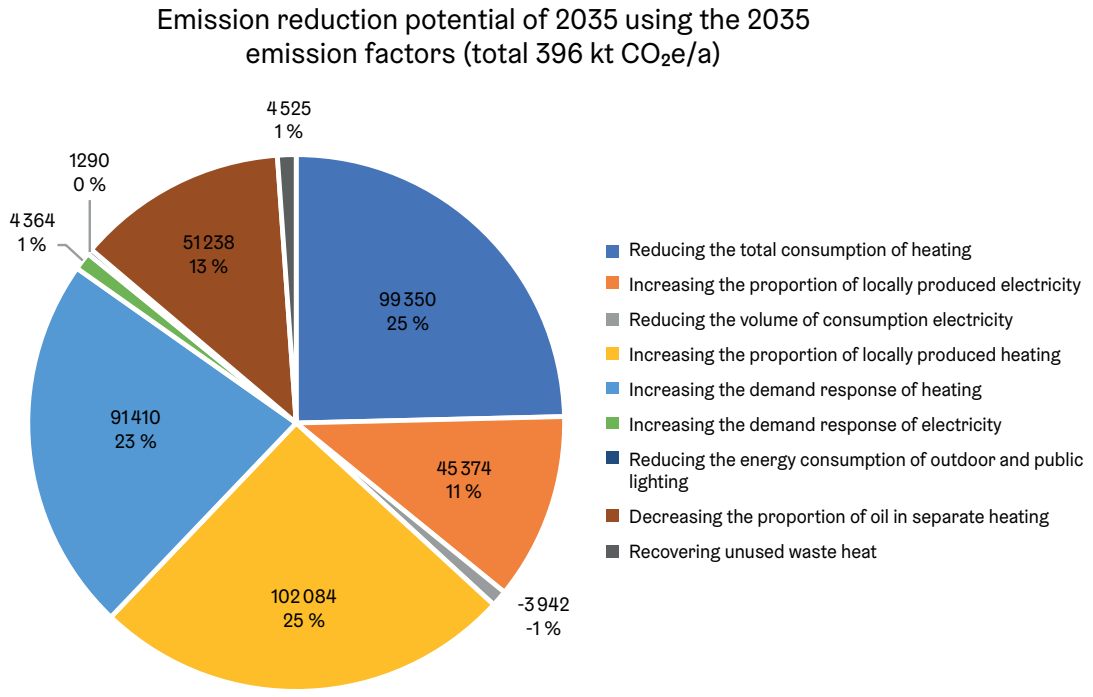
| | Consumption in 2015 (GWh) | Consumption in 2035 (GWh), including energy efficiency actions and heat recovery | Consumption in 2035 (GWh), including waste heat, heating, demand response, solar power and geothermal heating |
|---|---|---|---|
| District heating | 6,331 | 5,317 | 4,873 |
| Separate heating | 302 | No separate estimates | 172 |
| Electric heating (including the electricity used for heat pumps) | 304 | No separate estimates | 594 |
| **Heating in total** | **6,973** | No separate estimates | **5,639** |
| Consumption electricity | **3,953** | **4,041** | **3,032** |
| **Electricity and heating, total** | 10,926 | **No separate estimates** | 8,671 |

ulation growth. However, according to the assessment, the buildings also have a lot of technical and economic potential to improve energy efficiency by using renovations that are more efficient than the basic level. The technical and economic savings potential of the additional actions would be as high as 2,300 GWh by 2035, compared to the current level of consumption, when both heating and electricity consumption are taken into account (Table 5).

According to the estimate by Gaia Consulting, the emissions reduction potential of the energy use of buildings is 872 kt $CO_2e/a$ in 2035 (Figure 15). The amount is calculated using the 2015 emission factors to illustrate the entire impact during the entire reference period. Most of this potential (43 per cent) comes from the heating consumption becoming more efficient following the renovations. The renewable small-scale production of heating and electricity also possesses significant emissions reduction potential (total of 40 per cent of the emissions reductions for 2035). When calculated with the 2035 emission factors, the emission impact of the actions is much lower once the specific emissions have been reduced (Figure 17).

This means that the emissions reductions are affected significantly by the emission factors. For example, the emission factors for district heating in Helsinki are expected to decrease by 75 per cent in 2015–2035. This means that in 2035, the emissions reductions actions would need to be much more efficient to reach a corresponding level of emissions reductions. A summary of the emissions from buildings, traffic and energy production is presented in Chapter 3.5.

**Figure 17. The combined technical and economic emissions reduction potential of the Action Plan and the basic level of repair construction in the sector of construction and use of buildings compared to a situation where the actions would not be implemented. The 2035 emission factors for electricity and heating are used in the figure. The 2035 emission factor illustrates the emissions in 2035 but underestimates the emissions reductions of the actions being started in the near future. For comparison, Figure 15 illustrates the impact using the 2015 emission factor. A negative figure for consumption electricity means that the consumption of electricity will increase.** (Gaia Consulting Ltd 2018)



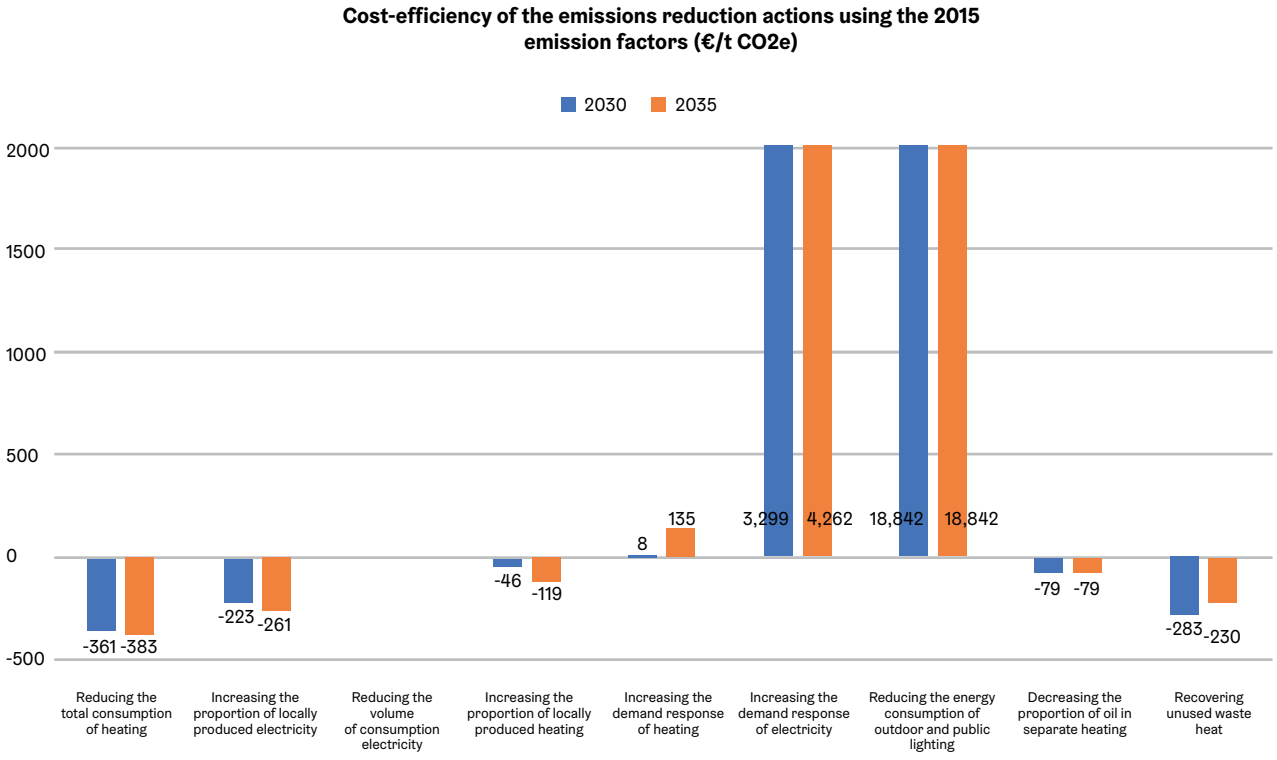
## Economic effects of the emissions reduction actions in the sector of construction and use of buildings

The energy efficiency actions and the increase in renewable production are largely profitable, even with the current prices. The profitability of small-scale production is affected by how much of the production may be used locally in the properties.

Based on Figure 18:

- **The energy efficiency actions and the increase in renewable production are largely profitable, even with the current prices.**
- **In the calculations, it is assumed that the regular norm-based repair constructions are implemented based on premises other than energy conservation, which is why a cost estimate for the investments in question has not been set. For the technical and economic additional actions, extra investment costs have also been taken into account.**
- **The absolute amount of consumption electricity will not decrease by 2035, which is why its energy efficiency has not been evaluated.**
- **When applicable, the annual costs include the capital costs of the investment, with interest included. Additionally, the maintenance costs and other potential costs, such as the increased electricity consumption of heat pumps have been included in the calculations.**

**Figure 18. The cost efficiency of the emissions reduction action assessed with the 2015 emission factors. A negative figure means a profitable action. (Gaia Consulting Ltd 2018)**



## 4.2.7 Reducing the carbon footprint of buildings

The lifecycle climate impacts of buildings are not included in the emission calculations since there are barely any industrial operations in Helsinki related to construction materials or the mining or steel industries, for example. These emissions and the opportunities to reduce them are covered in this chapter. The carbon footprint of construction, which is mainly caused by the manufacturing of construction materials such as steel and concrete, can be reduced significantly as the construction industry develops. According to the estimate by Gaia Consulting, the greenhouse gas emissions from construction in Helsinki amounted to approximately 247,000 tonnes $CO_2e$ in 2015, which equals approximately 10% of the direct greenhouse gas emissions of Helsinki in the year in question. If the emissions reduction objective of 80 per cent is realised, this would equal approximately a third of Helsinki's direct emissions. It has been estimated that by 2035, the carbon footprint during construction could be reduced by approximately 50 per cent from the current level, at the maximum, but here, a slightly lower emissions reduction potential is expected: 40 per cent (Gaia Consulting Ltd 2018).

The increase in wooden construction increases the carbon storage in the city area. In this case, the carbon sequester in the construction material is released as carbon dioxide only when the materials are burned or decomposed. Wooden products affect the greenhouse gas balance increasingly positively, the more they are used to replace more emissions-intensive products (such as concrete). Wooden construction sequesters carbon for a long time, in addition to which the construction process is energy efficient compared to concrete elements thanks to the light transport of materials, among other things, which produces fewer emissions. The drying and heating needs of massive wood buildings during the construction are also significantly lower than concrete. For example, the carbon footprints of the construction of wooden and concrete apartment buildings have been compared in Kuninkaantammi, with clear results: when taking the overground structures into account, the carbon footprint of the concrete building was much larger than that of the corresponding wooden building (Nykänen et al. 2017).

Wooden construction can be used to reduce the emissions from construction. If the emission-sequestering potential of wooden construction is taken into account, construction may even reach negative net emissions if the other construction materials and the energy consumption reach an emissions reduction of 40 per cent (Gaia Consulting Ltd 2018).

**Key actions related to wooden construction**

**88. The City will promote wooden construction through detailed planning.**

**Parties responsible:** Land Use and City Structure / Detailed Planning.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**89. The City will promote wooden construction in its own projects.**

**Parties responsible:** Buildings and Public Areas / Built Assets Management, ATT Housing Production, Heka Housing, HASO, Auroranlinna.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**The consumption-based carbon footprint of Helsinki residents is just over twice the amount of the direct emissions.**

## 4.3 Consumption, procurements, sharing economy and circular economy

### Background

The consumption of natural resources is not only connected to climate change, but also many other adverse environmental impacts. The WWF illustrates these impacts by calculating the Earth Overshoot Day for each year. It is a calculated day on which the ecological footprint of humans will surpass Earth's capacity to produce renewable natural resources and sequester the emissions caused by fossil fuels for the year. In 2018, the Overshoot Day for Finland occurred as early as 11 April.

Another indicator used to illustrate the climate impact of consumption is the carbon footprint. The 'carbon footprint of a Helsinki resident' means the greenhouse gas emissions caused by the consumption habits of a Helsinki resident regardless of the source of the emissions. The Finnish Environment Institute (SYKE) has led the development of the KUHILAS tools for municipalities used to calculate city-specific carbon footprints. The carbon footprint of Helsinki residents was estimated as early as 2011. The result was approximately 11 tonnes of $CO_2$ equivalents per capita. The consumption-based carbon footprint of Helsinki residents is just over twice the amount of the direct emissions. The emission sectors of direct emissions are presented in Chapter 2.1.

Housing, transport and food form the majority of the consumption load. According to the estimates made in past years, the carbon footprint of housing has decreased, while the carbon footprint of food has remained the same. The objective is to reduce the carbon footprint of Helsinki residents. Residents' carbon footprint will also be assessed in the future.

In this chapter, we present the objectives and actions related to education, consumption, waste management, public procurements, sharing economy and circular economy. The actions have been compiled from the workshops organised during the preparation of the Action Plan. However, the actions related to circular economy and procurements in construction and transport are presented in Chapters 4.1. and 4.2.

## 4.3.1 Education

The consumption habits of Finland's residents will have to become more sustainable. It is particularly important to incorporate new methods into people's everyday lives in early childhood education, schools and other educational institutions. Climate change, circular economy and sustainable lifestyle should be a part of the curriculum at all levels of education, from comprehensive education to vocational schools and universities. In Helsinki, the Education Division has remarkable opportunities to promote mitigation of climate change, since the Division's customers include the future residents and decision-makers of Helsinki. In addition to this, adult residents can be reached through adult education institutes. The environmental management and curricula of the Education Division include environmental education, in which day care centres, schools, educational institutions and adult education institutes are guided to promote an environmentally friendly lifestyle. The themes of the education include the protection of biodiversity, a sustainable lifestyle, energy conservation, waste sorting, the production methods of renewable energy and personal influencing methods to mitigate climate change. These themes will be highlighted in the environmental education sections of various subjects, programmes related to the environment and sustainability, the eco-support activity, nature schools and school camps. The local school principle of Helsinki will allow pupils to travel to school by foot and by bicycle. The school travel subsidies for longer journeys encourage the pupils to use public transport.

The implementation of the new technologies and smart solutions presented in the Action Plan will require contributions to competence and education on the subject at all levels of education, as well as complementary training. This will also create business opportunities for the education organisation.

**Key actions related to education**

**90. The skills related to the mitigation of climate change and to circular economy will be strengthened in school curricula and in schoolwork, in general. Teachers' knowledge will be expanded.**

**Parties responsible:** Education.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires more resources.

**91. The City will offer educational institutions internships in Smart & Clean, participate in joint development projects and support the institutions and their campuses in the adoption of low-carbon solutions.**

**Parties responsible:** Executive Office, Urban Environment, Education, Culture and Leisure, Social Services and Health Care.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**92. The amount of environmental education in early childhood education and schools will be increased.**

**Parties responsible:** Education, Environmental Services / Harakka.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**93. The City will organise courses and education on the mitigation of and adaptation to climate change, as well as circular economy and sharing economy for its employees, representatives and residents.**

**Parties responsible:** Finnish and Swedish Adult Education Institutes, Executive Office, Environmental Services.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**94. Urban agriculture will be promoted by using crowdsourcing to survey spaces suitable to be used by the residents. The criteria for spaces suitable for urban agriculture and the rules for the use of these spaces will be defined.**

**Parties responsible:** Land Use and City Structure, Buildings and Public Areas, Heka Housing.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

## 4.3.2 Consumption and waste

Of the sectors in private consumption, food has the largest environmental impact, according to estimates such as the KUHILAS calculations developed by the Finnish Environment Institute. The City of Helsinki has aligned culinary culture with its own development choices, which were used to raise the City's profile as an actor in the food sector. Helsinki became a Fair Trade City in 2013. Sustainable development has also been a significant part of these alignments, which were used to promote the use of organic and local food in the food services of the City, the environmental systems of restaurants and hotels and urban agriculture, among other things, and a report on the environmental impact of the City's food services was drawn up.

Helsinki has also developed its image as an ideal city for organising events. The environmental management of events has been developed significantly, for example through the Greening events project funded by the EU, during which the EcoCompass Event environmental management system was created, and the environmental management of events was aligned using environmental criteria.

### Key actions related to consumption and waste management

**95. Recipes will be developed to reduce the emissions from the City's food services and protect the Baltic Sea.**

**Parties responsible:** Education, Social Services and Health Care, Service Centre, Palmia Oy.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**96. The proportion of vegetarian meals will be increased in schools and day care centres. The recommendations for both school meals and the meals in early childhood education encourage institutions to increase the proportion of vegetarian food. Both recommendations are based on the national nutritional guidelines.**

**Parties responsible:** Education, Service Centre.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**97. Food waste will be reduced in the operations of the Service Centre, Palmia and other interest groups.**

- For example: by monitoring consumption and thus making appropriately-sized portions and ordering the right amount of food, by using campaigns, by making the processes more efficient and by rationalising the product selection and the package sizes.

