

Helsinki Capital Region as a global driver of cleantech

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Foreword

City regions are playing an ever greater role in meeting climate targets. In recent years, a number of collaborative initiatives have been started by major cities around the world. These include the C40 (Cities Climate Leadership Group), led by former mayor of New York Michael Bloomberg. C40's 69 members account for almost one fifth (18%) of global GDP. City regions have a role to play as enablers of the cleantech business, by supporting companies whose innovations and products promote the use of sustainable practices within cities. They are also involved in promoting competitiveness, creating new jobs and facilitating a managed transition towards a carbon-neutral society.

The top executives of major Finnish companies have recently placed an important item on their agenda: to develop the Helsinki Capital Region into a global champion in clean energy and cleantech. Finnish companies need a reference area on an international scale, in which new low-carbon solutions will be designed, innovations will be tested and cleantech expertise will be showcased. The Helsinki Capital Region can provide a suitable setting for such activities.

This study analyses the Helsinki Capital Region's position in relation to the world's top cities in terms of various aspects of sustainability. The results reinforce the idea that the main development effort in the Helsinki Capital Region should focus on the energy system, transport and the development of the cleantech business. Strongly supported by city organisations, the Helsinki Capital Region has achieved its greatest successes in promoting active participation by citizens.

If Helsinki is to become a leading metropolis in clean energy and cleantech, a key issue will be the setting of ambitious, common goals by various parties (the Finnish state, the cities in the region, major companies and third sector organisations). These should be set high enough to enable the Helsinki Capital Region to join other Nordic capitals in the C40 network of innovative cities. Achieving this will require a strong emphasis on selected focus areas. This study suggests that such focus areas could include making use of open data and integrative ICT, and embedding sustainability in the existing built environment.

Due to the approach taken and framework used in the study, the results and conclusions are indicative rather than exact, and are primarily intended to serve as guidelines and input for the further planning of goals and measures. However, we nevertheless hope that the "big picture" drawn by this study will serve as a practical basis for the further planning of steps taken towards the creation of a leading cleantech metropolis.

Helsinki, 15 September 2014

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Summary

The top executives of major Finnish companies have recently raised an important item on their agenda: to develop the Helsinki Capital Region to meet the level of global champions in clean energy and cleantech. The shared concern of these executives derives from several international benchmarking studies which have shown that Helsinki, the best-known city in the region, is far behind the likes of Copenhagen and Stockholm. Another underlying factor is the necessary, ongoing restructuring process within Finnish industry – the renewal of efforts to target growing cleantech markets globally.

The aim of developing the Helsinki Capital Region to bring it more in line with these global champions is also included in the Government Strategy to Promote Cleantech Business in Finland, published in May 2014. The aim of the strategy is to spur economic growth in the new important fields of bioeconomy and cleantech. One of the spearhead projects is the creation of a world-class cleantech demonstration and pilot reference area in

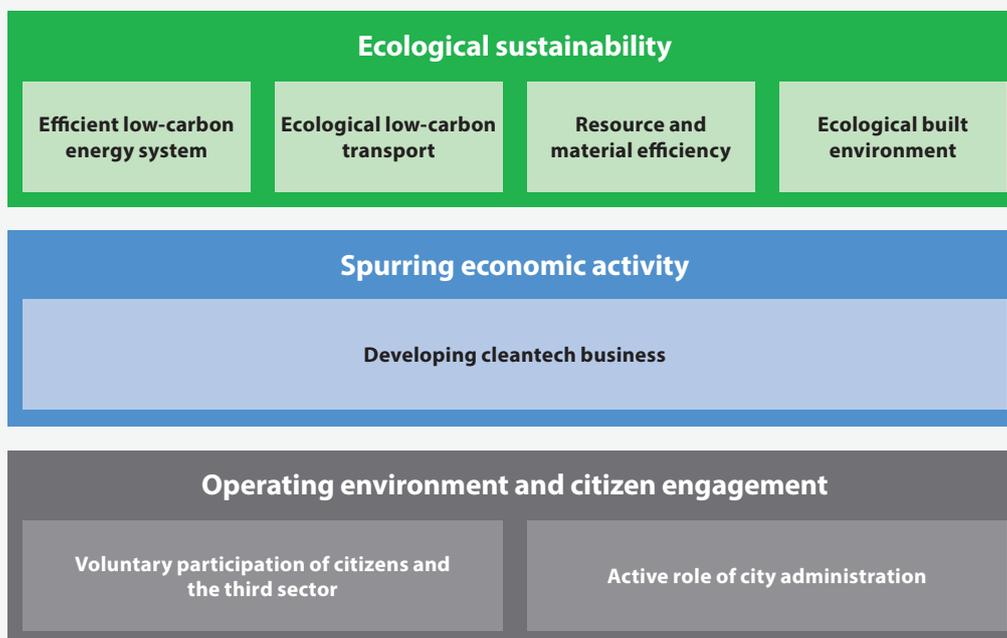
the Helsinki Capital Region. This reference area will include zones for the testing and trials of cleantech solutions.

The goal of this study is to support the aforementioned initiatives to develop the Helsinki Capital Region into a fore-runner of clean energy and cleantech. Therefore the Helsinki Capital Region was compared and positioned in relation to leading cities in the world, based on sustainability factors including ecological, economic and social sustainability. The results of the benchmarking led to several suggestions regarding the development potential and goals for the Helsinki Capital Region.

Six leading metropolitan areas were selected to be compared to the Helsinki region in this study: Stockholm, Copenhagen, Amsterdam, Bristol, Vienna and Vancouver. All these had reached top positions in international sustainability benchmark studies. The city of Tampere was chosen as a domestic benchmark.

The dimensions used in the benchmark study are described in the next figure.

Dimensions selected for the benchmarking study.



See chapter 3.1 Dimensions selected for the benchmarking study.