**Parties responsible:** actors ordering the food services, Service Centre, Palmia Oy.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**98. The opportunities to transport food optimally in terms of emissions will be examined.**

- For example: climate-friendly and long-life packaging; making deliveries more efficient.

**Parties responsible:** Education, Social Services and Health Care, Service Centre, Palmia Oy.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**99. Collaboration with grocery shops will be increased to reduce food waste.**

- For example: by transferring excess food from grocery shops to youth centres, home economics classes, courses in adult education institutes or the Shared Table initiative.

**Parties responsible:** Youth Services, Education, the Shared Table (Yhteinen Pöytä) initiative.
Time span: Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**100. The environmental criteria for events will be updated and materials to help with the planning of environmental matters will be produced. Both the City's own events and commercial events will be encouraged to use the EcoCompass environmental management system. Tools for measuring the $CO_2$ emissions of events will be developed.**

**Parties responsible:** Environmental Services, Helsinki Marketing, Executive Office / Competitiveness Team, Executive Office / Economic Development.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**101. The methods of personal emissions trading used in various cities will be examined and used.**

**Parties responsible:** Environmental Services.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki / requires further clarification.
**Cost estimate:** Requires resources.

**102. The principles of sustainable tourism, carbon-neutrality and the protection of the Baltic Sea will be taken into account in the preparation of the maritime strategy.**

**Parties responsible:** Executive Office, Environmental Services, all divisions.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki / requires further clarification.
**Cost estimate:** Requires resources.

**103. Efficient source separation of all separately collected waste will be made possible in all facilities of the City organisation.**

**Parties responsible:** Buildings and Public Areas / Maintenance, Buildings and Public Areas / Built Assets Management, all divisions and City enterprises.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs.

**104. The measuring of waste volume, the utilisation of new technology and further optimisation of logistics, such as IoT, surface level measuring and weighing waste collection vehicles, will be developed with HSY.**

**Parties responsible:** Buildings and Public Areas / Maintenance / Built Assets Management, HSY.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki / requires further clarification.
**Cost estimate:** Requires resources.

**105. The possibility of separating waste expenses from the rent in locations rented out to external parties by the City will be examined and decided on.**

- If the external parties pay for their own waste expenses, they will be motivated to reduce waste and sort waste more efficiently.
- Efficient waste sorting and space needs that support the optimisation of waste collection in the facilities and plots will be studied. Joint solutions for city blocks will be piloted.

**Parties responsible:** Buildings and Public Areas / Built Assets Management.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**106. City employees and residents will be encouraged to purchase products from the Pakila work centre, the Uusix workshops and the shops of the Helsinki Metropolitan Area Reuse Centre Ltd.**

**Parties responsible:** Social Services and Health Care / Pakila / Uusix, Helsinki Metropolitan Area Reuse Centre, Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki / requires further clarification.
**Cost estimate:** To be carried out as official work.

## 4.3.3 Procurements

The City organisation is a noteworthy procurer that is able to promote the development of more sustainable products and services, whether they are ICT equipment, food services or construction materials. The City can significantly reduce the emissions from its procurements by setting environmental criteria for the procurement of goods and services and by procuring new low-emission solutions. The goal of sustainable procurements is to reduce the energy and material consumption and negative environmental impact throughout the entire lifecycle of the product, service or building. Similarly, we aim to create incentives for the creation and adoption of cleantech solutions. These objectives can be advanced through active dialogue and collaboration on the market.

Procurements, meaning the internal and external purchases of services, materials, supplies and goods, form over 40 per cent of the City's expenses. The total value of procurements in the entire Helsinki Group is more than two billion euros each year. Construction accounts for approximately 50 per cent of these procurements.

The City of Helsinki has worked for the promotion of sustainable and environmentally positive procurements for a long time. This work has been directed by the environmental policy objective approved by the Council, among other things. According to the objective, all of the City's procurement processes will include environmental criteria by 2020. This objective has been promoted through training, environmental management in the sectors, consultations related to sustainable procurements and the definition of monitoring. The work has been coordinated by the City's shared environmental network for procurements, which, in turn, is coordinated jointly by Environmental Services and the Procurements and Tendering Division.

The City has also participated actively in the operations of the national eco-procurement network, collaborated with Nordic cities, and participated in the Procura+ project of ICLEI, which has focused on the exchange of experiences and the improvement of environmental skills related to procurements.

### Key actions related to procurements

**107. Existing procurement criteria will be developed and new criteria introduced to the procurements of the City of Helsinki, with regard to life cycle, circular economy and the climate.**

- The environmental criteria must be the minimum requirements or the significantly weighed comparison criteria when making procurements.

**Parties responsible:** Divisions, Procurements and Tendering + Environmental Services (role as the facilitating expert).
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**108. Procurements that are significant in terms of greenhouse gas emissions and circular economy will be identified, and emission calculations, life cycle models and climate impact assessment will be developed for these procurements. The impact of procurements will be assessed in terms of the environment.**

**Parties responsible:** Divisions, Procurements and Tendering + Environmental Services, the environmental network for procurements
**Time span:** Council term 2017-2021 + next terms.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**109. Collaboration with companies will be increased through various trials and cooperation pilots, and funding will be sought for the implementation of innovative procurements to reduce emissions.**

**Parties responsible:** Executive Office / Economic Development / Procurements and Tendering, Environmental Services.
**Time span:** Council term 2017-2021 + next terms.
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Requires resources.

**110. Strategic goals are to be created for sustainable and innovative procurements in the Helsinki Group. A road map for innovative and sustainable procurements will be created, and the City's procurement strategy will be updated.**

**Parties responsible:** The environmental group for procurements, the steering group for procurements, the procurement groups of divisions.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**111. Collaboration with the municipalities, joint municipal authorities and other public entities in the region will be increased on sustainable procurements. For example: joint training events, reports, market surveys and the definition of minimum requirements for climate criteria used in tendering.**

**Parties responsible:** The environmental group for procurements, the steering group for procurements, the procurement groups of divisions, HSY.
**Time span:** Council term (2017–2021).
**Complexity:** Cannot be decided on solely by the City of Helsinki.
**Cost estimate:** Requires resources.

**112. The planning and reporting of procurements will be developed, for example by adopting procurement calendars and uniform City-level reporting procedures.**
**Instructions for considering the overall economy of procurements (such as life cycle costs), combining procurements and increasing shared use of procurements will be increased. Monitoring will be conducted as a part of the environmental programmes and reporting.**

**Parties responsible:** The steering group for procurements, the procurement groups of divisions, the environmental group for procurements.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**113. The criteria that reduce the environmental and climate-related impact and take circular economy into account will be developed and tightened in the City's procurements related to foodstuffs and food service.**

**Parties responsible:** Education, Social Services and Health Care, Service Centre, Procurements and Tendering, Environmental Services.
**Time span:** Council term 2017-2021 + next terms.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources / to be carried out as official work.

## 4.3.4 Sharing economy and circular economy

'Sharing economy' is a model for a new kind of economic thinking, in which an increasing amount of goods are shared, borrowed or rented instead of being owned. The core ideas of sharing economy include more efficient use of underutilised resources, moving from ownership to access rights and peer to peer activities and production.

In turn, circular economy attempts to maximise the cycle of products, components, materials and the value included in them for as long as possible. In circular economy, production and consumption produce as little waste as possible.

The concepts of sharing economy and circular economy strongly support each other, and they both require new ways of thinking in terms of economic aspects.

In the Helsinki City Strategy, it is stated that Helsinki wants to function more and more actively as a platform for interesting and profitable innovations that will also create new export opportunities. In addition to this, circular economy projects are implemented in Helsinki and the metropolitan area in collaboration with businesses, cities and residents in the area.

New businesses based on sharing economy are being created in the cities at an increasing pace. The role of the cities is to act as platforms for new and potential sharing economy and circular economy trials and support their growth. In addition to this, there is much unused potential for advancing circular economy in the City's own operations.

### Key actions related to sharing economy and circular economy

**114. A road map for circular economy and sharing economy will be created.**

**Parties responsible:** Environmental Services, Executive Office, all divisions.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**115. The City will set an example by creating a digital platform and using it to share the City facilities and equipment with the staff, residents, entrepreneurs, adult education institutes, sports clubs and other actors.**

**Parties responsible:** Executive Office, Stara Construction, divisions, Forum Virium.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**116. Libraries will advance sharing economy in a significant manner. Libraries will offer facilities and resources to be used jointly by the residents, as well as guidance for the use of digital solutions and devices, and also offer access to technological innovations that will be a part of everyday skills in the future. Libraries will prevent digital marginalisation and enable residents to be engaged and share their skills. The expansion of the libraries' lending services will continue the cooperation with peer to peer services, such as Kuinoma.**

**Parties responsible:** Libraries, Helsinki Metropolitan Area Reuse Centre, Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**117. Rarely used objects and equipment will be inventoried, and a platform will be created for sharing them within the City organisation. The recycling of furniture and other movable property within the City will be made more efficient, for example by creating instructions that promote circular economy in the relocation of and changes to official facilities.**

**Parties responsible:** Executive Office / Financial and Planning Division, all divisions.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**118. The companies offering food services will be encouraged to sell surplus food, for example via food delivery apps, and the Shared Table model will be adopted.**

**Parties responsible:** Company advisers (Executive Office), food inspectors (Environmental Services), Service Centre, Palmia Oy, the Shared Table (Yhteinen Pöytä) initiative.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**119. The utilisation of the by-products of food preparation and other surplus materials (such as garden waste and animal manure) will be developed both locally and in the neighbouring regions.**

**Parties responsible:** Service Centre, Palmia Oy, Environmental Services, Stara Construction, Buildings and Public Areas, Korkeasaari Zoo, Wholesale Market.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** Requires resources.

**120. The City will see to that its property strategy will take sharing economy and circular economy into account (for example, by allowing the use of rarely used and poor-condition facilities by users that commit to maintaining the facilities).**

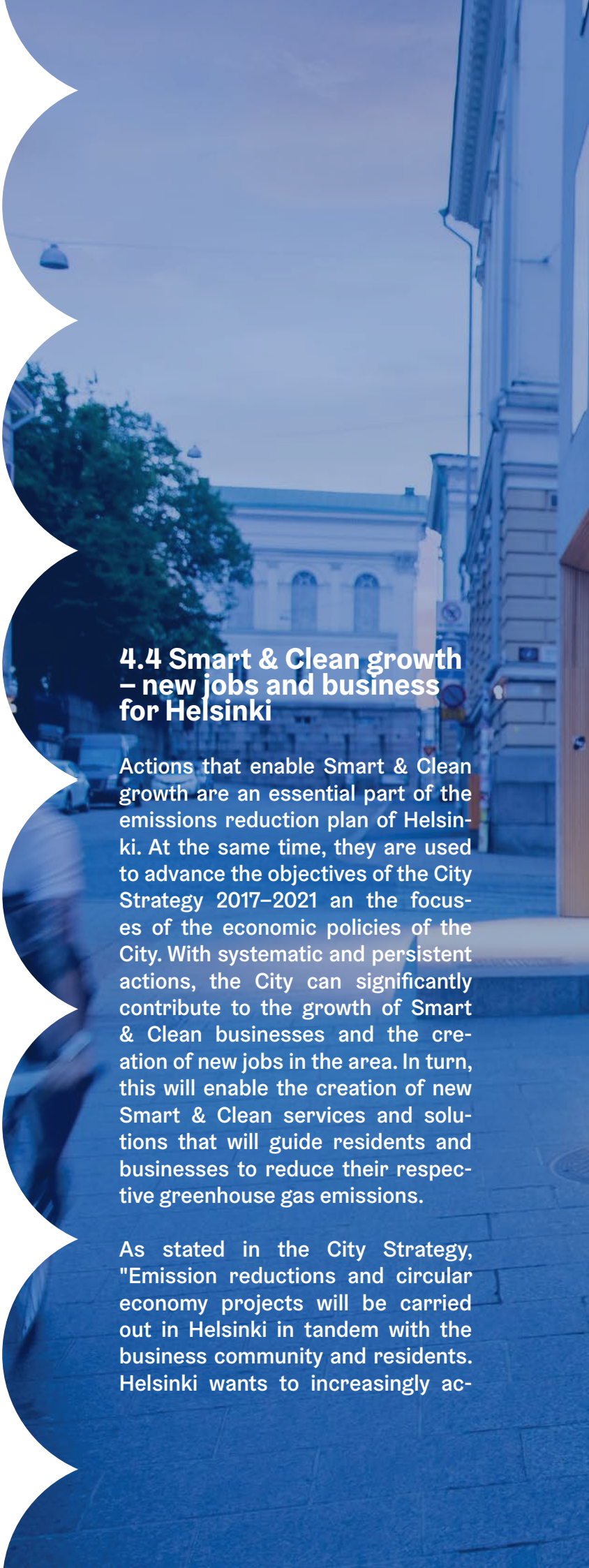
**Parties responsible:** Buildings and Public Areas
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**121. Cooperation with various parties (the City, companies, residents, etc.) will be advanced in terms of circular economy, sharing economy and environmental responsibility, for example through projects and pilots.**

**Parties responsible:** Executive Office, Stara Construction, all divisions, S&C Foundation, Forum Virium.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki, requires further clarification.
**Cost estimate:** Requires resources.

**122. The City will ensure that engaging budgeting will be conducted from the perspective of sharing economy and circular economy**

**Parties responsible:** Executive office.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.



## 4.4 Smart & Clean growth – new jobs and business for Helsinki

Actions that enable Smart & Clean growth are an essential part of the emissions reduction plan of Helsinki. At the same time, they are used to advance the objectives of the City Strategy 2017–2021 an the focuses of the economic policies of the City. With systematic and persistent actions, the City can significantly contribute to the growth of Smart & Clean businesses and the creation of new jobs in the area. In turn, this will enable the creation of new Smart & Clean services and solutions that will guide residents and businesses to reduce their respective greenhouse gas emissions.

As stated in the City Strategy, "Emission reductions and circular economy projects will be carried out in Helsinki in tandem with the business community and residents. Helsinki wants to increasingly ac-

# Smart & Clean


tively serve as a platform for interesting and successful innovations that generate new potential exports."

Helsinki, together with the cities in the metropolitan area and the City of Lahti, has set an ambitious shared objective to be the best testing area for Smart & Clean solutions. As the solutions are introduced first in Helsinki and their functionality has been proven, the solutions will generate references and export business. New urban solutions that improve residents' quality of life and reduce emissions will function as global 'calling cards' that will increase the international appeal of the City. The long-term objectives are the following:

- **pioneering in ecologically positive built environment**
- **being leading circular economy city in the world**
- **having the world's smartest urban energy solutions**
- **having the most appealing emission-free transport in the world**
- **having the most resource-wise residents in the world.**

Helsinki has also set the objective of being a global pioneer in digitalisation. Digitalisation has already revolutionised our way of life, and it will continue to do so. The solutions enabled by digitalisation need to be connected to the current infrastructure of the City. This will accelerate the transition towards emission-free and circular economy. Predicting and managing change is possible: it will provide the City and businesses with opportunities to build their desired future and prepare for change. When things are done differently in an unprejudiced manner, the next revolutionary solutions and services may be created in the Helsinki region. Helsinki can be the world's first city to lead disruption. Open data and the utilisation thereof are key here.

## From the carbon footprint to the carbon handprint

The main focus of the Carbon-neutral Helsinki 2035 Action Plan is on the reduction of direct local emissions. As stated in the beginning of the Action Plan, the true carbon footprint of Helsinki residents also includes the emissions caused by consumption on the part of the residents and Helsinki-based

companies and organisations: this includes food produced outside Helsinki, goods, services and travel The true carbon footprint is over twice the amount of the direct emissions. Because of this, we need to aim both for a smaller carbon footprint, but also a larger carbon handprint. The perspective is different to that of the carbon footprint: using the carbon handprint means taking a positive view of things – how much emissions can be reduced with the clean solutions and choices enabled by the City. The carbon handprint of Helsinki residents will also grow if actors outside Helsinki adopt the operation models developed in Helsinki: the indirect effect of climate-smart operations may be greater than the carbon footprint.

Residents and companies have key roles in emissions reduction actions. Companies can provide residents with solutions that will reduce their carbon footprint but also improve their quality of life. The City possesses many ways of reducing emissions and also promoting the vitality of the region. For example, the procurements and steering measures of the City administration can be used to influence the development of markets and the consumption choices of residents. The City can use its own choices to steer the choices of residents and the products offered by companies. The potential for emissions reductions is much greater than it would be if the City only focused on developing its own operations.