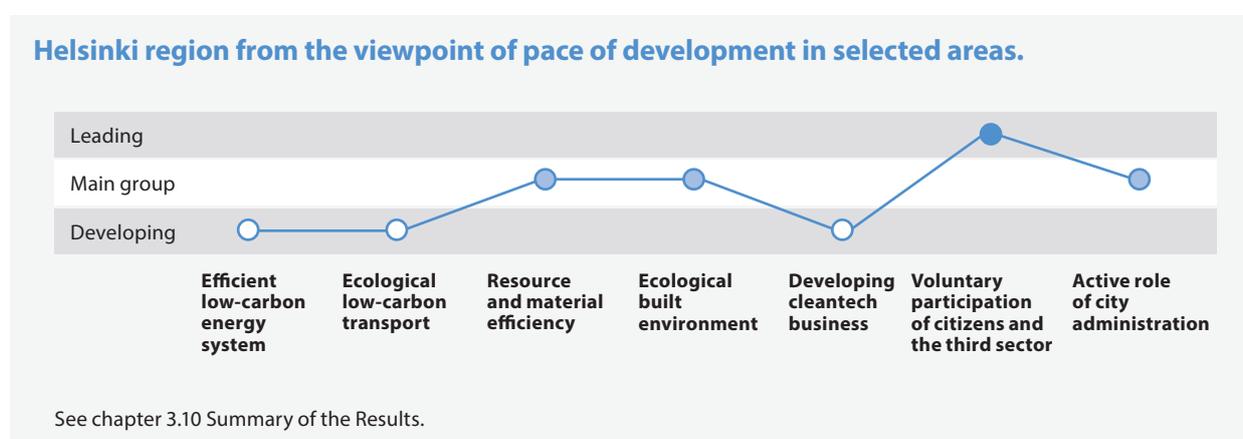
The Helsinki Capital Region – instead of solely the city of Helsinki – was intentionally selected to be for comparison, even though it was obvious that fully compatible information for all the selected benchmark regions was not available. This selection reflected the idea of the whole region delivering a unique national potential as a forerunner for sustainability and cleantech.

Instead of evaluating the current situation of cities or regions, it was decided to evaluate the pace of development in sustainability and cleantech, especially the ambitions in goal-setting as well as planned and implemented activities. This way the focus was on the future: which goals should be set and which activities should

be pursued by the Helsinki Capital Region in order to reach the status of a forerunner and a top performer?

Using the framework with the seven dimensions, the cities or regions were evaluated and classified in three groups: leading, main group, developing. The leading group consists of cities or regions which have demonstrated ambitious goals and performance as well as effective communication of these achievements. In the group of developing cities the goal-setting and activities have been on a modest level, which is also reflected in their communication. The main group is somewhere between these two.

The positioning of the Helsinki Capital Region in this classification is summarised in the following chart.



The overall results of the benchmarking study are presented in the following table.

A summary of the results: the position of each city/region with respect to development within each benchmarking category.

	Efficient low-carbon energy system	Ecological low-carbon transport	Resource and material efficiency	Ecological built environment	Developing cleantech business	Voluntary participation of citizens and the third sector	Active role of city administration
Leading	Copenhagen, Stockholm, Vienna	Copenhagen, Stockholm, Amsterdam, Bristol	Amsterdam, Vienna	Copenhagen, Stockholm, Amsterdam	Copenhagen, Stockholm, Vancouver	Helsinki Capital Region, Copenhagen, Amsterdam	Copenhagen, Stockholm, Vienna
Main group	Amsterdam, Bristol	Vienna	Helsinki Capital Region, Copenhagen, Vancouver, Bristol, Tampere	Helsinki Capital Region, Bristol	Vienna, Bristol	Stockholm, Vienna, Vancouver, Bristol	Helsinki Capital Region, Amsterdam, Bristol, Tampere
Developing	Helsinki Capital Region, Vancouver, Tampere	Helsinki Capital Region, Vancouver, Tampere	Stockholm (only minor differences with the main group)	Vienna, Vancouver, Tampere	Helsinki Capital Region, Amsterdam, Tampere	Tampere	Vancouver

See chapter 3.10 Summary of the Results.

The results indicate that the strongest development efforts in the Helsinki Capital Region should be directed at the energy system, transportation and the development of cleantech business. This message is very well aligned with the concerns of the top executives of major Finnish companies and with the messages of the governmental strategy. The Helsinki Capital Region has best succeeded in citizens' active participation, which has been supported by the activities of the city's administration.

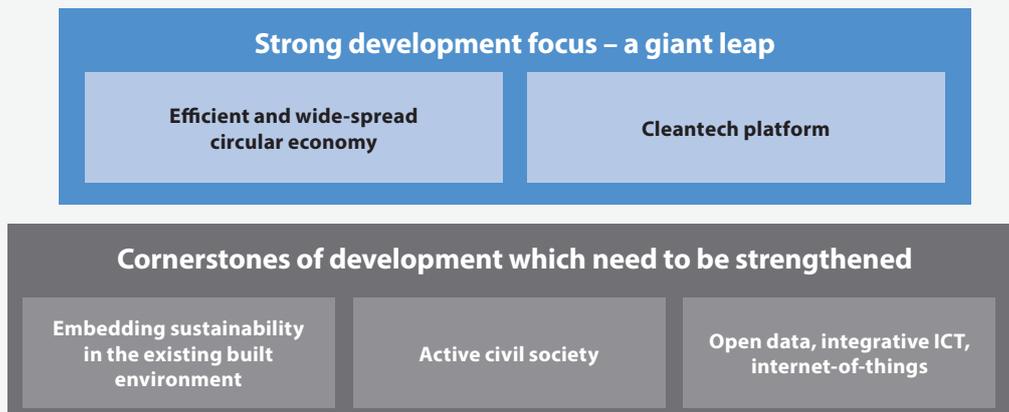
The overall target is to develop the Helsinki Capital Region into a forerunner and a pilot area for clean energy and cleantech. The first step requires ambitious goal-setting and commitment by various parties – i.e. the state of Finland, cities of the region, major companies and third sector organisations. An example of goal-setting could be "to reach top three position in selected international benchmarking studies during the years 2020–2030".

The commitment of all the region's cities to the selected goals and messages is crucial, especially when interacting with the international community. From the viewpoint of implementation, seamless co-operation in the Helsinki Capital Region and active international co-operation are of utmost importance.

The proactive actions and solution development efforts by companies are essential not only to achieve the business goals but also to achieve the sustainability goals of the region. Major companies are often forerunners in this, but the overall goal should be a strongly growing cleantech business with various players including micro-sized companies and SMEs.

The results of the study give a solid basis to suggest the following focus areas for the development of the Helsinki Capital Region:

Proposals for the Helsinki region on how to differentiate.



Due to the approach and framework used in the study, the results and conclusions are indicative rather than exact, and they are primarily meant to serve as an input for further steps in the goal-setting and action-planning process. However, even though the preliminary results have gone through many rounds of discussion and commenting, the main conclusions have not been criticised. Therefore it is justifiable to use the "big picture" derived from this study as a basis for further steps.