## A variety of measures to boost Helsinki's Smart & Clean growth

The City has an extensive selection of means at its disposal to create conditions for Smart & Clean growth. The City's selection of methods includes the following:

- **open infrastructure**
- **open data**
- **using efficient energy infrastructure to test and scale pioneering solutions**
- **funding and venture capital investments (the City, companies, VCs)**
- **developing public procurements in such a way that they support the creation and scaling of new solutions (carbon footprint and innovations)**
- **digital innovation platforms**
- **international networks**
- **international events for financiers and investors in the industry**
- **education programmes to promote low-carbon practices in companies (for example: the Climate Partners network)**
- **development of environmental management with the EcoCompass tool, among others.**

## Benefits of Smart & Clean growth

The Smart & Clean growth of the City will benefit everyone: residents, the City organisation, businesses and research centres in the region. The companies' solutions and the changes in residents' habits will reduce the greenhouse gas emissions. When these elements are included, the emissions reduction potential is greater than if the City only focused on developing its own operations. New businesses will be established in the region, which will create new jobs. At the same time, the international appeal of the city will increase. Operations that support Smart & Clean business will make the City stronger and more interesting, and its strong brand will support companies' marketing. Research centres will find good research topics and practical collaboration opportunities. Joint development will accelerate the commercialisation and scaling of innovations to a global level.

## Objective and content

The objective is to systematically and persistently grow the number of Smart & Clean

jobs, investments and businesses in the Helsinki region:

- **significant growth of new Smart & Clean jobs, investments, and business in Helsinki and the metropolitan area**
- **increasing the international reputation and appeal of the city**
- **acceleration and adoption of ambitious solutions that will improve residents' quality of life**
- **acceleration of the emissions reduction objectives.**

The planning and implementation of the actions and methods will be conducted in stages in collaboration between the City of Helsinki, the Smart & Clean Foundation of the metropolitan area and the businesses. When things are done together, all participants will commit to the objectives. It is important to create an Action Plan that is as flexible as possible and within which it is possible to react to the developments of the global markets and technologies and changes in residents' lives. This will strengthen Helsinki's role as a pioneer and leader of change, and also as a city of climate-smart and circular economy solutions that utilise digitalisation in the best possible way.

## Carbon-neutral organisations

The City organisation and the closely related subsidiary communities and joint municipal authorities are setting example and attempt to reach carbon neutrality before the City target of 2035. Environmental Services within the Urban Environment Division was the first department to reach carbon-neutrality in 2015. Since then, Stara has created a programme of its own, stating that it will become carbon-neutral by 2030, and Korkeasaari Zoo is also drawing up its own programme.

### Key actions related to Smart & Clean growth

**123. An action plan for Smart & Clean growth will be devised, the first phase of which will define the following:**

- The starting point (jobs in S&C, companies, investments) and monitoring
- Synchronisation with the indicators of international pioneer cities to facilitate sufficient comparisons Helsinki's strengths and focuses (in cooperation with businesses)
- The method selection, actions, time span, resources and steering of the plan

**Parties responsible:** Executive Office / Economic Development, S&C Foundation, Services and Permits / Environmental Services, Buildings and Public Areas / Built Assets Management.
**Time span:** First phase in 2018.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

**124. With procurements and available steering measures and other means, the City will support the creation of a market for new products and services that residents, companies and communities can use to reduce their own emissions.**

**Parties responsible:** Executive Office / Economic Development, Services and Permits / Environmental Services, Buildings and Public Areas / Built Assets Management, S&C Foundation, FVH.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**125. The residents are given opportunities to influence and participate in the development of new Smart & Clean solutions in an economically sustainable manner.**

**Parties responsible:** FVH, Executive Office / Economic Development, S&C Foundation, Services and Permits / Environmental Services, Buildings and Public Areas / Built Assets Management.
**Time span:** Council term (2017–2021). Complexity: Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**126. The City organisation will create operation models and criteria that enable the City to achieve its economic policy objectives simultaneously with the emissions reduction actions.**

**Parties responsible:** Executive Office / Economic Development, S&C Foundation, Services and Permits / Environmental Services, Buildings and Public Areas / Built Assets Management.
**Time span:** Council term (2017–2021). Complexity: Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**127. Companies will receive domestic market references, which will help with export. Domestic and international companies will be given opportunities to develop new solutions and operation models in Helsinki. The reputation of the Helsinki region as an international pioneer will be promoted, which will support the international growth of companies, as well as the appeal of the region.**

**Parties responsible:** Executive Office / Economic Development, S&C Foundation, Helsinki Marketing, Buildings and Public Areas / Built Assets Management, Maintenance, Housing Production, Culture and Leisure, Education, Land Use and City Structure, Services and Permits / Environmental Services, Heka Housing.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**128. The City will systematically develop its Smart & Clean joint development platforms and increase their effectiveness in the development of climate and circular economy solutions. The functionality of the platforms will take into account urban development, the companies' reference opportunities, the international business potential of the platforms, investments and the City's brand.**

**Parties responsible:** Executive Office / Economic Development, S&C Foundation, Buildings and Public Areas / Built Assets Management, Services and Permits / Environmental Services, Culture and Leisure, FVH, Helsinki Business Hub, Helsinki Marketing.
**Time span:** 2018
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**129. The organisations, subsidiary communities and joint municipal authorities of the Helsinki Group will be required to integrate the emissions reduction policies into their respective control systems. The minimum objective is to reach carbon-neutrality by 2035.**

**Parties responsible:** Joint municipal authorities and subsidiary communities, Executive Office / management of the Group administration.
**Time span:** Council term 2017–2021.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

# 5 Helen Ltd's development programme and actions in the coming years

The Carbon-neutral Helsinki 2035 Action Plan is complemented by the development programme of Helen Ltd, the energy company owned by the City, which is responsible for emissions reductions in energy production. Helen's development programme is used to reduce the emissions from centralised energy production, while the Carbon-neutral Helsinki 2035 Action Plan primarily focuses on energy consumption and the property-specific production of renewable energy. Both perspectives are needed, since the less energy is consumed, the less needs to be produced.

Helen's development programme is highly significant in terms of reducing the emission factor of district heating, in particular. The emission calculations for electricity consumption are made based on the national emission factor for electricity, as electricity can be acquired from anywhere. Thus, the changes in the electricity production of the Helsinki region only affect the emissions in proportion to the emissions' effect on the national emission factor.

Energy production in Finland is already 80-per-cent $CO_2$-free, and, according to the calculation, the emission factor of district heating will decrease by as much as 74 per cent by 2035 through the actions of Helen and the national government. The emissions reduction goal of 40 per cent by 2025 presented in Helen's development programme is well in line with the emissions reduction goal of 60 per cent set by the City for 2030. Helsinki's emissions reduction goal of 80 per cent for 2035 and the government's energy and climate strategy mean that Helen will decide on the continuation of the development programme once all investments to substitute Hanasaari or an investment decision on them have been made.

Centralised energy production belonging in the emissions trading sector has achieved and will continue to achieve significant emissions reductions. Helen's district heating production is regulated within the EU's emissions trading system. In emissions trading within the EU, the total amount of greenhouse gas emissions from production plants has been restricted through a shared emissions cap that is lowered annually. Emissions will be reduced by reducing the total amount of emissions rights granted and auctioned to companies by 2.2 per cent annually starting from 2021 (by 1.74 % before this). This will lead to emissions being reduced by the amount agreed on within the emissions trading sector in locations where it is most cost-efficient.

If Helen reduces its emissions by an amount that exceeds its calculated emissions rights, the emissions rights will be used elsewhere in the EU. In practice, the regional district heating reductions of Helsinki, which are more expensive than in the emissions trading sector, will not lead to a reduction in global emissions. Because of this, the City or the state should cancel a corresponding amount of emission rights from the market so that the climate can benefit from the local actions taken in Helsinki. The EU has

recently agreed to strengthen the steering effect of emissions trading by transferring the extra emissions rights on the market into the market balancing mechanism and by nullifying them.

Helen has decided that its development programme will be observed until 2024, and the programme presents the substitution of the district heating produced by the Hanasaari coal plant with other energy sources. It was decided that the substitutive production would be made in a decentralised manner, and it is included in this programme in the form of taking the plot and facility reservations for Helen's operations into account, as substituting coal with biomass and other emission-free, decentralised forms of energy production requires more space.

Helen Ltd is preparing further policies for its development programme, and its goal is to stop using coal entirely in the 2030s. The Finnish government has proposed that the use of coal for energy production ends by 2029, which would mean that the fuel used at the Salmisaari cogeneration plant would need to be changed in an accelerated manner and at greater cost.

According to the City Strategy, "Helsinki strives to combine renewable energy sources with energy efficiency in an optimal way, both in individual buildings and in areas." The Carbon-neutral Helsinki 2035 Action Plan describes actions at the consumer end, for which also Helen offers solutions. In addition to this, Helen is responsible for the more extensive energy system solutions in Helsinki. Helen has implemented the following projects which are also used to prepare for the Hanasaari B coal plant being shut down by the end of 2024, as decided by the City Council:

- **With district cooling being adapted, the utilisation of waste heat from properties was started as early as in 2000. The operations have expanded, and, at the same time, energy efficiency has improved greatly over the last 10 years.**
- **The Katri Vala heat pump plant, commissioned in 2008, is used to utilise wasted and recycled heat efficiently, which reduces the emissions from energy production. A new production record was set in 2017, once again; 565 GWh (490 GWh) of heating was produced, which is equal to the district heating consumption of the City of Lappeenranta.**
- **The heat pump plant below Esplanadi will be commissioned in 2018, after which it will produce renewable heating for approximately 10,000 apartments.**
- **In Salmisaari and Hanasaari, the mixed burning of coal and pellets in 2017 reduced the greenhouse gas emissions by almost 80,000 t $CO_2e$.**
- **Finland's largest pellet heat plant in Salmisaari started operating in 2018, and it is able to produce heating for a city the size of Savonlinna, meaning that it can produce enough energy to heat 25,000 two-room apartments.**

Helen will actively develop new services and solutions for both heating and electricity to enable emissions reductions for customers:

- **The largest energy storage facility in the Nordic region will be developed and connected to two large solar power plants and to the smart two-way charging of electric cars.**
- **Demand response will be used for electricity and for heating.**

- **The demand response project for heating was started in 2017 in collaboration with the City's housing company, Helsingin kaupungin asunnot Oy (Heka), and its 50,000 residents.**
- **Helen has participated in the development of property-specific electricity storage as a part the electricity grid, in collaboration the Urban Environment Division in the Viikki Environment House. The other projects developed in the Environment House include the demand response of electricity and heating, green district heating, charging services for electric cars and two-way district heating.**
- **At Sakarinmäki school, a hybrid solution for heating production has been tested; the hybrid system contains solar collectors, a geothermal heating system, an oil vessel and heat storage.**
- **Helen was the first company in Finland to create the solar power as a service concepts where the consumer can purchase a share in a large solar power station.**
- **Consumers are offered an electronic service for consumption reporting, Sävel Plus.**
- **Helen is implementing charging services for electric vehicles within the City.**

**Objectives by 2025:**

- **increasing the proportion of renewable fuels to reach 25 per cent (12 per cent in 2017)**
- **$CO_2$ emissions reduction of 40 per cent.**
- **Planned actions (note: the investments have not yet been decided on):**
- **heat battery in Mustikkamaa (in the planning stage)**
- **the seasonal heat storage and heat pump plant of Kruunuvuorenranta can provide heating energy for a third of the residents in Kruunuvuorenranta**
- **additional heat pumps (after Esplanadi, in the Katri Vala power plant)**
- **additional bio-heating plants (Patola, Tattarisuo or Vuosaari, depending on the surveys)**
- **additional solutions for the consumer end.**

The feasibility of actions undertaken after 2025 will depend on the development of the market and technology. The future sustainability criteria and acceptability of biomass will affect the energy production solutions of the future.

**The Helen development programme is responsible for emissions reductions in energy production.**

# 6 Carbon sinks and emissions compensation

Carbon-neutrality involves an 80-per-cent reduction in emissions (in 1990–2035) and compensation for the remaining 20 per cent. The final objective is that there will be no emissions to compensate for. Even if the carbon storage in the tree stand, vegetation and soil in the city area and the changes therein are not taken into account in the emission calculations for Helsinki, the urban nature plays its part in sequestering carbon dioxide emissions from the atmosphere. Growing the carbon storage and carbon sinks may also present the City with an opportunity for emission compensation. The next chapters describe the means to maintain, preserve and increase the size of Helsinki's carbon storage and the emissions compensation based on the carbon-neutrality objective.

## 6.1 Carbon sinks

According to the estimate made in 2014, the tree stand, vegetation and soil of the Helsinki urban area have sequestered approximately 1,250 kilotonnes of carbon, which, when converted into carbon dioxide, equals the greenhouse gas emissions produced in the city in 1.5 years (approximately 4,600 kt $CO_2e$). At the time when the estimate was made, the carbon storage was growing by 35 kilotonnes of carbon per year, which means that the vegetation and soil of the city are currently working as effective carbon sinks. When converted into carbon dioxide, the annual growth covers the emissions produced by approximately 26,000 residents, on average (130 kt $CO_2e/a$) (Rasinmäki & Känkänen 2014). The calculation method involves some uncertainties, but the results support the idea that the tree stand and soil of the city area also play a significant role in the sequestering of the carbon dioxide emissions produced by the City.

The preservation and growth of the carbon sinks in urban nature can be affected significantly through land use planning and the maintenance of green zones. In a rapidly growing city, increasing carbon sinks and carbon storage is challenging, and the carbon storage is expected to shrink in Helsinki too, as a result of the new construction based on the city plan (Helsinki City Planning Department 2014). However, it is difficult to estimate the true effect the city plan has on carbon storage, as the boundary between construction and green zones is defined only at the detailed planning stage. In detailed planning and construction, it is essential to aim for solutions that will preserve the most significant carbon sinks in the area. The City of Helsinki Nature Conservation Programme 2015–2024 and the inclusion of the forest network presented therein into the city plan was approved by the City Council in 2016. According to the programme, open spaces should be reforested to strengthen and preserve the green zone network of the City, amongst other measures.

The carbon sequestration capacity of the biomass can be improved through maintenance work on wooded areas and urban forests. The key actions related to taking carbon sinks into account in land use planning and construction have been identified in projects, such as the Climate-Proof City project coordinated by Helsinki. This selection of actions can be used when the perspective of carbon sinks is being further developed and integrated into the planning practices of the City (see Climate-Proof City – The Planner's Workbook 2014).

In addition to public spaces, the importance of the green mass on the plots should not be forgotten: the green factor method, which was developed for Helsinki and which is currently used in detailed planning, is meant to ensure sufficient green structures and stormwater management on the plots. The number of trees, bushes and useful plants, particularly those that produce climate-friendlylocal food, should be increased on the plots with the help of communication and interaction.

**Key actions related to carbon sinks**

**130. The impact on carbon storage will be taken into account when designing urban forests and nature and public green zones. Planning and green zone design will be complemented with procedures to compensate for the carbon storage lost during construction.**

**Parties responsible:** Land Use and City Structure / Urban Space and Landscape Planning, Detailed Planning, Strategic Urban Planning, Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**131. The forest network in the Helsinki city plan (including conservation areas and forests in the green network) will be implemented by reforesting open spots and complementing the city structure with tree stands that do not cast shadow on the solar power potential.**

**Parties responsible:** Land Use and City Structure / Urban Space and Landscape Planning, Detailed Planning, Strategic Urban Planning, Buildings and Public Areas / Maintenance,
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**132. Forests and wooded areas owned by the City (including City-owned areas outside the City borders) will be kept vegetative, covered and diverse with various tree species and sustainable forestry.**

**Parties responsible:** Land Use and City Structure / Urban Space and Landscape Planning, Buildings and Public Areas / Maintenance.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**133. The number of fruit trees, decorative trees, useful plants and shrubs that offer climate-friendly local food will be increased on plots through raising of awareness and other forms of communication.**

**Parties responsible:** HSY / Ilmastoinfo, Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021). Complexity: Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**134. The planning and implementation of new plots will use Helsinki's green factor method to ensure sufficient green structures on each plot.**

**Parties responsible:** Land Use and City Structure / Detailed Planning, Services and Permits/ Building Regulation.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Low costs / to be carried out as official work.

**135. An estimate of Helsinki's carbon storage and carbon sinks will be updated each council term, and the full carbon sink potential of the Helsinki Group will be examined. The calculation methods for and reporting on the shared carbon storage and carbon sinks of the metropolitan area will be developed.**

**Parties responsible:** HSY, Land Use and City Structure / Urban Space and Landscape Planning, Services and Permits / Environmental Services.
**Time span:** Each council term
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## 6.2 Compensation

According to the objective set, Helsinki will have reduced the usage-based greenhouse gas emissions in the area of the city by 80 per cent from 1990 to 2035. To become carbon-neutral, the City must compensate for any remaining emissions so that the net emissions of the City in the assessment period of 2035 (and onwards) will be at zero. Primarily, emission compensation should however, only be a temporary solution to reach a calculated emission-free state more rapidly without the operations being fully emission-free. In addition to compensation, emissions reduction actions need to actively continue even after 2035.

The next chapters will summarise the key principles and potential methods of emissions compensation. The volume of greenhouse gas emissions remaining in 2035 and the costs of the compensation actions are also estimated below. In the next few years, the City needs to examine the potential presented by emission compensation in more detail (including the opportunities for using carbon sinks).

As the compensation actions become more pertinant, the distribution of responsibilities between the City organisation and other actors will need to clarified. For example, Helen Ltd, the energy company of the City, is involved in the emissions trading of the EU, which means that Helen is currently 'compensating' for its emissions by acquiring emission rights that exceed the free distribution level.

### Key actions related to compensation

**136. Helsinki's potential emission compensation methods, compensation needs and costs will be assessed. The compensation methods of other cities will be examined, and Helsinki will participate in national and international collaboration to define shared rules for the calculations. Helsinki will aim to implement the compensations in a fashion that will benefit the City, for example by actively creating conditions for the production of clean energy, such as wind power, and by sequestering carbon in the City area.**

**Parties responsible:** Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** Requires resources.

## Principles and methods of compensation

Until the last few years, emission compensation was primarily practised by companies and large industrial plants, both in Finland and globally. There are no uniform or clear rules or procedures for the emissions compensation actions of cities. Despite the lack of procedures, emissions compensation involves principles that should steer the compensation at city level. The most important principles are the requirement of additionality and securing the permanence of the emissions reductions.

The additionality requirement means that the target for compensation needs to be such that the emissions reductions would not have become reality without the (financial) contribution of the actor performing the compensation. This principle is used to ensure that the compensation produces new emissions reductions in reality instead of supporting actions that would have produced the emissions reductions anyway. Emission reduction objects that fulfil the requirement of additionality will likely be more difficult to find in the future as an increasing number of countries, cities and organisations will actively reduce the emissions they produce themselves. (Seppälä et al. 2014)

The second essential principle for compensation is permanence, meaning that the emissions reduction cannot be cancelled. Partially because of this, the compensation through reforesting, for example, have been criticised in some contexts as they cannot be guaranteed to have permanent impact: if the forest burns down or is felled later, its emissions reduction effect will end, and, in the worst case scenario, the carbon dioxide emissions reduced will return to the atmosphere (Alhola & Seppälä 2014). However, the practices planned or implemented by some cities seem to indicate that carbon sinks are considered a means of compensation. For example, the City of Stockholm was finishing a report in spring 2018 regarding the emission compensation potential of increasing the amount of carbon sinks in the urban area (Stockholm City Executive Office, 2016, p. 41). Similarly, Copenhagen has planned to compensate for some of its emissions by reforesting idle land by 2025 (Copenhagen 2013).

There are international standards for emission compensations made through financial contributions, which can be used to verify the reliability and additionality of the actions. The Gold Standard, supported by the WWF and the UN, is considered one of the most reliable actors assessing and verifying emissions reductions. The Gold Standard directs compensations outside the emissions trading system of the EU into projects that reduce the greenhouse gas emissions in developing countries. In the past the Gold Standard certificates were only granted to projects that increase the use of clean energy and energy efficiency (Alhola & Seppälä 2014). Currently, the project selection also includes emissions reduction projects related to reforestation, which supports the idea that carbon sinks are a part of emission compensation.

In addition to emissions reductions verified by external parties, emissions can be compensated for though the active measures of the City. When this is the case, special attention needs to be paid to ensuring the addi-

tionality and permanence of the measures. For example, the most important compensation measure in Copenhagen is the investment in the construction of 100 new wind power plants. They are used to produce more energy than needed by the city, and the extra energy is sold outside the city (Pangerl 2014, p. 121). As such, emissions compensation is not only a cost item for the city; instead it will also generate income after the investments. However, it should be noted that to create true emissions reductions, the energy from wind power should replace the emission-intensive forms of energy production instead of simply introducing a new energy source to the market. Ensuring and verifying this can be challenging. Other potential ways include the processing of the by-products of forestry into biochar, which is used in agriculture to raise the carbon content of soil and improve the growth of plants, or the sequestering of carbon in a drained swamp to be restored. So far, the Hiilipörssi carbon exchange of the Finnish Association for Nature Conservation only offers the restoration of swamps for private individuals.

The emission compensation of the Helsinki metropolitan area can also be looked at from the perspective of a functional metropolitan area as the shared climate strategy of the area is being updated in terms of the stricter climate objectives and the mitigation actions that are best implemented jointly by the actors in the area. In this context, it is reasonable to inspect the carbon sinks in the City area and in materials as a single unit. This approach would also strengthen the rational development of the carbon sinks, communications and the development of uniform calculation criteria.

## Emissions to be compensated for

When the emissions reduction actions are implemented, the greenhouse gas emissions of Helsinki will decrease from the level in 1990 (3,600 kt $CO_2e$/a) to 720 kt $CO_2e$/a by 2035 (emissions reduction of 80 %). The remaining emissions to be compensated for, 720 kt $CO_2e$/a, will primarily come from the use of natural gas and the fuels of ship traffic and heavy traffic in 2035.

## Cost estimate

If Helsinki aims to reach the calculated emission-free state in 2035, it will have to prepare for the compensation of the remaining emissions. However, an accurate cost estimate for a longer period is difficult to make: the costs are naturally affected by the volume of emissions to be compensated for, as well as the methods chosen (for example, the increase of carbon sinks, investments in renewable energy, purchasing emissions reductions from outsiders). According to an estimate provided by Gold Standard (mentioned earlier in this Plan), the average price of a tonne of carbon dioxide in 2035 would be approximately 15 euros, based on the current estimates (discount of 5 %) (Gold Standard 2018b; EPA 2015). Fully compensating for the remaining amount of emissions, 720 kt $CO_2e$/a, by purchasing emission rights, would cost approximately 10 million euros per year.

The UN's offset website includes many certified projects with a price level of under 1 EUR/$CO_2$ tonne. This is used to fund the growth of carbon sinks and the implementation of $CO_2$emissions reductions in developing economies.

# 7 It is necessary to adapt to climate change

Since the impacts of climate change are encountered at a local level, cities have a central role to play in adaptation to climate change. Despite mitigation measures, the impacts on Helsinki will be so significant that adapting to them will be absolutely necessary. The impacts of climate change have been identified at city level, and the City of Helsinki has assumed an active role in adaptation to climate change. As the adaptation actions are already covered in the other plans and programmes of Helsinki, such as the stormwater programme for the City of Helsinki (2018), the flood strategy, the green roof policies (2016) and the policies on the adaptation to climate change (2017), the adaptation actions will not be covered in this Plan. The adaptation policies will be brought into the decision-making process simultaneously with the Carbon-neutral Helsinki 2035 Action Plan (Helsinki's climate work group 2017c).

Mitigation and adaptation can either support or harm each other. The dense urban structure reduces greenhouse gas emissions, but it may also increase the risk of stormwater floods and strengthen the heat island phenomenon. At the same time, adaptation measures may cause maladaptation if the implementation increases greenhouse gas emissions significantly. An example of this would be the electricity consumption brought on by the increased cooling needs of buildings. At their best, mitigation and adaptation can support each other. For example, the City's green structures will hold back stormwater and cool heat islands while also acting as carbon sinks. Some of the adaptation measures require shared policies of the metropolitan area, and the implementation of the measures through collaboration will be the easiest. Knowledge of what to adapt to is changing regularly based on updates to scientific research. Because of these changes, the shared adaptation strategy of the cities in the metropolitan area will be updated in the near future, along with its background information (HSY 2019–2021).

### Key actions related to the adaptation to climate change

**137. The adaptation policies will be finished and brought into the decision-making process simultaneously with the Carbon-neutral Helsinki 2035 Action Plan.**

**Parties responsible:** Executive Office, Services and Permits / Environmental Services.
**Time span:** Current council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

# 8 Communication and interaction

**The Carbon-neutral Helsinki 2035 Action Plan requires collaboration between residents and the City.**

The Carbon-neutral Helsinki 2035 Action Plan requires collaboration between residents and the City for the actions in the plan to be implemented. The objective of communications and interaction related to the Action Plan is to support the implementation of the Plan by starting and supporting practical climate actions. Communication and interaction are ways to reach the interest groups and to get them to participate in the implementation of the Action Plan. Communication and interaction are essential for the Plan to succeed, and if they fail, the Plan cannot be implemented.

Communication and interaction related to the Action Plan will realise the objectives of the City Strategy: “Helsinki increasingly understands its role as the creator and enabler of possibilities. Helsinki actively forms partnerships with residents’ organizations and with everyone interested in developing and vitalizing the city. […] Helsinki develops digital solutions, which make it easy for residents to follow and engage in matters of interest and concern to themselves, regardless of whether they are the city’s or other actors’. Helsinki’s operating model is based on openness and transparency. Helsinki is the world’s leading city in opening up and utilizing public data.”

All actors who are interested in the subject matter of the Plan are seen as participants in the Plan. The effects of the Action Plan are expected to concern the residents, in particular. As the residents are also required to perform the actions, their engagement is vital.

Ccommunication and interaction related to the Action Plan will follow the principles below:

- **Everyone is a communicator: the Action Plan will be connected to all communications of the City when it makes sense in the context.**
- **Be concrete: communications should concern the concrete climate actions, not the Plan itself.**
- **Here and now: focus will be on the actions Helsinki residents can take right now.**
- **Interesting stories: climate actions of the residents will be highlighted, and exemplary actors will receive recognition.**
- **Open participation: anyone will be able to follow the progress of the Action Plan and participate in the updating of the Action Plan.**
- **Communications will reach their audience: matters related to the Action Plan will be shared in various channels to reach as many residents as possible.**
- **The City is listening: the feedback of the residents will be learned from, and the actions will be updated based on the feedback.**

### Key actions in communication and interaction

**138. A communication and interaction plan for the Action Plan will be developed. The communication strategy will be implemented, and it will be monitored and updated regularly.**

**Parties responsible:** Urban Environment Division / Administration and Support, Environmental Services, Executive Office.
**Time span:** Council term (2017–2021).
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / requires resources.

**139. The implementation of the Action Plan will develop engagement and interaction according to Helsinki's model for engagement and interaction, aiming for as much openness and transparency as possible.**

**Parties responsible:** Services and Permits / Administration and Support / Environmental Services, Executive Office, in collaboration with the National Institute for Health and Welfare.
**Time span:** The engagement model will be created during this council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / low costs.

**140. The City organisation will aim to identify local activities that are significant in terms of carbon-neutrality, for example with the help of the stadiluotsi service, and to seek a suitable role to promote these activities.**

**Parties responsible:** Services and Permits / Environmental Services / Administration and Support, Executive Office / communications.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / low costs.

# 9 Coordination, monitoring and assessment of climate work

Climate matters must be integrated into the routines of the City and the residents, and climate work needs to be done systematically and determinedly. This requires efficient coordination of climate work, as well as short-term and long-term monitoring and steering.

## 9.1 Coordination of climate work

A cross-division climate work group operated in Helsinki in 2016–2017. The group was tasked with the coordination and monitoring of climate work, as well as the promotion of the practical implementations. The climate work group prepared the Report on the Climate Objectives of Helsinki, the Adaptation Policies of Helsinki and the presentation on the Coordination of Climate Work and started Helsinki's assessment of climate risks in collaboration with the Finnish Meteorological Institute. The work group also acted as the steering group for the stormwater programme. The work of the group was interrupted as the deputy mayor who was serving as the chair, Pekka Sauri, left his position 1 June 2017 and the organisation was changed at the same time.

**The climate work group had the following vision for the management of climate matters:** *"Climate matters will be an integral part of operations planning in the divisions. Sufficient resources will be reserved for climate matters in the annual operation plans based on the City Strategy, environmental policy, climate objectives and climate policies. The climate objectives will be a part of the environmental management of divisions and they will also steer the investments and procurements of the City. Climate protection cooperation with the actors within the City will be natural and everyone will have clear roles in the promotion of climate work. The political level, the officials and the experts will work together to progress the climate objectives. Residents and companies will participate in the development of climate matters in Helsinki. Climate matters will be constantly developed based on best practices, and different forms of collaboration will be sought and utilised. The climate objectives will be monitored, and they will be reported on annually in the City's environmental report. The climate work group will coordinate climate protection in the City, supported by the preparation team and the climate network."*

The distribution of climate work in the City's organisation, based on the report of the climate work group, is outlined in Appendix 3.

The management team for climate and environment of the Urban Environment Division coordinates environmental management in the City organisation, meaning the management of environmental matters and the implementation of objectives related to management of environmental policy. The collection of tasks also includes the environmental reporting, the environmental accounting and the monitoring of the environmental policies and emissions reduction

plan of the City. Environmental management will be coordinated at the level of the Helsinki Group, meaning that subsidiary communities and foundations will also be included, in addition to the central administration. Environmental management is closely related to climate management and the implementation of the objective of carbon-neutrality since new climate objectives are the most challenging and significant part of the environmental objectives of the City.

The City requires a group for managing and being in charge of the implementation of environmental matters and the mitigation of and adaptation to climate change. The group will also need to report to the executive group of the City on the realisation of the work on emissions reductions. In climate work, the tasks would be the same as those of the climate work group. The Environmental Services management team for climate and environmental matters would perform secretarial duties.

Additionally, due to the extent of the Plan and its impact on everyone operating in the City, constant dialogue between businesses and other interest groups will be required. The dialogue will use the Climate Partners network for businesses and the related events.

**Key actions related to the coordination of climate work**

**141. A group for climate-related and environmental management will be founded. The group will be responsible for informing the City's executive group on the implementation of the Carbon-neutral Helsinki 2035 Action Plan, coordinating environmental management and climate work, and monitoring and supporting the implementation of the actions.**

**Parties responsible:** Executive Office, Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**142. In its operational and economic planning, the City will set sector-specific objectives in terms of emissions reductions.**

**Parties responsible:** Executive Office
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

**143. A group or forum will be established to facilitate the cooperation between the City, businesses and other interest groups, as well as the monitoring and sparring related to the Action Plan. In addition to this, new ways to discuss climate matters will be developed.**

**Parties responsible:** Executive Office / Economic Development, Services and Permits / Environmental Services.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

## 9.2 Monitoring and reporting

For the Action Plan to succeed, it needs to be actively and continuously monitored, and reactions to potential problems need to be rapid. It is clear that some of the dozens of actions in the Plan will not succeed, and some will be revealed to be less effective than assumed. However, some actions may progress more rapidly than predicted, or new, more effective methods may be developed. Thus, it is essential that data on the progress of the Plan is collected and that the plans can be changed based on new information.

### Open decision-making policy

For the regular monitoring and extensive assessments of the Action Plan to succeed, we should follow the open decision-making policy and the related tools and principles (for example, the openness of information and participation, allowing for criticism and regularly updated info pages to facilitate access to information) (Tuomisto et al. 2014, Tuomisto et al. 2016).

The open decision-making policy involves the openness of data and participation, which means that all data will be available to all interested parties and that as an extensive group of people as possible will be able to participate in impact assessments, for example. In this approach, the City organisation, experts and interest groups are constantly encouraged to participate in discussions and provide feedback. This approach will also advance the objectives of the City Strategy: "Helsinki's operating model is based on openness and transparency. Helsinki is the world's leading city in opening up and utilizing public data. Helsinki strengthens its position as an international forerunner in inclusion and transparency."

The open decision-making policy will advance collaboration with the climate projects of other cities and make it easier to use the competence of research institutes. Thus, the organisation of the City of Helsinki will need to aim for dynamic working methods and learning through collaboration, as well as identifying and fixing errors quickly. Residents' commitment to the actions is vital for achieving the objectives.

**Key actions**

**144. Open policy practice and the related tools and principles are adopted in monitoring of the Action Plan. An operation model for the monitoring of the Action Plan will be created to ensure that the best and current information is always available. The operation model will be used when implementing and updating the Action Plan.**

**Parties responsible:** Services and Permits / Environmental Services, in collaboration with the National Institute for Health and Welfare.
**Time span:** Started during 2018; the operation model will be created during the current council term (2017–2021); continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / low costs.

## Development of reporting, impact assessments and data compilation

The most important channel for monitoring the Carbon-neutral Helsinki 2035 Action Plan is the current environmental reporting system. The City Council will be provided with an annual overview of the progress of the Action Plan in connection with the environmental reporting: how the emissions in Helsinki are developing and how well the actions have been implemented. Data for the environmental reporting will be collected from the divisions of the City, the subsidiary communities and the joint municipal authorities, and an overview of the climate actions of the City will be formed based on the data. HSY will produce the annual information on emissions reductions.

In addition to annual environmental reporting, the actions in the Action Plan need to be monitored constantly and actively with the help of the monitoring tool (see Chapter 1). The actors in charge of the actions will see to it that the monitoring tool includes up-to-date information on the progress of the actions. The climate work of Helsinki acknowledges that traditional reports and studies get outdated rapidly as they cannot be updated. Based on the experiences, the constant monitoring may be expanded to be used in other work of the Helsinki Group and in the implementation of strategies.

The premise for the monitoring of the Action Plan is to produce all necessary data during the operations (preferably automatically or with minimum effort), refine the data into open data and distribute it via the monitoring tool to be used freely. The monitoring data will be made as universally usable as possible, meaning that only data items with at least one identified usage purpose, and preferably several usage purposes, are collected.