1 Background and objectives

1.1 Background

The top executives of major Finnish companies have recently placed an important item on their agenda: developing the Helsinki Capital Region into a global champion in ecological sustainability, clean energy and cleantech.

On 2 April 2014, in the Finnish newspaper, Helsingin Sanomat, a group of top executives in major Finnish companies expressed their concern about Finland's position relative to the world's great metropolises. Many countries are rapidly leaving Finland behind in the fields of clean energy and cleantech. The world leaders in cleantech include Germany, South Korea, Denmark, Sweden, the United States and China.

According to the writers, nearly ten years have passed since Stockholm met the target level for reducing emissions. Based on its current action plan, the Greater Helsinki Region will only achieve this by around 2030.

On the other hand, the article emphasises that the city of Helsinki, or the Helsinki Capital Region as a whole, has what it takes to become a leading clean energy and cleantech metropolis. This could be achieved by investing in new power plants, for example; an option currently under review by the city of Helsinki.

This is also reflected in the outcome of the European Green City Index (EGCI), a study conducted for Siemens by the Economist Intelligence Unit (EIU) in 2009. The EGCI rated the environmental performance of 30 leading European cities on the basis of 30 indicators. These indicators were grouped into eight categories. Even now, many years after its publication, the European Green City Index is still viewed as one of the most comprehensive of its kind in the world. Helsinki's overall ranking in the EGCI was seventh. At the top of the list were Copenhagen, Stockholm, Oslo, Vienna, Amsterdam and Zurich. Helsinki's category-based rankings varied between 1 and 19. It achieved its highest score in the category of environmental governance, in which it shared first position with Copenhagen, Stockholm and Brussels. Its lowest score was in the energy category.

Finland has several plans and policies for its transition towards a low-carbon society. Key policies include:

- Climate Change and Energy Strategy (2008)
- Government Foresight Report on Long-term Climate and Energy Policy: Towards a Low-carbon Finland (2009)
- Government Programme of Prime Minister Jyrki Katainen's Cabinet
- Government decision-in-principle on energy efficiency (2010) Government decision-in-principle on promoting sustainable choices in public procurements (2009)
- ERA17 for an Energy-Smart Built Environment 2017 (2010)
- Programme to Promote Sustainable Production and Consumption (2005).

The fairly recent publication "Transition Towards a Low-carbon Society" (2014) by the Finnish Ministry of the Environment includes an evaluation of methods for reducing energy consumption and increasing the use of renewable energy sources. It also includes case studies of completed or ongoing projects for implementing the transition.

May 2014 saw the long-awaited publication of the government's decision-in-principle and strategy for boosting the new spearheads of Finland's industrial growth, cleantech and bioeconomy. The Government Strategy to Promote Cleantech Business in Finland sets the following numerical goals to be met by 2020:

- to raise the turnover of cleantech companies to EUR 50 billion, of which exports will account for more than 75%;
- to double the cleantech home market to EUR 20 billion;
- to raise the number of cleantech companies from 2,000 to 3,000;
- to create at least 40,000 new jobs in clean technology in Finland.

As part of the priority action required by the government, the strategy includes the creation of an extensive cleantech demonstration and pilot environment, which will serve as a global showcase. Rather than creating several small-scale demonstration environments, the first step must involve concentrating all available resources on the creation of an ambitious global showcase in the Helsinki Capital Region (Ministry of Employment and the Economy, 2014).

1.2 Study’s approach and objectives

The objectives of this benchmarking study are summarised in table 2.

Table 1. Helsinki Capital Region as a global driver of cleantech, the objectives.

Primary objective	Study objectives
To support the development of the Helsinki Capital Region into a driving force for clean energy and cleantech.	<ul style="list-style-type: none"> • To evaluate the current status of the Helsinki Capital Region and benchmark it against the world’s leading cities • To us a gap analysis to position the Helsinki Capital Region in relation to leading cities • Based on this positioning, to propose a vision and goal setting for the Helsinki Capital Region

The Helsinki Capital Region (which comprises Helsinki, Espoo, Vantaa and Kauniainen) was intentionally selected for benchmarking purposes, despite the fact that fully compatible regional information was not available for all of the selected benchmark cities. The Helsinki Capital Region is Finland’s only urban area with over a million inhabitants, giving it a unique position in Finland as a showcase for foreign visitors. The starting point for this study consisted of a vision of how greater co-operation within the Helsinki Capital Region could help the area to become a global champion in clean energy and cleantech. The Finnish Government has also named cleantech and bioeconomy as the new spearheads of Finland’s industrial growth.

Rather than evaluating the current situation, the decision was taken to evaluate the setting of future goals and targets related to clean energy and the cleantech business.

Planned development measures to which the Helsinki Capital Region is committed – and their success at the time at which this study was conducted – were also to be assessed. Correspondingly, the focus was set on the future: what goals to set and what measures to commit to within the Helsinki Capital Region.

Business plays a key role in the development of the cleantech business. Such a role is highlighted in the excerpt given below: “business is a key provider of solutions – so leverage the full capabilities of the private sector”. This was one of the main guiding principles of this study. At the same time, there is a need to improve the company offerings, operating environment and demand enabled by central and local governments, and to step up consumer incentives for making choices that support the realisation of a carbon-neutral society.

One of the most inspiring aspects of the global sustainability agenda is how city leaders on every continent are driving real action on climate change and sustainable development. However, even the leaders of the most advanced cities will say that they can’t do it alone and they need the engagement and collaboration of all stakeholders.

One stakeholder group that is the subject of increased attention is business. Business is a key solutions provider for addressing complex urban sustainability challenges.

Cities and businesses need to develop new models of collaboration early in the planning process so as to leverage the full capability of the private sector to drive innovative solutions and support effective decision-making.

Source: Sustainable Cities Collective

1.3 Methodology and data sources

Research methods used in this study included the meta-analysis of data sources, benchmarking and positioning (gap analysis) conducted on the basis of the meta-analysis's results, and workshops conducted with Sitra's key representatives.

Using the meta-analysis approach, conclusions are formed by contrasting and combining results and findings from previous studies on the same subject. The idea is to create a synthesis in order to build a more solid body of evidence on the subject than that which could be provided by an individual study. For this study, use was made of ten previous international benchmarking studies of metropolises and cities.