**According to the City Strategy:**
*"Helsinki develops digital solutions, which make it easy for residents to follow and*

*engage in matters of interest and concern to themselves, regardless of whether they are the city's or other actors'."*

A monitoring page will be opened for each action presented in the Action Plan. The pages will contain up-to-date information on the following, at the minimum: the organisation or person in charge of the action, a detailed implementation plan, the planned budget, the estimated emissions reductions, a description of the indicator used to measure and monitor the emissions reductions, a list of other essential impacts, the realised budget (this will be generated automatically from the City's accounting system, if possible) and the emissions reductions measured.

The monitoring pages for the actions will be implemented uniformly so that the content of the pages can be read and compiled into a report automatically. This way, a situation report can be generated at any time. A person responsible will be appointed for each action, and the person in question will be in charge of updating the page of their respective action. The maintenance of the pages should be light (the accuracy of the content will be inspected twice a year, for instance), but important changes will still be logged immediately. The pages should be so clear, simple and functional that the person in charge of a page can use it as the primary record for logging information concerning the action.

### Key actions related to reporting and impact assessment

**145. New assessment tools will be adopted and used for the monitoring of the progress, costs, benefits and emission development of the actions, as well as the development of green jobs, air quality, health impacts and other impacts.**

Parties responsible: Services and Permits / Environmental Services, HSY, research centres, other municipalities.
**Time span:** Council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / low costs.

**146. An operation model will be developed for the annual reporting of the operations and finances of the Helsinki Group in terms of emissions reduction; for example, as a part of environmental reporting.**

**Parties responsible:** Services and Permits / Environmental Services, Executive Office.
**Time span:** Continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work.

## 9.3 Extensive assessment of effectiveness

In addition to continuous and annual monitoring, extensive updates should be made each Council term, analysing new and relevant research data, estimating the success of the actions, comparing the status of various cities and developing new actions to ensure the realisation of the Plan. Separate funding will be reserved for this so that extensive impact assessments do not eat up the annual funds for the actions. Carrying out an extensive impact assessment will become easier than traditional surveys as the monitoring tool will contain up-to-date information in each action. A summary on the overall status of the Action Plan will be presented to the Council once every Council term, and the Council will decide on any strategic changes to the Action Plan.

**147. Assessment of the Action Plan during each council term.**

**Parties responsible:** Services and Permits / Environmental Services.
**Time span:** The engagement model will be created during this council term (2017–2021), continuous.
**Complexity:** Decision by the City of Helsinki.
**Cost estimate:** To be carried out as official work / low costs.

# 10 Assessment of the impact on business

VTT has been commissioned by the City of Helsinki to assess the impacts the Action Plan has on business (VTT 2018). The assessment is based on the evaluations carried out by VTT's experts, statements from the interest groups and interviews with companies. The assessment team received 25 statements and held 33 interviews. All actors who participated in the assessment of the Action Plan see significant business impact potential in the Plan. At the same time, the statements of the interest groups, in particular, point out factors that may decelerate growth. The company representatives who participated in the interviews are mainly positive about the Action Plan and see significantly more opportunities than threats in the Plan. They hope the City makes bold investments in the implementation of the Plan. The significance of the impacts depends on the implementation, target level and realisation of the goals of the Plan. The City can influence the above-mentioned elements in many ways. In the short term, the City can create conditions for businesses and the improvement of the employment rate by changing regulations and making public procurements. In the medium term, the City can indirectly affect the operations of companies by affecting the behaviour and consumption habits of the residents. Finally, in the long term, the City can create conditions for future business. The City will support the establishment of new businesses through innovative procurements, pilots and market experiments. When new businesses successfully achieve growth and internationalisation, they can also affect the employment rate of the area in a significant manner.

According to the assessment by VTT, the pricing system for traffic is an investment that may have an substantial effect on consumer habits. Using this method, the City can increase costs for undesirable modes of transport and, similarly, favour more sustainable modes. The adoption of the pricing system for traffic involves clear risks from the perspective of companies. Companies fear that the system will impede and reduce residents' mobility in the City. It was considered important that the solution is created in close collaboration with the cities and municipalities of the region so that Helsinki will not be placed in a different position to other actors.

In particular, young companies in the logistics sector considered the creation of market-determined conditions important. What the companies mean by this is that they should have sufficient room to create profitable business. Innovative procurements and pilots are good ways of testing new solutions, but they will not be sufficient for the creation of market conditions. From the perspective of these companies, the Action Plan should include a sufficient number of numerical objectives so that the companies can calculated the significance of their own solutions compared to the objectives and deduce which types of investments or contributions are made possible by the mar-

ket. After innovative procurements and pilots, the City should be able to make rapid decisions regarding the implementation of the procurements and the opening of the market. The companies felt that market-determined business alone constitutes a sufficient reference to support the internationalisation of the companies.

When attempting to make the built environment carbon-neutral, decentralised solutions based on renewable energy and the business plans thereof are essential. Properties can become partially self-sustaining in terms of energy, and properties could also transform from passive consumers into producer-consumers through the business-like use of energy investments. The changes may have a significantly positive effect on the business operations of companies and on the demand for technical solutions and services.

The City will play a large role in the promotion of energy efficient renovations through planning, guidance, examples and incentives For the resourcing of the Action Plan, it would be beneficial to pay more attention to area-level renovations. Both clients and service providers still require a great amount of new and objective information and guidance. The role of the City as the provider of objective information is essential. In addition to the guidance offered to the decision-makers and residents of housing cooperatives, networks and active professional support are also needed for construction professionals. Financial incentives may have an extensive and rapid effect on the acceleration of energy renovations. This is why the use of incentives and their significance as a part of the actions should be solidified. Successful demonstrations that involve powerful communications are some of the essential actions in the implementation of the Plan. That is why the planning, funding, conceptualisation and implementation of the demonstrations should have an even more central role among the actions in the Plan.

# 11 Costs and advantages of the key action entities

The costs and benefits of the key action entities are summarised in Appendix 5 (calculations: traffic / WSP Finland Ltd; construction and use of buildings / Gaia Consulting Ltd). The assumptions used in the calculations are also explained in the appendix. It also includes information on the current status and recent developments of each action. A summary of the emissions reductions calculated for each key action entity is presented in Appendix 4. The tables do not include the actions related to the emissions reduction actions of Helen and the Port since these companies define the actions and asses the cost efficiency by themselves. In the calculations, it is estimate that the Helen development programme will achieve approximately 32 per cent of the emissions reduction by 2035, while the actions of the Port of Helsinki will achieve approximately 2 per cent of the reductions.

The majority of the measures to reduce the emissions of buildings are financially attractive to building owners in the long term. In several identified action entities, development work is required for the impact assessment.

As for the emissions reduction potential of the key action entities, an extensive range of means is required to reach the emissions reductions goals. Even in the calculations alone, only a few action entities have an impact of more than 5 per cent on the total target emissions reduction. The actions that impact the whole the most (which are calculated to make up more than 5 percent of the total emissions reduction) are reducing the total heating consumption, increasing the proportion of locally produced heating and electricity and increasing the proportion of electric cars.

# 12 Sources


Alhola, K. & Seppälä, J. (2014). Osa 1: Hiilineutraalius käsitteenä. [Part 1: Carbon-neutrality as a concept]. p. 8–43 in J. Seppälä (editor) (2014). Kohti hiilineutraalia yhteiskuntaa. Ilmastopaneelin raportti 28/5/2014. [Towards a carbon-neutral society. Report of the Ilmastopaneeli climate panel 22/4/2014]. http://www.ilmastopaneeli.fi/uploads/selvitykset_lausunnot/Hiilineutraalisuus_taustaraportit_2014.pdf

Copenhagen (2013). Climate Plan – Copenhagen Climate Neutral by 2025. Available at: https://www.energycommunity.org/documents/copenhagen.pdf

EPA (2016). Technical support document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis. Available at: https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

Gaia Consulting Ltd (2014). Helsingin 30 % päästövähennysselvitys. Kasvihuonekaasupäästöjen kehitys ja vähentämisen kustannustehokkaat toimenpiteet. Helsingin kaupungin ympäristökeskuksen julkaisuja 7/2014. [A report on Helsinki's 30-% emissions reduction. Development of greenhouse gas emissions and cost-efficient actions for emissions reduction. Publications of the City of Helsinki Environment Centre 7/2014.] https://www.hel.fi/static/ymk/julkaisut/julkaisu-07-14.pdf

Gold Standard (2018a). About Gold Standard: What types of projects are eligible to register with Gold Standard? Available at: https://www.goldstandard.org/resources/faqs

Gold Standard (2018b). Carbon pricing: What is a carbon credit worth? Available at: https://www.goldstandard.org/blog-item/carbon-pricing-what-carbon-credit-worth

Helsinki's climate work group (2017a). Selvitys Helsingin uusista ilmastotavoitteista. Hiilineutraalisuustavoitteen päivitys sekä vuoden 2030 päästötavoite ja toimenpiteet. Helsingin kaupungin ympäristökeskuksen julkaisuja 4/2017. [A report on Helsinki's new climate objectives. An update to the carbon-neutrality objective and the emissions reduction objective and actions for 2030. Publications of the City of Helsinki Environment Centre 4/2017]. https://www.hel.fi/static/ymk/julkaisut/julkaisu-04-17.pdf

Helsinki's climate work group (2017b). Helsingin kaupungin ilmastoasioiden koordinointi. Helsingin ilmastotyöryhmä. [Coordination of climate matters in the City of Helsinki. Helsinki's climate work group]. http://www.stadinilmasto.fi/files/2016/06/Helsingin-kaupungin-ilmastoasioiden-koordinointi.pdf

Helsinki's climate work group (2017c). Helsingin ilmastonmuutokseen sopeutumisen linjaukset 2017–2025. Esitys kaupunkistrategian valmistelua varten valtuustokaudelle 2017–2021. [Helsinki's policies for climate change adjustment 2017–2025. A presentation for the preparation of the City Strategy for the council term of 2017–2021]. https://www.hel.fi/static/ymk/ilmasto/Helsingin-ilmastonmuutokseen-sopeutumisen-linjaukset.pdf

City of Helsinki Environment Centre (2014). Ilmastonkestävän kaupungin suunnitteluopas Hiilinielut osaksi kaupunkisuunnittelua. Toimenpidevalikoima hiilinielujen lisäämiseksi. [Climate-Proof City – The Planner's Workbook: Carbon sinks as a part of city planning. A selection of actions to increase the amount of carbon sinks]. http://ilmastotyokalut.fi/vihrea-infrastruktuuri/hiilinielut/

City of Helsinki Environment Centre (2016). Helsingin kaupungin ilmansuojelusuunnitelma 2017–2024. Helsingin kaupunki, ympäristökeskus. [The Air Quality Plan of the City of Helsinki 2017–2024. City of Helsinki Environment Centre]. https://www.hel.fi/static/ymk/ilmansuojelu/ilmansuojelusuunnitelma.pdf

Helsinki City Planning Department (2014). Yleiskaavan ilmastovaikutusten arviointi. Helsingin kaupunkisuunnitteluviraston yleissuunnitteluosaston selvityksiä 2014:42. [Assessment of the climate impacts of the city plan. Reports of the Strategic Urban Planning Section of the City Planning Department 2014:42]. https://www.hel.fi/hel2/ksv/julkaisut/yos_2014-42.pdf

HSL (2016). Ajoneuvoliikenteen hinnoittelun teknistoiminnallinen selvitys. HSL:n julkaisuja 4/2016. [Report on the technical and functional qualities of the pricing of vehicle traffic. Publications of HSL 4/2016]. Available at: https://www.hsl.fi/sites/default/files/uploads/hsl_julkaisu_4_2016_ajoneuvoliikenteen_hinnoitteluselvitys_teknistoiminnallinen.pdf

The Helsinki Energy and Climate Atlas (2018). https://kartta.hel.fi/3d/atlas/

HSL (2016a). Helsingin seudun työssäkäyntialueen liikenne-ennustejärjestelmän kysyntämallit 2014. HSL:n julkaisuja 21/2016. [Demand models for the traffic forecast system in the employment area of the Helsinki region 2014. Publications of HSL 21/2016]. https://www.hsl.fi/sites/default/files/21_2016_kysyntamalliraportti.pdf

HSL (2016b). Helsingin seudun työssäkäyntialueen liikenne-ennustejärjestelmän tarjontamallit 2014. HSL:n julkaisuja 22/2016. [Supply models for the traffic forecast system in the employment area of the Helsinki region 2014. Publications of HSL 22/2016]. https://www.hsl.fi/sites/default/files/22_2016_tarjontamalliraportti.pdf

HSL (2016c). Ajoneuvoliikenteen hinnoittelun teknistoiminnallinen selvitys. HLJ 2015 jatkoselvitys. HSL Helsingin seudun liikenne 4/2016. [Report on the technical and functional qualities of the pricing of vehicle traffic. HLJ 2015, continuation report. HSL, Helsinki Region Transport 4/2016]. https://www.hsl.fi/sites/default/files/uploads/hsl_julkaisu_4_2016_ajoneuvoliikenteen_hinnoitteluselvitys_teknistoiminnallinen.pdf

HSL (2017a). Liikennejärjestelmän tehokkaimmat keinot ilmastotavoitteiden saavuttamiseksi Helsingin seudulla. MAL 2019. 4.9.2017 luonnos. [The most effective measures in the Transport System to reach the climate objectives of the Helsinki region. MAL 2019. 4 September 2017, draft]. https://www.hsl.fi/sites/default/files/uploads/luonnos.pdf

HSL (2017b). Lausuntopyyntö jäsenkunnille sähköbussien lisähankintojen rahoittamisesta. Alustava TTS2018-2020, liite j. [A request for statements from the member municipalities regarding the funding of the additional electric bus acquisitions. Preliminary TTS2018-2020, Appendix j] http://hsl01.hosting.documenta.fi/kokous/2017476-2-5.PDF

HSY (2015). Helsingin seudun yrityskatsaus (2015). Toimipaikat 2013. [Business report of the Helsinki region (2015). Locations in 2013]. https://www.hsy.fi/sites/Esitteet/Esitteet-Katalogi/Julkaisusarja/9_2015_helsingin_seudun_yrityskatsaus_toimipaikat2013.pdf

HSY (2017). Pääkaupunkiseudun kasvihuonekaasupäästöt. [Greenhouse gas emissions in the Helsinki metropolitan area]. Updated 13 November 2017. https://www.hsy.fi/fi/asiantuntijalle/ilmastonmuutos/hillinta/seuranta/Sivut/Paastot.aspx

Motiva (2018). Vähäpäästöisyysselvitys. [Report on low-emission solutions]. Available at: http://www.stadinilmasto.fi/

Nykänen, E. et al. (2017). Puurakentaminen Euroopassa. [Building with timber in Europe – a SWOT analysis]. LeanWood. VTT Technology 297. Available at: http://www.vtt.fi/inf/pdf/technology/2017/T297.pdf

Pangerl, E. C. (2014). A Comparative analysis of Copenhagen's and Vienna's climate targets. Available at: https://www.wien.gv.at/umweltschutz/nachhaltigkeit/pdf/pangerl-2015.pdf

Rasinmäki, J. & Känkänen R. (2014). Kuntien hiilitasekartoitus osa 1: Helsingin, Lahden, Turun, Vantaan ja Espoon maankäyttösektorin kasvihuonekaasupäästöt, hiilinielut ja hiilivarastot. Helsingin kaupungin ympäristökeskuksen julkaisuja 9/2014. [Survey of the carbon balance of municipalities, part 1: The greenhouse gas emissions, carbon sinks and carbon storage of the land use sector in the cities of Helsinki, Lahti, Turku, Vantaa and Espoo. Publications of the City of Helsinki Environment Centre 9/2014]. Available at: http://ilmastotyokalut.fi/files/2014/06/hiilitase_osa-1_julkaisu_ymk_2014.pdf

Seppälä, J.; Alestalo, M.; Ekholm, T.; Kulmala, M. & Soimakallio, S. (2014). Hiilineutraalisuuden tavoittelu - mitä se on missäkin yhteydessä. Ilmastopaneelin raportti 22/4/2014. [The objective of carbon-neutrality – what it means in different contexts. Report of the Ilmastopaneeli climate panel 22/4/2014]. Available at: http://www.ilmastopaneeli.fi/uploads/Hiilineutraalisuuden%20tavoittelu%20-%20mit%C3%A4%20se%20on%20miss%C3%A4kin%20yhteydess%C3%A4.pdf

Siemens CyPT (2016). Helsinki's 2030 Climate Technologies / City Performance Tool Report 2016. https://issuu.com/helsinginYmparistokeskus/docs/helsinki_cypt_report_-_2016

Stockholm City Executive Office (2016). Strategy for a fossil-fuel free Stockholm by 2040. Available at: http://international.stockholm.se/globalassets/rapporter/strategy-for-a-fossil-fuel-free-stockholm-by-2040.pdf

Electric traffic working group (2015). Helsingin kaupungin sähköisen liikenteen työryhmän raportti 2015–2016. [Report of the City of Helsinki's electric traffic working group for 2015–2016]. https://dev.hel.fi/paatokset/media/att/6f/6fce79144ea6a782b29778bfa4c6b1f02e9e8149.pdf

Ministry of Economic Affairs and Employment of Finland (2017). Valtioneuvoston selonteko kansallisesta energia- ja ilmastostrategiasta vuoteen 2030. Työ- ja elinkeinoministeriön julkaisuja 4/2017. [Report by the Finnish Government regarding the national energy and climate strategy until 2030. Publications of the Ministry of Economic Affairs and Employment 4/2017]. http://urn.fi/URN:ISBN:978-952-327-190-6

Tuomisto, J.; Muurinen, R.; Paavola, J.-M.; Asikainen, A.; Ropponen, T.; Nissilä, J. (2016). Tiedon sitominen päätöksentekoon. Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 39/2017. [Tying information to decision-making. The Reports and Research Conducted by the Finnish Government, Series of Publications, 39/2017]. http://fi.opasnet.org/fi-opwiki/images/7/71/Yht%C3%A4k%C3%B6ytt%C3%A4-hankkeen_loppuraportti.pdf

Tuomisto, J., Pohjola, M., Pohjola, P. (2014) Avoin päätöksentekokäytäntö voisi parantaa tiedon hyödyntämistä. Yhteiskuntapolitiikka 79:1:66-75. [Open decision-making would improve the utilisation of data. Social Policy 79:1:66-75]. http://urn.fi/URN:NBN:-fi-fe2014031821621 (See also the newer article manuscript: Tuomisto, J.T.; Pohjola, M.; Asikainen, A.; Meriläinen, P.; Rintala, T. (2018) From open assessment to shared understanding: practical experiences. http://en.opasnet.org/w/Opp_article, retrieved 16 February 2018)

Valor (2015). Kaukolämmön kysyntäjousto. [Demand response in district heating]. 31 August 2015. Finnish Energy. https://energia.fi/files/439/Kaukolammon_kysyntajousto_loppuraportti_VALOR.pdf

VTT (2018). Hiilineutraali Helsinki 2035 -toimenpideohjelman elinkeinovaikutusten arviointi. [Assessment of the Carbon-neutral Helsinki 2035 Action Plan's impact on business]. http://www.stadinilmasto.fi/elinkeinovaikutusten-arviointi-hiilineutraali-helsinki-2035/

Ministry of the Environment of Finland (2018). Maankäyttö- ja rakennuslain uudistus. [Reform of the Land Use and Building Act]. Published 10 March 2017, updated 17 April 2018. http://www.ym.fi/mrluudistus

# Appendix 1. Terms and abbreviations used

| | |
|---|---|
| **t** | tonne, 1,000 kg |
| **kt** | kilotonne = 1,000 t, one million kilograms |
| **e, equiv.** | Equivalent: all greenhouse gases are summed up based on their climate impacts. |
| **Greenhouse gas** | A gas in the atmosphere that transmits short-wave, visible light but absorbs long-wave infra-red light and turns it into heat. Water vapour is the most powerful greenhouse gas, while carbon dioxide is essential for climate change. |
| **Carbon storage** | A part of the soil, seabed, buildings or tree stand, which contains a high volume of carbon in a solid, preservable form, thus preventing the carbon from entering the atmosphere. For example, wooden buildings can store carbon for centuries, while limestone can store it for millions of years. |
| **Carbon sink** | A process that sequesters more carbon dioxide from the atmosphere than it releases. In Finland, the forests and the soil are extremely important carbon sinks. With other types carbon sinks, such as marshes, it is important to also consider the other greenhouse gases, such as methane. |
| **Carbon-neutral** | A quality of a process or an area where the amount of greenhouse gas emissions produced is equal to or lower than the amount of greenhouse gases sequestered in the long term. |
| **Climate-neutral** | Climate-neutral energy means that the energy consumption of society will no longer increase the concentration of greenhouse gases in the atmosphere and, therefore, will not warm the climate (Finnish Energy). |

| | |
|---|---|
| Education Division | Kasko |
| Culture and Leisure Division | Kuva |
| Social Services and Health Care Division | Sote |
| Urban Environment Division | Kymp |
| Land Use and City Structure service entity | Maka |
| General Land Use Planning | Myle |
| Detailed Planning | Aska |
| Land Property Development and Plots | Make |
| Traffic and Street Planning | Like |
| Urban Space Planning and Landscaping | Kamu |
| Buildings and Public Areas service entity | Rya |
| Built Property Management | Roha |
| Facility Services | Tila |
| Maintenance | Ylpi |
| Construction Contracting | Rake |
| Housing Production | ATT |
| Services and Permits service entity | Palu |
| Urban Environment Resident and Business Services | Aspa |
| City Survey Services | Kami |
| Building Control Services | Rava |
| Environmental Services | Ympa |
| Parking Control and Parking Services | Pyva |
| Management and Support Services | Hatu |
| City Executive Office | Executive Office |
| Economic Development Division | Elo |
| Financial and Planning Division | Taso |
| Neighbourhood Construction Unit of the Financial and Planning Division | Ary |
| Helsingin kaupungin asunnot Oy | Heka |
| Helsingin Asumisoikeus Oy | HASO |
| Public Enterprise for Transport | HKL |
| Soil and Bedrock | Geo |
| Procurements and Tendering Team | Hanki |
| Forum Virium Helsinki Oy | FVH |
| Technical and Economic Planning | Tek |
| Helsinki Metropolitan Smart & Clean -foundation | S&C Foundation |

# Appendix 2. Work group for the emissions reduction programme

| | |
|---|---|
| Land Use Director Raimo K. Saarinen, | Urban Environment Division, President |
| Budget Manager Matti Malinen, | City Executive Office, Vice President |
| Head of Traffic and Street Planning Reetta Putkonen, | Urban Environment Division |
| Head of Built Assets Management Sari Hildén, | Urban Environment Division |
| Head of Environmental Affairs Esa Nikunen, | Urban Environment Division |
| Strategy Manager Marko Karvinen, | City Executive Office |
| Project Manager Juha Viljakainen, | City Executive Office |
| Head of Premises Services Jaana Lunnela, | Social Services and Health Care Division |
| Head of Premises Services Matti Kuusela, | Culture and Leisure Division |
| Head of Premises Services Mauno Kemppi, | Education Division |
| Head of Production and Distribution Heikki Hapuli, | Helen Ltd |
| Traffic Planning Officer Tuire Valkonen, | HSL |
| Result Area Manager Irma Karjalainen, | HSY |
| Managing Director Tiina Kähö, | Helsinki Metropolitan Smart & Clean –foundation |
| Environmental Inspector Jari Viinanen, | Urban Environment Division, secretary of the work group |
| Planning Engineer Saara Kanto, | City Executive Office, Secretary for the work group |

Preparation group:
Urban Environment Division/Environmental Services/Management of climate and environmental issues: Jari Viinanen, Petteri Huuska, Sonja-Maria Ignatius, Mira Jarkko
City Executive Office: Saara Kanto

# Appendix 3. Responsibilities in the climate work of the City organisation

The report of Helsinki's climate work group (2017b) presents the tasks of the City organisation in the mitigation of and adaptation to climate change.

| Service/entity | Climate work tasks |
|---|---|
| City Executive Office | Climate objectives in the preparation of the City Strategy; considering climate risks when managing preparedness; climate partnership with businesses; considering the climate perspective in centralised procurements. |
| Environmental Services (Urban Environment Division / Services and Permits) | Coordinating steering, communications, guidance and reporting related to climate matters; coordinating the eco-support activities, climate partners, climate work group and adaptation; preparing climate projects; cooperation related to preparedness for climate risks. |
| Land Use and City Structure (Urban Environment Division) | Planning of land use and transportation that will densify the City structure; assessing the climate impacts of land use; city plan regulations that support the changing of the energy system; transport planning that reduces climate emissions; promotion of cycling; climate perspective in plot conveyances. |
| Buildings and Public Areas (Urban Environment Division) | Coordinating work on energy efficiency and energy use in public construction; taking climate-related matters in construction, public lighting and infrastructure into account in investments and procurements. |
| Building Control Services (Urban Environment Division / Services and Permits) | Steering and guiding the energy efficiency of construction and the rainwater management of plots. |
| Rescue Department (Urban Environment Division) | Climate risk management |
| Housing Production (Urban Environment Division / Buildings and Public Areas) | Energy efficiency of the City's rental apartments in new construction and renovations. |
| Sports (Culture and Leisure Division) | Energy efficiency of sports facilities, customer traffic and accounting for adaptation. |
| Education Division | Climate matters in education. |

| Corporations, city enterprises and joint municipal authorities | Climate work tasks |
|---|---|
| Helsinki Region Environmental Services | Organising the climate cooperation of the municipalities in the Helsinki metropolitan area; emission calculations; climate matters in water and waste management. |
| Helsinki Region Transport | Maintaining climate matters as an integral part of the planning, organisation and procurements of public transport. In the planning of the Helsinki region transport system, the reduction of the emissions from traffic is a central premise in the planning round for MAL 2019. |
| Service Centre | Climate impacts of food, food services for schools, day care centres and social and health care locations. |
| Helen Ltd | Solutions for centralised energy production; energy guidance; the objective is to reduce greenhouse gas emissions by 20% by 2020 and produce energy in a climate-neutral manner by 2050. |
| Stara | Considering climate matters in services rendered (construction, public spaces). |
| HKL | Energy efficiency of the metro network<br>and the tram network and the related infrastructure. |
| Port of Helsinki | Energy efficiency of the harbours and ship traffic. |

## Carbon-neutral Helsinki 2035, a summary of the emissions reduction potential of the action entities

The table presents the actions in the CNH2035 Action Plan, categorised into action entities. Gaia Consulting Ltd (construction and use of buildings) and WSP Finland Ltd (traffic) have estimated the emissions reduction potential. Distribution of the emissions reductions in construction and use of buildings has also been calculated for the buildings owned by the City and the buildings owned by others.

| Key action entities | Proportion of the full emissions reduction potential of the Action Plan | |
|---|---|---|
| **Reducing the total consumption of heating** (actions 31, 33, 34, 39, 46–49, 52, 55, 57–69, 73–76, 78, 82–86) | 16 % | 2.5 % City buildings |
| | | 13.5 % Other buildings |
| **Increasing the proportion of locally produced heating** (actions 31, 33, 36–41, 43, 46, 50–52, 54, 57–69, 71, 74–75, 77, 79–86) | 15 % | 1.5 % City buildings |
| | | 13.5 % Other buildings |
| **Increasing the proportion of locally produced electricity** (actions 33, 36-41, 47, 50, 52, 54, 57–63, 68–69, 72, 74, 77, 82–86) | 8 % | 1.5 % City buildings |
| | | 6.5 % Other buildings |
| **Increasing the proportion of electric cars** (actions 17–20) | 8 % | |
| **Heavy-traffic technology** (actions 17, 19–23) | 4 % | |
| **Increasing demand response in heating** (actions 31, 35–36, 62, 69) | 3 % | 0.5 % City buildings |
| | | 2.5 % Other buildings |
| **Reducing the proportion of oil in separate heating** (actions 31, 67–69, 86) | 2 % | |
| **A pricing system for vehicle traffic** (action 10) | 2% | |
| **Increasing the proportion of cycling and walking as modes of transport** (actions 2–7, 9) | 2% | |
| **Recovering unused waste heat** (actions 32 and 78) | 1 % | 0.3 % City buildings |
| | | 0.7 % Other buildings |
| **Reducing the use of consumption electricity** (actions 31, 33, 34, 38–41, 47-49, 52, 56, 58–65, 67–69) | 1 % | 0.1 % City buildings |
| | | 0.9% Other buildings |
| **Increasing demand response in electricity** (actions 31, 35–36, 62, 69) | 1 % | 0.2% City buildings |
| | | 0.8 % Other buildings |
| **Densifying land use** (actions 14–16) | 1 % | |
| **New mobility services** (actions 26–28, 30) | 1 % | |
| **Increasing parking fees** (actions 11–13) | 1 % | |
| **Increasing the proportion of cycling and walking as modes of transport** (actions 1, 7, 8) | 1 % | |
| **Reducing the energy consumption of outdoor and public lighting** (action 53) | Less than 1 % of the full potential | |
| **Smart & Clean** (actions 121–126) | Assessment requires separate analyses | |
| **Education** (actions 29, 74, 89–92) | Vocational education supports the implementation of the other actions and is therefore included in the other actions | |
| **Consumption and waste**(actions 93–104) | Assessment requires separate analyses | |
| **Procurements** (actions 105–111) | Assessment requires separate analyses | |
| **Sharing economy and circular economy** (actions 44, 45, 112–120) | Assessment requires separate analyses | |
| **Carbon footprint and lifecycle of construction** (actions 42, 52, 60) | Assessment requires separate analyses | |
| **Wooden construction** (actions 87–88) | Assessment requires separate analyses | |
| **Administrative actions in climate work:**<br>- Carbon-neutrality of the Helsinki Group (action 127)<br>- Communication and interaction (actions 136, 137)<br>- Coordination of climate work (138, 139)<br>- Monitoring and reporting (140–143) | To be implemented as a part of the other actions; a proportion can be calculated for action 127, but this will require a separate calculation. | |

The table does not include the emissions reduction actions of Helen Ltd and the Port of Helsinki Ltd as those are included in the respective carbon-neutrality programmes of these companies. The actions in Helen's development programme are calculated to account for 32% of the full emissions reduction potential of the Action Plan, while the actions in the Port's development programme are calculated to account for 2% of the full emissions reduction potential by 2035.

# Carbon-neutral Helsinki 2035 – summary of the emissions reduction potential and cost-efficiency of the action entities

Population growth (as well as the growth of the building stock) has been estimated based on the 'rapid growth scenario'.

In the sector of construction and use of buildings, the cost-efficiency has been calculated for individual entities. This means that if an action is carried out, it will affect the cost-efficiency of the actions that follow.

The table does not include the emissions reduction actions of Helen Ltd and the Port of Helsinki Ltd as those are included in the respective carbon-neutrality programmes of these companies.

The actions based on Helen's development programme are calculated to achieve an emissions reduction of 355 kilotonnes (32% of the full emissions reduction potential of the Action Plan), and the actions of the Port of Helsinki are calculated to achieve an emissions reduction of 27 kilotonnes (2%) by 2035.

Scale of cost-efficiency:

Economically viable.
EUR 0–10 per kg $CO_2$ – High
EUR 10–50 per kg $CO_2$ – Intermediate
EUR 50–100 per kg $CO_2$ – Low
Over EUR 100 per kg $CO_2$ – Very low

| Key action entities | Direct cost effects for the City | Other direct cost effects; which actors do they concern? | Proportion of the full emissions reduction potential of the Action Plan | Cost-efficiency from the City's perspective | Other benefits | Other challenges | The City's key influencing methods | Notes |
|---|---|---|---|---|---|---|---|---|
| **Reducing the total consumption of heating** (actions 31, 33, 34, 39, 46–49, 52, 55, 57–69, 73–76, 78, 82–86) | As for the building stock owned by the City and its subsidiary communities, the modernisation that is 'better than normal' in terms of energy efficiency will require additional investments, but the annual savings are estimated to exceed the annual costs.<br><br>The additional costs of more efficient modernisation are estimated as EUR 0.5 per kWh saved (11), and the estimated service life of the modernisation investments is 25 years.<br>The City of Helsinki's proportion of the buildings is estimated as approximately 15 % (volume/floor area). (7)<br><br>The estimated investments required for the buildings owned by the City of Helsinki amount to 68 million euros by 2035.<br><br>At the moment, the City's investments in buildings amount to the following:<br>- 113–239 million euros/year for modernisations (5) (financial statements 2016–2017: approximately 121–142 million euros/year)<br>- 104–27 million euros/year for the construction of new buildings (5) (financial statements 2016–2017: approximately 39–64 million euros/year), of which substitutive new construction projects amount to approximately 20–40%.<br>In addition to this, subsidiary communities are investing in modernisation.<br><br>**It has not been possible to estimate the additional costs brought to the City budget for modernisation and new construction by the energy efficiency actions.** | Modernisation that is 'better than normal' in terms of energy efficiency will require additional investments for the building owners, but the annual savings are estimated to exceed the annual costs.<br><br>The additional costs of more efficient modernisation are estimated as EUR 0.5 per kWh (11), and the estimated service life of the modernisation investments is 25 years.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City are 394 million euros by 2035. | 16 %<br>(Proportion of City-owned buildings: approximately 2.5%. Proportion of other buildings: approximately 13.5%). | Economically viable. | | Building ownership is fragmented.<br><br>Quality of indoor air.<br><br>Developing the measuring of and invoicing for heating consumption. | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | Total consumption will be reduced primarily through the modernisation of existing buildings. The modernisations are estimated to achieve energy conservation of 1.1 TWh/a by 2035 in the basic scenario and 2.0 TWh/a in the enhanced scenario.<br><br>Costs are not allocated for the modernisations based on the basic scenario as these measures are expected to be realised for reasons other than energy efficiency.<br><br>The City's modernisation and construction operations aim for levels based on the near-zero-energy instructions. Restrictions may arise for the modernisation sites on a case-by-case basis. |
| **Increasing the proportion of locally produced heating** (actions 31, 33, 36–41, 43, 46, 50–52, 54, 57–69, 71, 74–75, 77, 79–86) | As for the building stock owned by the City and its subsidiary communities, the increase in locally produced heating are assessed as requiring additional investments, but the annual savings are estimated to exceed the annual costs.<br><br>The profitability calculation does not include the investments required by the alternatives, which would improve the profitability of locally produced heating.<br><br>The estimated percentage of City buildings is approximately 10% (number of buildings). (7)<br><br>The estimated equipment investments required for the buildings owned by the City of Helsinki amount to 16 million euros by 2035. | The increase in the proportion of locally produced heating will require additional investments for the building owners, but the annual savings are estimated to exceed the annual costs.<br><br>The profitability calculation does not include the investments required by the alternatives, which would improve the profitability of locally produced heating.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City are 92 million euros by 2035. | 15 %<br>(Proportion of City-owned buildings: approximately 1.5 %. Proportion of other buildings: approximately 13.5 %). | Economically viable. | New business opportunities. | Building ownership is fragmented.<br><br>**Regional energy planning is required.** | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | The estimated volume of locally produced heating is in excess of 1,500 GWh in 2035.<br><br>Local renewable energy produced with heat pumps is economically viable.<br>Separate calculations have been prepared for exhaust air, air, geo, air/air and air/water heat pumps. The role of geothermal heating, in particular, is estimated to grow in the future as it will replace oil heating, electric heating and district heating.<br><br>The emissions reduction potential is significantly affected (reduced) by the estimated decrease in the emission factor for district heating from 2015 to 2035, which is caused by Helen's development programme.<br><br>The City is starting a pilot for researching the proportion of locally produced heating as a part of all construction projects in progress. |