Benchmarking involves comparing one's own achievements to top performers within the area of interest. Six leading metropolises were selected as benchmark cities: Stockholm, Copenhagen, Amsterdam, Bristol, Vienna and Vancouver. The city of Tampere was chosen as a domestic benchmark. The grounds for selecting these cities include their metropolis-like structure, their overall size, and their ranking in various international comparisons. The city-specific grounds are discussed in greater detail in chapter 2. Appendix 2 comprises city-specific fact sheets summarising the data used in this study.

The benchmarking study covered the development goals of selected cities, and their completed and projected development regarding energy solutions, transport, resource and material efficiency, built environments, economic activity related to clean energy and cleantech, the activation of citizens and various operators, and how active the city administrations have been in promoting

these issues. These dimensions were selected in collaboration with representatives of the Finnish Innovation Fund Sitra. The dimensions are presented in chapter 3.1.

Based on a framework comprising seven dimensions, the cities or regions were evaluated and classified into three groups: *leading*, *main group* and *developing*. The *leading* group comprises cities or regions which have set ambitious goals for a specific dimension – such as a low-carbon energy system – and which, through their performance and communications on the issue, have demonstrated the progress made in achieving these goals. In the group of *developing* cities, goal setting and performance regarding a specific dimension have probably been more modest and this is reflected in their communications on the matter. The *main group* is positioned somewhere between these two groups.

This classification formed the basis for positioning the Helsinki Capital Region in relation to the selected benchmark cities, particularly the highest-ranking ones. This helped in identifying the goal-setting process and the measures necessary for developing the Helsinki Capital Region and meeting the level of the best-performing cities. The results of the benchmarking and positioning are discussed in chapter 3.

Due to the approach and framework used in the study, the results and conclusions are indicative rather than exact and are primarily intended to serve as guidelines and input for further planning of the goal-setting process and future action.

A list of data sources and references is provided in Appendix 3.

1.4 A brief description of the study’s implementation

This benchmarking study was carried out in a fairly tight schedule. Each stage of the work is presented in the following chart.

Chart 1. The work stages of the benchmarking study.

Month	April				May				June	
Week	15	16	17	18	19	20	21	22	23	24
1. Work commences	■									
2. Current state and benchmarking of the Helsinki Capital Region	■	■	■							
3. Gap analysis and positioning			■							
4. Vision and goal-setting (draft for the workshop)			■							
5. Limited workshop (29 April)				■						
6. Materials update based on workshop results					■	■				
7. Presentation of preliminary results to stakeholders							■			
8. Comments from the cities								■	■	
9. Finalisation of the report										■

The study was performed by Mirja Mutikainen (project manager), Maarit Vuorela, Pipsa Purhonen and Kalle Lamminmäki of Ramboll Finland Oy. The work was led by Senior Lead Pekka Salmi of the Finnish Innovation Fund Sitra. Senior Lead Tiina Kähö, Senior Advisor Jouni Keronen, Assisting Specialist Liisa Lahti, Specialist Pia Mero, Communications and Public Affairs Lead Tuula Sjöstedt and Senior Lead Jukka Aaltonen, all from Sitra, participated in setting the objectives for the benchmarking study and commenting on the study results.

2 Presentation of the benchmark cities

This chapter comprises the city profiles of the Helsinki Capital Region and the benchmark cities, which present these cities' characteristics from the viewpoint of the dimensions selected for this benchmarking study.

The characteristics of the Helsinki Capital Region are presented more extensively in order to provide a comprehensive picture of the region. The profiles of the other cities or regions include characteristics and factors that can be viewed as particularly enhancing their comparative value, while further information is provided in city-specific facts sheets in Appendix 2.

2.1 Helsinki Capital Region

Dimension: Energy system

Helsinki Capital Region's energy use is characterised by the use of natural gas and coal fuel, which has led to higher than average CO₂ emission levels compared to other European capital regions. The Helsinki Capital Region currently relies on an efficient and comprehensive district heating system. It will continue to do so in the future, and this will also include district cooling solutions. The capital region's existing CHP plants are efficient by global comparison. The power companies Helsingin Energia, Espoo-based Fortum, and Vantaan Energia are currently mapping the possibilities of replacing the use of coal with biofuels. In the autumn of 2014, the incineration of waste will be launched in Vantaa. This will reduce the use of fossil fuels at Vantaan Energia by around 30%. In the future, the introduction of smart performance metrics will facilitate dynamic pricing and active demand response.

In particular, the Helsinki Capital Region is struggling with the challenges of promoting low-carbon energy production solutions. According to estimates, roughly 70% of the capital region's CO₂ emissions are caused by energy production activities. The sources of greenhouse gas (GHG) emissions within the capital region and the city of Helsinki are distributed in such a way that the share of GHG emissions arising from the heating of buildings remained close to 50% throughout the 2000s rather than increasing in line with the building stock (Helsinki Region Environmental Services Authority HSY). Less than one quarter of the

Figure 1. Energy production in the Helsinki Capital Region



Photo: Kimmo Brandt

capital region's GHG emissions results from electricity consumption and 7% from electric heating (HSY).

The cities of Helsinki, Espoo, Vantaa and Kauniainen are committed to observing a common climate strategy for the capital region. This includes a common vision and understanding of the plan of action to reduce GHG emissions in the capital region. The climate strategy is aimed at finding a consistent approach to reducing emissions. The main focus of the strategy is on solutions that can be implemented by local authorities, who make the decisions, choose the operating model and handle the steering involved. The climate strategy has set the target of reducing GHG emissions by 39% per capita by 2030, compared to the 1990 baseline (Helsinki Metropolitan Area Council YTV, 2012). Adjusted in 2014, the current emission reduction target is 20% by 2020, with the goal is of becoming carbon-neutral by 2050. The city-specific emission reduction targets and goals for becoming carbon-neutral set by

the four cities in the capital region are aligned with the common climate strategy.

Dimension: Transport

More use is made of private cars in the Helsinki Capital Region compared to average user levels in other European cities. The density of the capital region's built-up area is lower than that of many metropolitan areas. With the aim of becoming more environmentally friendly, a large emphasis has been placed on providing the Helsinki Capital Region with versatile public transport solutions. Such efforts include the expansion of the metro system, the construction of the Ring Rail Line (Kehärata), and the introduction of a ride-sharing minibus service (Kutsuplus), as well as developing the electric vehicle charging infrastructure. The strength of the Helsinki Capital Region lies in the efficient production of real-time traffic information not only for road and transport service users, but also for various providers of value-added services, in the form of open data. Helsinki has set itself the target of increasing the share of all traffic accounted for by walking, cycling and public transport by one percentage point per year. Espoo has launched a programme to promote cycling, which is aimed at raising the share of cycling among all modes of transport to 15% by 2024. Vantaa aims to increase walking, cycling and public transport's share of all traffic.

Dimension: Resource and material efficiency

The level of material efficiency in the Helsinki Capital Region is good, when measured using factors such as the amount of waste recycled. The reform of Finnish waste legislation and the waste incineration facility to be constructed in Vantaa will be game-changers in 2014-2016. The reduction in landfill will be particularly significant.

Dimension: Ecological built environment

The Helsinki Capital Region is fairly advanced with respect to the energy-efficiency of its built environments. Whenever possible, low-energy solutions are chosen for new buildings. In Helsinki, the highest class A energy-efficiency rating is required and the trend is towards constructing net zero-energy buildings on residential plots sold and leased by the City of Helsinki. The Kalasatama neighbourhood (Fish Harbour in English) is the flagship of low-energy construction in Helsinki. Other examples include the Viikki Environment House – the office building with the lowest energy consumption in Finland – and an ecologically sustainable urban residential area to be built in Kuninkaantammi. Examples of ecological neighbourhoods in Espoo include Suurpelto and Finnoo. Vantaa also has an area like this, Kivistö.

Helsinki Region Transport (HSL) and the City of Vantaa were the winners of Motiva's **Kestävä julkinen hankkija 2014** (sustainable public procurement) competition.

"HSL was awarded for the systematic account of environmental aspects in its purchases. It has successfully combined innovation and environmental responsibility in its public transport purchases, and has thus been able to introduce low-emission buses. Because 60% of Finland's public transport operations take place within HSL's operating area, the equipment choices made by transport service providers have a major impact on emissions arising from public transport in Finland."

In 2012, the City of Vantaa used the ESCO procurement model to present an open call to energy service companies regarding the improvement of the energy-efficiency of buildings. The aim is to achieve savings of up to 30,000 MWh in heat and electricity consumption during the contracting period. Local greenhouse gas emissions will also be reduced by nearly a million kilograms a year. Under the ESCO model, costs will be covered by savings generated during the contracting period. Vantaa's ESCO project covers 15 buildings of varying age, size and type of property, all of which are more than 20 years old or have been renovated within the last ten years. According to Isa-Maria Bergman, chair of the award jury and Motiva's Group Lead on Sustainable public procurement, little use has so far been made of the ESCO model generate savings in the public sector.

"This contract proves that the City of Vantaa has courage and an open mind," says Bergman, explaining the award criteria.

The municipalities of the capital region are active participants in the action ERA17 for an Energy-smart Built Environment 2017, which is aimed at improving the energy-efficiency of low-carbon and energy-efficient built environments, as well as reducing emissions and promoting the use of renewable energy. Included in the ERA17 are targets related to distributed methods of energy production, action related to new building and renovation projects, and action for promoting the use of energy-smart services.

Another prime example is the Tools for Low Carbon Neighbourhood Construction (LOCO) project. The project partners include the cities of Helsinki and Vantaa and the Helsinki Region Environmental Services Authority (HSY). The project supports sustainable regional development by creating climate impact assessments tools. Among other tasks, the project aims to develop a calculator tool for modelling CO₂ emissions when assessing the climate impacts of construction (Berninger, 2014). Helsinki, Espoo and Vantaa are also participants in the KEKO (*Kaupunkien ja kuntien alueellinen ekolaskuri*) project. The Finnish Environment Institute SYKE will take responsibility for maintaining the basic tool, created under the project, for assessing regional eco-efficiency. Another example project is Climate-proof City – Tools for Planning (ILKKA in Finnish), in which a carbon balanced calculator was created, for use by land use planners, in order to avoid destroying carbon sinks (the project website can be found in English at: <http://www.ilmastotyokalut.fi/en>).

Dimension: Developing cleantech business

The Helsinki Capital Region is home to the head offices of several major Finnish firms that have begun to direct their attention more to cleantech, such as Kemira, Neste Oil, Fortum, UPM, Wärtsilä and Vaisala. Cities are looking to establish partnerships with business and industry.

The Climate Partners network, formed by business and the City of Helsinki, enables joint efforts to reduce emissions and strengthen competitiveness. The companies joining the network have signed a climate commitment with the City of Helsinki, setting their own goals for curbing climate change. Climate Partners has the objective of creating new operating models and business opportunities, and stimulating novel and innovative partnerships (Finnish-language website: <http://www.ilmastokumppanit.fi>). Based on this partnership concept, Espoo became one of the six finalists competing for the first European Capital for Innovation award, or iCapital. In total, 58 cities from all corners of Europe applied to enter the competition.

Green Net Finland has been promoting cleantech business and the development efforts related to it for over ten years. The city-owned Vantaa Innovation Institute is also

The comprehensive energy strategy for the Finnoo district, which won the Smart Energy competition organised by the Finnish Funding Agency for Technology and Innovation Tekes, is a prime example of the Helsinki Capital Region's active approach to promoting energy-efficient built environments. The City of Espoo and power company Fortum's proposal for the Finnoo energy system is an ambitious undertaking involving a host of challenges; this new city district of 17,000 residents has the goal of achieving energy consumption which is only half of that of an equivalent residential area (ERA17, 2014b).

All of the winning ideas in the Smart Energy competition arranged by Tekes are being implemented within the Helsinki Capital Region. The first honourable mention was accorded to a proposal for an energy data solution for the Otaniemi campus area, **The Open Energy Site ae5**. This idea concerns a software tool for making energy consumption-related data – such as consumer information, energy audit reports and energy use data – available with respect to a building located in the Otaniemi campus area. The underlying notion is that open data will enable service providers and communities as a whole to engage in open innovation. The idea was presented by Aalto University Properties Ltd and Reaktor. The second honourable mention went to **"Energia- varastot osana Fiksun kaupungin energijärjestelmää – Case Kruunuvuori"**. This proposal for energy storage as part of a smart city's energy system was put forward by Skanska, the City of Helsinki and Aalto University. It involves the integration of large-scale underground thermal energy storage (set of caves in Kruunuvuori) as part of a smart energy system based on the co-production of electricity and heat, and using renewable energy sources (ERA17, 2014a).

involved in developing the cleantech business, including the use of the Living Lab research concept. Under the CityMobil2 project, automated transport systems will be piloted in Vantaa in 2015.