| Key action entities | Direct cost effects for the City | Other direct cost effects; which actors do they concern? | Proportion of the full emissions reduction potential of the Action Plan | Cost-efficiency from the City's perspective | Other benefits | Other challenges | The City's key influencing methods | Notes |
|---|---|---|---|---|---|---|---|---|
| **Increasing the proportion of electric cars** (actions 17–20) | If electric cars are purchased as the City's new cars, the cost effect would be approximately 900,000 euros/year. The least expensive combustion engine vehicle in the current framework agreement costs EUR 12,940 (0 % VAT), the Nissan Leaf costs EUR 28,500 (0 % VAT). (12) | The investment concerns the user.<br><br>For example, acquiring a charging station costs a housing co-operative EUR 2,000 per station, at the minimum. (13)<br><br>The Ministry of Economic Affairs and Employment is supporting the investments in public charging stations for electric cars with a total of 4.8 million euros in 2017–2019 (14).<br><br>In the Finnish Government's budget for 2018, a subsidy of 1.5 million euros is reserved for housing co-operatives for the changes to be made in properties' electricity systems to accommodate charging stations. (25) | 8% | Assessment requires separate analyses. | Air quality, noise. | Decisions made by individual consumers and housing co-operatives, which will be difficult to influence. | The City's influencing methods regarding land use planning, traffic planning, plot conveyance and construction.<br><br>The City makes the decisions regarding procurements and investments.<br><br>The City's support for low-emission vehicles (in matters such as parking).<br><br>Communication and interaction. | The calculations are based on the following assumptions: in 2035, electric cars will account for 30% of the cars in Helsinki.<br><br>Estimated based on VTT's prediction (approximately 370,000 rechargeable passenger cars in Finland in 2030), Motiva states that there could be approximately 45,000–55,000 plug-in hybrid cars and 15,000–20,000 fully electric cars in Helsinki in 2030. If the numbers keep growing at the same, accelerating rate in 2030–2035, there could be twice as many rechargeable passenger cars in Helsinki in 2035 (120,000–150,000), which would equal 55–68 % of the current car stock. The estimate does not take the predicted population growth or the potential changes in the density of cars into account.<br><br>On 31 March 2018, the proportion of electric cars of all operational cars in Helsinki amounted to ca. 0.2%. The proportion of cars that were electric cars and plug-in hybrids amounted to ca. 1.1 %. (18)<br><br>In September 2018, the City of Helsinki was using approximately 600 passenger cars, of which 9 were electric cars or plug-in hybrids (31). In other words, the proportion of electric cars of the passenger car stock of the City of Helsinki equals approximately 1.5 %. |
| **Heavy-traffic technology** (actions 17, 19–23) | Stara is estimated to face additional costs of approximately 150,000 euros/year due to the use of biofuels (24). Stara and HKL will switch to biofuels by 2020.<br><br>In machinery, the prices of chargeable hybrids are approximately 1.5–2 times higher than those of ordinary machinery (24). However, the fuel costs are lower.<br><br>Constructing a charging station for electric buses will cost approximately 350,000 euros per station. In HKL's investment plan, approximately 11.5 million euros in total have been reserved for the implementation of an electric charging system during 2018–2027 (5). Currently, the operating costs are higher due to the time required for charging. | A 12-metre electric bus costs approximately 400,000 euros, while a corresponding diesel bus costs 225,000 euros (source: HSL).<br><br>In machinery, the prices of chargeable hybrids are approximately 1.5–2 times higher than those of ordinary machinery (24). However, the fuel costs are lower. | 4 % | Assessment requires separate analyses. | Air quality, noise.<br><br>Advancing the development of clean technology. | The effect of cold winter days on charging times and battery capacity. | The City has limited means of influence; the City makes the decisions regarding its own procurements and investments.<br><br>The City's support for low-emission vehicles. | The calculations are based on the following assumptions:<br>- The emissions per unit in heavy traffic are estimated to be approximately 42 % lower than the BAU level in 2035.<br><br>In September 2018, the City of Helsinki was using approximately 1,400 heavy vehicles or similar (31). At the end of 2017, there were approximately 41,000 heavy vehicles registered in the Uusimaa region (30). This means that the proportion Helsinki's heavy vehicles account for in Uusimaa is approximately 3.4 %. |
| **Increasing demand response in heating** (actions 31, 35–36, 62, 69) | The investment costs are estimated to be approximately 3,000–5,000 euros per property, while the annual service costs (including maintenance) are estimated to be 600–1,500 euros.<br><br>The estimated service life of the system is 10 years.<br><br>The City of Helsinki's proportion of the buildings is estimated as approximately 15% (volume/floor area). (7)<br><br>The estimated equipment investments required for the buildings owned by the City of Helsinki amount to 10 million euros by 2035. | The investment costs are estimated to be approximately 3,000–5,000 euros per property, while the annual service costs (including maintenance) are estimated to be 600–1,500 euros.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City are 58 million euros by 2035. | 3 %<br>(Proportion of City-owned buildings: 0.5 %. Proportion of other buildings: 2.5 %). | High. | Development of the business environment related to smart solutions. | Building ownership is fragmented. | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | The district-heated properties participating in demand response have been estimated using registry data from Statistics Finland (20). The following savings are expected to be achieved in 2035:<br>- savings of 20 % from cutting the spikes (559 GWh/a)<br>- 10 % from energy conservation (279 GWh/a).<br><br>The emissions reduction potential will be significantly higher if the emission factors of 2035 are used in the calculations, in which case the difference between the emission factors of the peak load (natural gas) and the basic load (bio district heating) will grow remarkably. |
| **Reducing the proportion of oil in separate heating** (actions 31, 67–69, 86) | The City of Helsinki is not assessed as having oil-heated buildings. | The decrease in oil heating will require additional investments for the building owners, but the annual savings are estimated to be higher than the annual costs.<br><br>It is estimated that oil will be replaced by geothermal heating for separate heating; the investment costs of a geothermal heat pump will be 12,000 euros, the maintenance costs will be 5 euros per MWh, the service life will be 20 years and the repayment period will be 15 years.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City will be 188 million euros by 2035. | 2 % | Economically viable. | Air quality. | Building ownership is fragmented. | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | The normalised oil consumption is assumed to decrease to a level of 172 GWh by 2035 (in 2016, consumption was 322 GWh).<br><br>The proportion of oil in heating will reach zero with time, but reaching zero by 2035 will be challenging and require significant additional actions. |
| **A pricing system for vehicle traffic** (action 10) | No direct cost effects for the City. | The net income will be 160–170 million euros/year and it will be allocated to the entire Helsinki region.<br><br>The net income and emissions reduction has been calculated using an average annual fee of 670 euros incurred by car-using residents.<br><br>(From a socio-economic perspective, the optimised average fee incurred by a car-using commuter is estimated at 340 euros/year; in this case, the net income will be 80 million euros/year, and the emissions reduction will be approximately 50 % of the reduction achieved through the higher fee.) | 2% | Economically viable. | Frees up City space.<br><br>Air quality, noise.<br><br>Improved traffic safety and functionality.<br><br>An effective steering measure for advancing low-emission traffic technology. | Uneven allocation of effects from a regional and social perspective.<br><br>Effects on the competitive strength/business life of the city centre. | Decisions made by the state, which requires regional co-operation. The City can participate in further research. | The adoption of a road toll cannot be decided on by the City. Requires changes to legislation and additional research regarding matters such as the allocation of effects (various user groups and areas, the vitality of the city centre, etc.), the level of the fee and the method used for allocating the income.<br><br>It is required that the income be allocated for the development of the region's transport system and that the method does not reduce the state's average long-term traffic funding for the region. |

| Key action entities | Direct cost effects for the City | Other direct cost effects; which actors do they concern? | Proportion of the full emissions reduction potential of the Action Plan | Cost-efficiency from the City's perspective | Other benefits | Other challenges | The City's key influencing methods | Notes |
|---|---|---|---|---|---|---|---|---|
| **Increasing the proportion of cycling and walking as modes of transport** (actions 2–7, 9) | Direct investments in pedestrian and cycling routes: 11–20 million euros/year (5) (financial statements for 2016–2017: approximately 11–14 million euros/year), including the Baana cycling network and the target network for the inner city. Additionally, the routes will be implemented using the funding for new construction of streets, in connection with the street construction related to housing production.<br><br>Based on experiences from winter 2017–2018, high-quality winter maintenance of cycling paths costs approximately 6,000–8,000 euros more per kilometre per year, meaning that the cost level is approximately 1.6–2 times higher than the normal level (28, 24). In winter 2017–2018, there were approximately 35 km of prioritised routes maintained during the winter.<br><br>City bikes: approximately 0.7–1.3 million euros/year; cycling infrastructure: 0.2–0.4 million euros/year (funding for HKL) (4). | Consumers' capital will be less tied to transport than in vehicle traffic. | 2 % | High*<br><br>* the assumption is that the calculated emissions reductions can be reached through the current contributions. | Air quality, noise.<br><br>Physical fitness of the residents.<br><br>Frees up City space. | The effect of conditions on the proportion as a mode of transport.<br><br>For other vehicle traffic, this often means reduction in city space in the current city structure. | The City's influencing methods regarding land use planning and traffic planning.<br><br>Communication.<br><br>Education and early childhood education. | According to the City's financial statements, over the period 2010–2017 approximately 2.4–14 million euros/year have been invested directly in pedestrian and cycling routes. At the same time, depending on the year, 9–11 % of all trips were made with a bicycle (12–18 % of commutes to work and 11–14 % of journeys to school or to another educational institution) (29).<br><br>According to the traffic model based on the emissions reduction scenario, the proportion of cycling as a mode of transport would need to be doubled compared to the current level. |
| **Recovering unused waste heat** (actions 32 and 78) | As for the building stock owned by the City and its subsidiary communities, the increase in the recovery of waste heat will require additional investments, but the annual savings are estimated to exceed the annual costs.<br><br>The estimated utilisation potential of the City's building stock amounts to 28 % of the full potential of the City. (10)<br><br>The power of the system required to recover heat is estimated as approximately 14 MW, and the average investment is estimated as EUR 1,600/kW. (23)<br><br>The annual costs have been calculated for a service life of 20 years and annual maintenance costs of EUR 5/MWh. (23)<br><br>The estimated equipment investments required for the buildings owned by the City of Helsinki will amount to 6.2 million euros by 2035. | The recovery of unused waste heat will require additional investments for the building owners, but the annual savings are estimated to exceed the annual costs.<br><br>The power of the system required to recover heat is estimated as approximately 14 MW, and the average investment is estimated as EUR 1,600/kW.<br><br>The annual costs have been calculated for a service life of 20 years and annual maintenance costs of EUR 5/MWh.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City will amount to 15.9 million euros by 2035. | 1 %<br>(Proportion of City-owned buildings: 0.3%. Proportion of other buildings: 0.7%). | Economically viable. | | Building ownership is fragmented. | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | Helsinki is estimated to possess a utilisation potential of 92 GWh/a (10). The potential consists of approximately 215 grocery shops, 100 laundry facilities, 13 swimming halls, 11 ice rinks, 5 hospitals and 12 server centres.<br><br>The effect that two-way and low-heat district heating networks may have on the utilisation of waste heat has not been assessed. |
| **Reducing the use of consumption electricity** (actions 31, 33, 34, 38–41, 47-49, 52, 56, 58–65, 67–69) | Reduction in electricity consumption reduces electricity costs.<br><br>The estimated percentage of City buildings is approximately 10% (number of buildings). (7) | Reduction in electricity consumption reduces electricity costs. | 1 %<br>(Proportion of City-owned buildings: 0.1 %. Proportion of other buildings: 0.9 %). | Assessment requires separate analyses. | Development of the business environment related to smart solutions. | From the perspective of energy conservation, the increase in technology and equipment (including electric traffic) will compensate for their advancing energy efficiency.<br><br>Developing the measuring and invoicing of electricity consumption. | The City makes the decisions regarding the procurements and investments in buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding construction.<br><br>Communication.<br><br>Education and early childhood education. | In Helsinki, the volume of resident-specific consumption electricity is very low as it is (1,925 kWh/resident/year), which is why the calculations are based on a moderate reduction goal of 0.5 %/resident/year.<br><br>If the goal is achieved, the absolute volume of consumption electricity will grow by 223 GWh/a in 2015–2035 due to population growth. |
| **Increasing demand response in electricity** (actions 31, 35–36, 62, 69) | The investment costs are estimated to be approximately 3,500–5,000 euros per property, while the annual service costs (including maintenance) are estimated to be 1,500–2,000 euros.<br><br>The estimated service life of the system is 10 years.<br><br>The City of Helsinki's proportion of the buildings is estimated as approximately 15 % (volume/floor area). (7)<br><br>The estimated equipment investments required for the buildings owned by the City of Helsinki will amount to 6 million euros by 2035. | The investment costs are estimated to be approximately 3,500–5,000 euros per property, while the annual service costs (including maintenance) are estimated to be 1,500–2,000 euros.<br><br>The estimated investments required for the buildings located in Helsinki but not owned by the City will be 35 million euros by 2035. | 1 %<br>(Proportion of City-owned buildings: 0.2%. Proportion of other buildings: 0.8%). | High. | Development of the business environment related to smart solutions. | Building ownership is fragmented. | The City makes the decisions regarding the buildings owned by the City and its subsidiary communities.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Communication. | The demand response potential for electricity was calculated for the electrically heated properties (data from HSY), of which there are significantly fewer than properties connected to district heating in Helsinki. Because of this, the emissions reduction potential is quite low.<br><br>It is expected that savings corresponding to those of heating will be achieved:<br>- savings of 20 % from cutting the spikes (46 GWh/a)<br>- 10 % from energy conservation (27 GWh/a).<br><br>The possibility of demand response will be studied as a part of the energy survey regarding the new construction sites of the City. |
| **Densifying land use** (actions 14–16) | Considering the overall economy, complementary construction is less expensive but requires more resources in land use planning, plot conveyance and building control. | When construction is focused next to the trunk lines of public transport, a more relaxed norm for parking spaces may facilitate lower construction costs. | 1 % | Assessment requires separate analyses. | Creates conditions for making services more efficient. | Complementary construction often faces opposition and is slow to implement. | The City's influencing methods regarding land use planning, traffic planning, plot conveyance and construction. | The effects of densifying land use have been assessed by focusing the population based on the rapid growth scenario for the city plan next to the trunk lines of public transport more intensively than in the BAU scenario (in accessibility zones I and II). |
| **New mobility services** (actions 26–28, 30) | Development is required for the City to act as a testing platform. | No cost effects for other actors. | 1 % | Assessment requires separate analyses. | Frees up City space.<br><br>Development of the business environment related to smart solutions. | City space is reduced if vehicle traffic in increased. | The City can act as a testing platform.<br><br>The City makes the decisions regarding procurements and investments. | The calculations are based on the average load of passenger car traffic increasing by approximately 0.1 units on average. Currently, the average load of passenger car traffic is approximately 1.3.<br><br>There is only a little information available on the effects of new mobility services. Assessing the full potential of new mobility services in terms of emissions reductions is currently difficult, and further studies are needed. |
| **Increasing parking fees** (actions 11–13) | The costs of the parking zone reform are estimated to amount to 100,000 euros per new zone (traffic signs).<br><br>Because of the parking zone reforms implemented in 2016–2017, the City's income from parking fees increased by 6.5 million euros. | The increased price of parking is paid for by the users. | 1 % | Economically viable. | Frees up City space.<br><br>A steering measure for advancing low-emission traffic technology. | Effects on the competitive strength/business life of the city centre. | Decision by the City of Helsinki. | The calculations are based on the assumption that parking fees are increased by 50 %. |