Dimension: Voluntary participation of citizens and the third sector

The distinguishing characteristics of the Helsinki Capital Region lie in the activation of various actors by means of digital open data and ICT, and the way it has made open data resources available to developer communities and others who utilise such resources. Helsinki Region Infoshare is an important part of this work. In the CitySDK (Service Development Kit) project, re-usable interfaces and processes have been created by eight cities across Europe. CitySDK, though heavily focused on the capital region, is about improving city services through open data.

Dimension: Active role of city administration

Environmental governance in the Helsinki Capital Region is also heavily reliant on open data and digitisation. The four cities of the capital region promote the introduction of novel environmental and energy technologies through development projects in the field of construction. Helsinki's Kalasatama area is being built into a model district for

smart urban development. Forum Virium Helsinki manages the project as a subcontractor for the city. At present, the office building with the lowest energy consumption in Finland is the Viikki Environment House (<http://www.stadinilmasto.fi/en>).

Three municipalities in the Helsinki Capital Region – Espoo, Vantaa and Helsinki – are members of a climate network involving the mayors of the six largest cities in Finland and which was established in 2011. The purpose of the mayors' climate network is to promote the meeting of the EU's emission reduction targets, improve energy-efficiency, increase the use of renewable energy sources and develop low-carbon urban policies. These six mayors are also members of the European Commission's Covenant of Mayors, which comprises some 5,500 cities in EU countries. The signatory cities support the achievement of the EU's climate targets and are committed to reducing their own area's carbon dioxide emissions by at least 20% by 2020. Members of the mayors' climate network promote renewable energy use, energy-efficient construction and the provision of energy advice, as well as taking account of climate impacts in budgeting. Network members also organise the provision of climate advice to city residents, eco-support activities for city personnel and video conferences to reduce the need for travel (City of Helsinki, 2014).

2.2 Copenhagen

Copenhagen was selected as a benchmark city for the following reasons: Copenhagen is a pioneering city in green growth, cleantech and sustainable development. Copenhagen has been at the top of several city comparisons (e.g. Siemens Green City Index). Copenhagen was the 2014 European Green Capital. In particular, Copenhagen has received attention for its strong commitment to promoting low-carbon solutions and communication on sustainable development.

The selected dimensions highlighted in the benchmarking value attributed to Copenhagen are a low-carbon energy system, ecological transport, an ecological built environment, a developing cleantech business and the active role played by the city administration.

Copenhagen has set itself ambitious climate targets. The City of Copenhagen's decision-making processes are characterised by firm and widely co-ordinated action aimed at meeting low-carbon and energy-efficiency targets. Copenhagen (City of Copenhagen, 2012) has listed the following 2025 targets for reducing energy consumption:

- 20% less consumption for heating
- 20% less electricity consumed by retail and service sector companies
- 10% less electricity consumed by households
- 1% of electricity demand met using solar panels.

Copenhagen has a strong cycling culture and the city is striving to make cycling as attractive as possible. The city has set itself the goal of becoming "the world's best city for cycling", and aims to increase the proportion of residents who cycle to work from 36% to 50% by 2015. The City of Copenhagen actively aims to increase the use of biofuels in public transport buses (Gerdes, 2013).

Copenhagen's land use and construction policy is geared towards exploiting and re-purposing old city districts. Urban spaces are viewed as references for companies and the city's green brand as a means of attracting capital investment in cleantech to the city. The City of Copenhagen, energy companies, architectural offices, construction companies and other interested parties have jointly launched two flagship projects for building

Figure 2. Copenhagen



Source: Ramboll

carbon-neutral residential areas. The construction work emphasises low-energy solutions, renewable energy sources and environmental modes of transport.

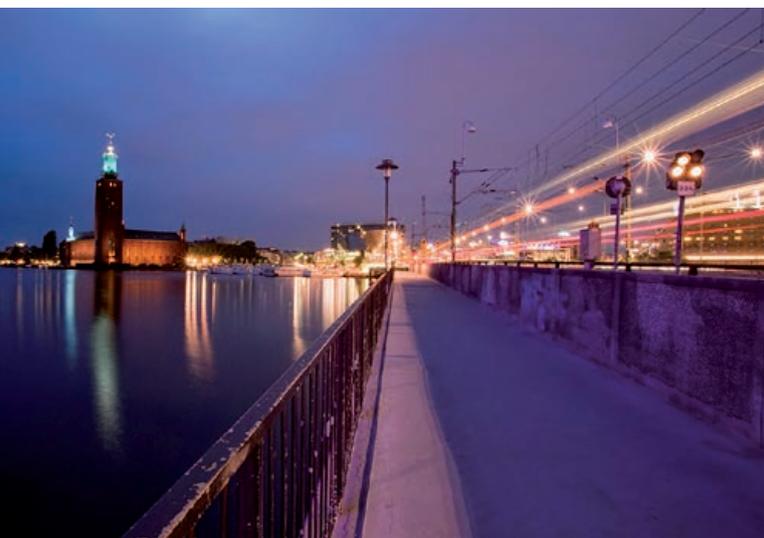
Green technology export activity has increased markedly in the Copenhagen region. The 77% growth rate achieved between 2004 and 2009 was unparalleled by other sectors. In 2011, the cleantech sector employed 34,000 people in total.

Copenhagen's green growth is supported by the city's strong commitment to promoting the achievement of sustainable development goals. In particular, the climate and environmental expertise of the City of Copenhagen receives widespread attention. The city has striven to integrate environmental management into all of its functions and its administrative structure. Copenhagen is making solid efforts to encourage its residents to promote a low-carbon future. Campaigns aimed at boosting citizen engagement represent one way of motivating the city's residents to change their lifestyles. Trying to influence people's lifestyles is an important way of promoting sustainable development.

2.3 Stockholm

Stockholm was selected as a benchmark city for the following reasons: Stockholm is ranked high in various comparisons of sustainable cities (e.g. second position in the European Green City Index; European Green Capital 2010). Stockholm receives special attention for its contribution to promoting low-carbon business. Major ecological construction projects covering entire city districts – and in which Swedish firms have been active participants – have been implemented in Stockholm.

Figure 3. Stockholm



Source: Ramboll

The selected dimensions particularly highlighted in the benchmarking value attributed to Stockholm are a low-carbon energy system, the development of the cleantech business and the voluntary participation of citizens and the third sector.

Stockholm's long-term goal is to be free of fossil fuels by 2050. This includes specific requirements concerning residential buildings and office spaces, as well as transport and the energy production sector (Economist Intelligence Unit, 2009). Stockholm will strive to reduce its annual emissions to a maximum of 3 tonnes of CO₂ per capita by 2015. Other targets for 2015:

- At least 50% of energy will be derived from renewable sources.
- Greenhouse gas emissions will be reduced by at least 40%, compared to the 1990 baseline (Environment and Health Administration, 2012).

Stockholm aims to increase its green growth and cleantech business through methods such as public procurement. Green public purchases made by the city promote the development and introduction of low-carbon solutions in the fields of transport, resource-efficiency and construction, among other sectors. The City of Stockholm's strong commitment to reducing emissions and adopting a low-carbon lifestyle is significantly increasing companies' willingness to develop new cleantech products and solutions.

It is believed that construction projects in particular are generating more business in the cleantech sector. The City of Stockholm's support for construction projects includes an investment of between USD 0.9 and 1.1 billion in the ecodistrict of Hammarby Sjöstad (Floater et al., 2013). The costs associated with the development of new technologies are huge. Luckily, the City of Stockholm has been able to support companies' product development by bearing some of the risks.

The residents of Stockholm play their part in promoting energy-efficiency. 93% of Stockholm's residents take public transport, cycle or walk to work. Environmental considerations are a major element in the everyday lives of Stockholm's residents.

2.4 Amsterdam

Amsterdam was selected as a benchmark city for the following reasons: Amsterdam took top position in the Smart City study (2014), which mapped 468 European cities based on aspects such as the smart environment perspective. This study was conducted for the European Parliament. Within the context of the study, “smart environment” referred to renewable energy use, green urban planning, resource-efficiency and electric grid ICT solutions. Amsterdam was also cited as an example in the comparison of the world’s smartest cities by Forbes (2009).

Selected dimensions that are particularly highlighted in the benchmarking value attributed to Amsterdam are a low-carbon energy system, material and resource efficiency, development of the cleantech business and the voluntary participation of citizens and the third sector.

Amsterdam aims to be one of the world’s most sustainable cities by 2040. The goal is to use sustainable development projects to reduce carbon dioxide emissions by 40% by 2025, compared to the 1990 baseline. This goal is supported by the Amsterdam Smart City (ASC) platform, which serves as co-operation network between the private and public sector, and as a think tank for ASC projects (Amsterdam Smart City, 2014). Many of the projects are aimed at saving energy. For example, the Climate Street project tests new and innovative sustainable technologies focusing on three areas: entrepreneurs, the public space and logistics. Amsterdam Smart City has particularly succeeded in supporting citizens’ active participation in co-development. In addition, by virtue of Amsterdam’s canal-based infrastructure, it seems natural that a high percentage of the city’s residents would choose walking and cycling rather than vehicles.

Amsterdam has the world’s tightest restrictions on landfill. However, the recycling rate for waste is “merely” 43% (Green City Index) due to the significant role played by incineration. Starting with the 2008 level, the goal is to keep halving the amount of waste going to landfill sites and incinerators.

On a global scale, Amsterdam is a pioneer in the treatment and incineration of waste, and the city is believed to have the strictest restrictions on landfill in the world.

According to many evaluations, only a tiny per cent of the waste generated in the Amsterdam region goes to landfill sites, mainly due to highly developed and widely used waste incineration processes.

On that note, Amsterdam’s special strengths lie in the ecological activation of citizens and the third sector, and an innovation environment that supports the creation of new cleantech business. The City of Amsterdam and the Amsterdam Innovation Motor (AIM) have formed Eco Cluster Amsterdam, which brings together firms, organisations and the municipalities of the Amsterdam Metropolitan Area to generate new business in the region (Eco Cluster Amsterdam, 2014). The cluster is engaged in international co-operation with the following parties: Eurocities, ICLEI – Local Governments for Sustainability, Connected Urban Development, European Commission – Green Capital Award, Covenant of Mayors and C40 Cities Climate Leadership Group.

Figure 4. Amsterdam



Source: www.iamsterdam.com/mediabank

2.5 Bristol

Bristol was selected as a benchmark city for the following reasons: Bristol has been named by the European Commission as the 2015 European Green Capital. The European Green Capital Award is intended to support sustainable, low-carbon housing and urban development. Bristol won the award due to characteristics such as compliance with high environmental standards, ambitious goal-setting for sustainable development and best practices and actions that serve as an inspiration to other cities.

Selected dimensions particularly highlighted in the benchmarking value attributed to Bristol are a low-carbon energy system, ecological transport and the active role played by the city administration.

Bristol's targets for 2015 are:

1. active citizens, businesses and organisations will join co-development projects and networks, which will lead to a permanent change in attitudes and actions in support of sustainable development;
2. to build Bristol into an internationally recognised pioneer city in sustainable development, which will attract tourists and investments to the area and support its competitiveness and export efforts; and
3. to turn Bristol into a specialist forum on sustainable development that will bring together Europe's leading experts (Bristol 2015 European Green Capital, 2014).

The deciding factors underlying Bristol's selection as the 2015 European Green Capital (Bristol Green Capital, 2014; Bristol 2015 European Green Capital, 2014) include:

- **Energy-efficiency:** households in Bristol consume less energy than in other major British cities. Bristol is investing GBP 140 million in an energy investment programme to promote solar energy production and district heating.
- **Being healthy and accessible:** Bristol has the highest modal share of cycling among Britain's major cities – nearly 3.5 times the average. Cycling has been promoted through numerous development projects organised by local government, businesses, communities and organisations.
- **Structural change of the transport system:** Bristol is investing GBP 400 million in developing elements of the transport infrastructure, such as low-emission buses.
- **Energy-efficiency:** the residents of Bristol have reduced the amount of household waste they generate by 29%, have increased the recycling and composting rate from 13% to nearly 50%, and have cut down the amount of waste going to landfill sites by 75%.
- **Quality of life:** one third of Bristol is green or "blue" open space, and 95% of construction projects are implemented on areas of wasteland.

The city infrastructure supports the development of the green economy. In 2012, the green economy sector experienced growth of 4.7% and there were nearly 1,000 green businesses offering environmental services or products in the Bristol and West of England regions. These businesses provide jobs for around 9,000 people in Bristol and more than 19,000 in the West of England.