| Key action entities | Direct cost effects for the City | Other direct cost effects; which actors do they concern? | Proportion of the full emissions reduction potential of the Action Plan | Cost-efficiency from the City's perspective | Other benefits | Other challenges | The City's key influencing methods | Notes |
|---|---|---|---|---|---|---|---|---|
| **Increasing the proportion of cycling and walking as modes of transport** (actions 1, 7, 8) | HKL's direct investments amount to approximately 130 million euros/year (5) (the financial statements for 2010–2017: approximately 44–177 million euros/year), including the investments related to the development programme for tram traffic, approximately 4–5 million euros/year (19), for example, based on which annual savings of approximately 4–4.5 million euros are estimated to be achieved in the operating costs when the programme has been fully implemented.<br><br>Helsinki's payment share for organising public transport in the HSL coverage area amounts to approximately 195–203 million euros/year (4) (financial statements 2010–2017: approximately 149–189 million euros/year)<br><br>Support for HKL (depreciation and interest-rate subsidy, share of the contributions to West Metro, compensation for the freight traffic in Suomenlinna): 20–31 million euros/year (5) (financial statements 2012–2017: approximately 2–19 million euros/year)<br><br>The total costs of the development programme for interchange stations (HSL's Solmu project) amount to a total of 0.5–1.4 million euros in 2016–2020, of which Helsinki's share is 0.4–1 million euros (2). To be implemented annually with the allocations for the development of the City's public transport, traffic arrangements and HKL investments. | The other member municipalities of HSL incur total costs of 142–146 million euros/year for the organisation of public transport in the Helsinki region (4).<br><br>Ticket income covers approximately 50 % of the annual costs.<br><br>The increased speed of public transport will reduce the operating costs and increase the time and service level benefits for the passengers. | 1 % | Intermediate*<br><br>* the assumption is that the calculated emissions reductions can be reached through the current contributions. | Air quality, noise.<br><br>Physical fitness of the residents.<br><br>Frees up City space.<br><br>Accessibility/competitive strength of the urban region. | For other vehicle traffic, this often means reduction in city space in the current city structure. | The City's influencing methods regarding land use planning and traffic planning.<br><br>Communication.<br><br>Education and early childhood education. | On an autumn weekday in 2017, the proportion of public transport at the border of the peninsula accounted for 70.4 % of all modes of transport; the proportion had increased by 2 per cent since 2016. (17)<br><br>During 2007–2017, the proportion of public transport has increased by 7 per cent. (17)<br><br>In the traffic model based on the emissions reduction scenario, the proportion of public transport would be 33 % in 2035. |
| **Reducing the energy consumption of outdoor and public lighting** (action 53) | In the update (22) to the cost comparison related to the Helsinki LED report made in 2014 (21), the construction costs of 6,350 lighting fixtures were estimated to be 6.1 million euros in 2016, and the annual energy savings were estimated at 230,000 euros (2.9 GWh/a) while the annual maintenance savings were estimated at 49,000 euros/a.<br><br>According to the estimate made by the Helsinki LED work group in 2016, replacing all of Helsinki's lighting with LED lights would cost 68.5 million euros (22). | No cost effects for other actors. | Less than 1 % of the full potential. | Intermediate. | | | The City makes the decisions regarding procurements and investments.<br><br>The City's influencing methods regarding construction. | The calculations are based on the following assumptions:<br>- 4,242 light fixtures will be replaced by LEDs annually, in which case the all public lighting would be replaced by 2035.<br>- The City is expected get 1,000 new light fixtures annually, the smart control of which is estimated to achieve savings of 15%.<br>- The service life of light fixtures is 20 years.<br>- The estimated price of electricity is 0.11 euros/kWh. |
| **Smart & Clean** (actions 121–126) | In the City's own procurements, the increase in Smart & Clean solutions will increase the costs of goods and services, but they can also introduce savings in the lifecycle costs. It is estimated that new resources will be needed for the development and testing platforms so that the solutions' functionality for the City can be tested before they are scaled up to cover the City's operations. | The increase in Smart & Clean solutions in the City's own investments will create new jobs on the market as new expertise is required, for example. This will affect the recruitment needs of companies, which will increase the short-term costs for the companies. In the long term, the new expertise of the companies will be a competitive advantage. Here is additional information on the assessment of the impact on business. | Assessment requires separate analyses. | Cost-efficiency depends largely on the project in question. Further information on the assessment of the impact on business. | Creation of new business. | Legal challenges and undeveloped business environment. | The City can act as a testing platform.<br><br>Partnerships with companies. | The City's participation in extensive EU projects, such as Horizon, will need to be considered from the perspective of developing the co-operation with companies and research centres. |
| **Education** (actions 29, 74, 89–92) | Low cost effects; some resources needed for additional education. | No cost effects for other actors.<br>The implementation of the entire plan requires the level of expertise to increase in all sectors. | Vocational education supports the implementation of the other actions and is therefore included in the other actions. | High. | Vocational education supports the quality of construction. | Expertise of teachers. | Education and early childhood education. | |
| **Consumption and waste**(actions 93–104) | No significant cost effects.<br><br>Decrease in food waste and better separation at source can help achieve savings and income from the sales of surplus food.<br><br>Savings potential through the development of waste volume monitoring and an increase in waste sorting. Requires us to develop monitoring technology and organise better opportunities to sort waste. | No cost effects for other actors. | Assessment requires separate analyses. | Assessment requires separate analyses. | Health benefits of vegetarian food. | | Decision by the City of Helsinki.<br><br>Communication.<br><br>Education and early childhood education. | |
| **Procurements (actions** 105–111) | The development can primarily be carried out as official work, but additional investments are required for market surveys and calculation methods, for example. Taking the criteria related to the climate, environment and circular economy into account in the procurements themselves will increase the costs, but a detailed analysis of the increased cost needs to be carried out separately for each procurement. | As the criteria develop, the product and service providers need to develop competitive solutions that meet the criteria. This may affect the profitability of companies momentarily. | Assessment requires separate analyses. | Assessment requires separate analyses. | Strengthening of environmentally aware business. | Measuring and expertise.<br><br>Legal challenges. | The City makes the decisions regarding its own procurements and investments. | |
| **Sharing economy and circular economy** (actions 44, 45, 112–120) | Requires resources for the development of the platforms, expertise and tools. Using circular economy solutions in the City's procurements and investments will increase costs at first. As the market develops, the costs will decrease. | The re-use of materials will enable savings on a large scale, but on an undeveloped market, new circular solutions will cause additional costs. The effects are directed at construction contractors and product manufacturers, among others. However, it is estimated that circular economy and sharing economy will create new companies and jobs. | Assessment requires separate analyses. | Assessment requires separate analyses. | Strengthening of environmentally aware business. | Undeveloped business environment. | The City can act as a testing platform.<br><br>Partnerships with companies.<br><br>The City makes the decisions regarding its own procurements and investments.<br><br>Communication. | According to an estimate by Sitra and McKinsey, the potential of circular economy for the national economy of Finland totals 1.5–2.5 billion euros (26). Developing circular economy solutions in the City requires active co-operation and external funding. |

| Key action entities | Direct cost effects for the City | Other direct cost effects; which actors do they concern? | Proportion of the full emissions reduction potential of the Action Plan | Cost-efficiency from the City's perspective | Other benefits | Other challenges | The City's key influencing methods | Notes |
|---|---|---|---|---|---|---|---|---|
| **Wooden construction** (actions 87–88) | Requires resources for the development of expertise. Requires further analyses. | Requires further analyses. | Assessment requires separate analyses. | Assessment requires separate analyses. | Strengthening of environmentally aware business. | Undeveloped business environment. | The City makes the decisions regarding its own procurements and investments.<br><br>The City's influencing methods regarding land use planning, plot conveyance and construction.<br><br>Partnerships with companies.<br><br>Communication. | There is no information available on the effects that increased wooden construction may have on construction costs. |
| **Carbon sinks and compensation** (actions 128–134) | Requires resources for the development of expertise. | No cost effects for other actors. | Assessment requires separate analyses. | Assessment requires separate analyses. | Diversity of nature.<br><br>Air quality. | The acceptable principles for emissions compensation at city level are still a work in progress<br><br>Significantly increasing carbon storage and carbon sinks is challenging in a growing city. | The City's influencing methods regarding land use planning.<br><br>The City's own principles and practices for nature conservation and forestry.<br><br>Communication and interaction | To achieve the objective of carbon-neutrality, it is required that a maximum of 20 % of the emissions in 1990 are compensated for.<br><br>The current price estimate presented by Gold Standard for the total compensation of the remaining emissions, 720 kt $CO_2e$/a, through the acquisition of emissions rights: approximately 10 million euros/year (if $tCO_2e$ = EUR 15 (discount of 5 % )) (3, 15)<br><br>Currently, the annual carbon sinks in the City area and the areas owned by the City account for approximately 5 % of the emissions in 1990. (27) |
| **Administrative actions in climate work:**<br>- Carbon-neutrality of the Helsinki Group (action 127)<br>- Communication and interaction (actions 136, 137)<br>- Coordination of climate work (138, 139)<br>- Monitoring and reporting (140–143) | To be primarily carried out as official work; the City will partially pay for the regional climate work through its payment share for HSY.<br><br>The implementation and monitoring of Helsinki Group's carbon-neutrality plans will cause both costs and savings, which will be separately assessed by each actor in the Group.<br><br>Communication and interaction skills, as well as resources for communication and interaction with residents, are required. | No cost effects for actors outside the City. | A part of other actions. A proportion can be calculated for Action 127, but this will require separate calculations. | Assessment requires separate analyses. | An influencing method that supports other actions. | Engagement of residents and companies. | Decision by the City of Helsinki.<br><br>Partnerships with companies.<br><br>Interaction, communication, production of information. | |

**Sources:**


1 Liikenteen kehitys Helsingissä vuonna 2016 [The development of traffic in Helsinki in 2016], City of Helsinki, City Planning Department. Available at: https://www.hel.fi/hel2/ksv/julkaisut/esitteet/esite_2017-2.pdf
2 Solmu-projektin osatehtävien (1-5) loppuraportit [The final reports on the subtasks (1–5) in the Solmu project], 2016–2017, HSL. Available at: https://www.hsl.fi/julkaisut
3 Technical support document, Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis, 2016, EPA. Available at: https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf
4 Toiminta- ja taloussuunnitelma 2018 - 2020 [HSL Operational and Financial Plan 2018–2020], HSL. Available at: https://www.hsl.fi/sites/default/files/tts2018-2020.pdf
5 Helsingin kaupungin talousarvio 2018 ja taloussuunnitelma 2018 - 2020 [Helsinki City Budget 2018 and Financial Plan 2018–2020]. Available at: https://www.hel.fi/static/kanslia/Julkaisut/2017/HKI_TA_2018_web.pdf
6 Kiinteistökohtaisen hajautetun energian tuotannon potentiaali Helsingissä [The production potential of property-specific decentralised energy production in Helsinki], 2015, Pöyry. Available at: https://dev.hel.fi/paatokset/media/att/9d/9d03ce885409c36fff4f836ff30314d0f95bcb72.pdf
7 Information on the volume, floor area and number of buildings, Helsinki municipal register, 13 February 2018.
8 Energiansäästötoiminta ja energiankäytön kehittyminen Helsingin kaupungissa [Energy conservation operations and the development of energy consumption in the City Of Helsinki], 2016, City of Helsinki. Available at: https://dev.hel.fi/paatokset/media/att/b2/b237731306e0912d7a622904704096c5ff24d140.pdf
9 Energiaälykäs pääkaupunkiseutu, Sitran selvityksiä 89 [Energy-smart Helsinki metropolitan area, Sitra Studies 89], final report 17 March 2015. Available at: https://media.sitra.fi/2017/02/23220606/Selvityksia89.pdf
10 Anttila Jorma, 2017, Helsingin hukkalämmön hyödyntämisen potentiaalisia kohteita [Potental locations for utilising waste heat in Helsinki]. Available at: http://www.stadinilmasto.fi/2018/02/15/helsingissa-kartoitettiin-suuria-hukkalampokohteita/
11 Analysis by Gaia, https://wwf.fi/mediabank/7784.pdf
12 Helsingin kaupungin sähköisen liikenteen työryhmän raportti 2015-2016. [Report of the City of Helsinki's electric traffic working group for 2015–2016]. Available at: https://dev.hel.fi/paatokset/media/att/6f/6fce79144ea6a782b29778bfa4c6b1f02e9e8149.pdf
13 Helen's website 25 May 2018. Available at: https://www.helen.fi/en/electricity/real-estates/charging-electric-vehicles/
14 The website of Korkia, the support coordinator for the development of public charging infrastructure for electric cars, 25 May 2018. Available at: http://lataustuki.fi/
15 Carbon pricing: What is a carbon credit worth? Gold Standard, 2018. Available at: https://www.goldstandard.org/blog-item/carbon-pricing-what-carbon-credit-worth
16 Helsinkiläisten liikkumistottumukset 2017, kaupunkiympäristön julkaisuja 2017:18 [Transport habits of Helsinki residents 2017, publications of the Urban Environment Division 2017:18]. Available at: https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-18-17.pdf
17 Liikenteen kehitys Helsingissä vuonna 2017, kaupunkiympäristön julkaisuja 2018:16 [The development of traffic in Helsinki in 2017, publications of the Urban Environment Division 2018:16]. Available at: https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-16-18.pdf
18 Trafi's statistics database. Available at: http://trafi2.stat.fi/PXWeb/pxweb/en/TraFi/TraFi__Liikennekaytossa_olevat_ajoneuvot/010_kanta_tau_101.px/?rxid=714713ea-4df2-4b82-8e0a-68b51dad9956
19 Raitioliikenteen kehittämisohjelma, Kaupunkiympäristön julkaisuja 2017:9 [The development programme for tram traffic, publications of the Urban Environment Division 2017:9]. Available at: https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-09-17.pdf
20 Buildings (number, square metres) by purpose and year of construction, 31 December 2016, Statistics Finland. Available at: http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__asu__rakke/statfin_rakke_pxt_002.px/?rxid=1c67b08d-4674-4d09-9f04-1a53bf1626a8
21 Helsinki LED-hanke - Selvitys ledeihin siirtymisen aikataulusta ja kustannuksista [The Helsinki LED project – A report on the schedule and costs of moving on to LED], 2014. Available at: https://dev.hel.fi/paatokset/media/att/91/91503f57b8294ca40871db2b0cd50ce52694ce42.pdf
22 Helsinki LED-hanke - kustannusarvion päivitys [The Helsinki LED project – an update to the cost estimate], 2016. Available at: https://dev.hel.fi/paatokset/media/att/97/97de8ee358580027aed6d94db12bcf8256ccd627.pdf
23 Analysis made by Gaia for the Carbon-neutral Helsinki 2035 emissions reduction calculations
24 Stara's estimate for the preparation of the Carbon-neutral Helsinki 2035 emissions reduction plan
25 Avustus sähköautojen latausinfran rakentamiseen [Subsidies for the construction of charging infrastructure for electric cars], Ara's website, 3 August 2018. Available at: http://www.ara.fi/fi-FI/Lainat_ja_avustukset/Sahkoautojen_latausinfraavustus
26 The opportunities of a circular economy for Finland, 2015, Sitra Studies 100. Available at: https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf
27 Kuntien hiilitasekartoitus osa 1, Helsingin, Lahden, Turun, Vantaan ja Espoon maankäyttösektorin kasvihuonekaasupäästöt, hiilinielut ja hiilivarastot. Helsingin kaupungin ympäristökeskuksen julkaisuja 9/2014 [Survey of the carbon balance of municipalities, part 1: The greenhouse gas emissions, carbon sinks and carbon storage of the land use sector in the cities of Helsinki, Lahti, Turku, Vantaa and Espoo. Publications of the City of Helsinki Environment Centre 9/2014]. Available at: http://ilmastotyokalut.fi/files/2014/06/hiilitase_osa-1_julkaisu_ymk_2014.pdf
28 Pyöräväylien priorisoitu talvihoito, loppuraportti kokeilusta 2015-2018 [Prioritised winter maintenance of cycling routes, final report on the experiment 2015–2018]. Available at: https://www.hel.fi/static/public/hela/Kaupunkiymparistolautakunta/Suomi/Paatos/2018/Kymp_2018-09-04_Kylk_22_Pk/5C7B78A9-6D74-CF15-8CAD-655AF4700000/Liite.pdf
29 A summary of the annual transport habit studies regarding Helsinki residents (phone interview), Urban Environment Division, 6 September 2018
30 Statistics Finland, motor vehicle stock 2017. Available at: https://www.tilastokeskus.fi/til/mkan/index_en.html
31 Information on the registered vehicles held by the City of Helsinki, September 2018 (Stara)

Helsinki