2.6 Vienna

An important reason for selecting Vienna as a benchmark city was “The Top 10 Smart Cities on the Planet”, a study by Boyd Cohen. The study ranked cities in four categories: innovation city, regional green city, quality of life and digital governance. In the comparison, Vienna was identified as the most consistent. It was also the only city to make it into the top ten in every category. The results highlighted how Vienna’s urban planners have set ambitious goals in their Smart City Wien (SCW) strategy and are moving forward using well-planned comprehensive programmes. In the European Green City Index (EIU/Siemens, 2009) Vienna is also in the top five in many categories, beating Helsinki in terms of the overall score.

Selected dimensions highlighted in the benchmarking value attributed to Vienna are a low-carbon energy system, ecological transport, development of the cleantech business and the active role played by the city administration.

Vienna has a good basis for becoming carbon-free. The city consumes half as much energy per capita and generates only one third of the CO₂ emissions compared to the European standard levels. The percentage of renewable energy consumed by the city is 13%. This figure is based on water power and waste incineration. Vienna’s targets

Figure 5. Vienna’s Smart City Initiative



Source: www.iamsterdam.com/mediabank

for 2050 are 50% for renewable energy, a reduction of 80% for CO₂ emissions and a 60% reduction in energy end-use per capita (from the 2005 baseline).

Of the working population 68% take public transport, cycle or walk to work. Target 2050 (“Modal Split”) is 77%. The target of Smart City Wien from 2025 onwards will be “Zero-Emission-Transport”. An excellent example of resource-efficiency lies in energy from waste supply networks: drinking water from the Alps is used for running 13 hydroelectric power plants (65 GWh/a).

A high-publicity programme, Smart City Wien (SCW), has been implemented in Vienna since its launch in 2011. SCW consists of three parts:

1. **Vision 2050:** reduction of CO₂ emissions, energy-efficiency, renewable energy, the “Modal Split”
2. **Roadmap for 2020 and beyond:** action packages for promoting a low-carbon society
3. **Action Plan for 2012-2015:** deployment of demo and pilot sites.

SCW has been integrated with previously launched development programmes, and has a wide range of committed participants.

Investments in Vienna’s Climate Protection Programme 1999-2011 totalled more than EUR 20 billion. This helped to secure an estimated 58,000 jobs in 2011. The Environmental Cluster Vienna was established in 2011 (cf. Stockholm in 2005). It comprises educational institutions, research institutes and businesses. Vienna is home to 400 environmental companies and 14 R & D & I organisations.

The focus areas of development selected by Vienna are:

- Energy-efficient construction
- Smart Grid
- Biofuels
- Environmental monitoring
- Water management

The new cleantech business showcase is the Seestadt Aspern (Vienna’s Urban Lakeside) project. Led by the Vienna Business Agency, an ecological “aspern IQ” Technology Centre and hot spot was created in the area for clean energy and those working in the cleantech sector. Another example is the Treibhaus 1010, a community of SMEs, which has dubbed itself a cleantech hot spot.

2.7 Tampere

Tampere was selected as a benchmark city for the following reasons: it was decided that a major Finnish city should be included in the benchmarking study. Tampere's strengths lie in the active role and operating model of its city administration, which takes particular account of ecological considerations. In a smart city ranking conducted by the Vienna University of Technology, the University of Ljubljana and the Delft University of Technology (2007), Tampere received the highest score out of a group of 70 European medium-sized cities in the Smart Governance category. The category's smart city factors included transparent governance, public and social services, and participation in decision-making.

Selected dimensions particularly highlighted in the benchmarking value attributed to Tampere are a low-carbon energy system and the active role played by the city administration.

The Tampere Region aims to become a national pioneer in climate change mitigation.

The ECO2 – Eco-efficient Tampere 2020 project, launched jointly by the City of Tampere and the Finnish Innovation Fund Sitra, received broad attention in the European Parliament's Smart City study (2014). ECO2 is aimed at helping the city comply with its climate commitments, carry out low-carbon urban development projects, generate new environmental business, and become a climate change pioneer. The intention is to reduce the carbon footprint of Tampere by 20% or more per capita by 2020, and by 40% or more by 2030, compared to the 1990 baseline (Sitra, 2014).

ECO2 has boosted the weighting of climate and energy issues in the city administration's operations (ECO2 – Eco-efficient Tampere 2020, 2014):

- The start-up phase of the project involved developing eco-efficient urban development tools, such as planning-related energy audits, carbon footprint calculations, energy criteria for plot transfers and energy consulting on construction management.
- The city-owned power company Tampereen sähkölaitos has increased renewable energy's share of all energy production.
- Tampere has begun conducting energy system surveys in new areas.

The aim is to embed new operating practices in the city's existing practices. R & D platforms are being developed in Tampere, in order to accommodate new competencies and business activities. These development projects share a common theme – smart city or smart built environment. This is also a topical issue in the programmes of the EU and the Finnish Funding Agency for Technology and Innovation Tekes. Related to the smart city theme is the Innovative Cities (INKA) programme, within which ECO2 is involved (ECO2 – Eco-efficient Tampere 2020, 2014). Tampere Region leads the programme's Smart cities and industrial regeneration theme.

2.8 Vancouver

Vancouver was selected as a benchmark city for the following reasons: in the Siemens-sponsored Green City Index, Vancouver's ranking was the second highest out of all US and Canadian cities. In the index, Vancouver stood out especially in the categories for CO₂ emissions, air quality and environmental governance.

The selected dimensions highlighted in the benchmarking value of Vancouver are the development of cleantech business and the active role of the city administration.

Vancouver has set the ambitious goal of becoming the world's greenest city by 2020. The Greenest City 2020 action plan (City of Vancouver, 2014) has ten goal areas, each with a specific target:

1. **Green economy:** double the number of green jobs and companies that are actively engaged in "greening" their operations over 2010 levels by 2020.
2. **Climate leadership:** reduce community-based greenhouse gas emissions by 33% from 2007 levels.
3. **Green buildings:** require buildings to be carbon-neutral and energy-efficient.
4. **Green transportation:** make over 50% of trips by foot, bicycle and public transit.
5. **Zero waste:** reduce total solid waste going to the landfill by 50% from 2008 levels.
6. **Access to nature:** ensure city residents live within five-minute walk of a park or green space; plant 150,000 additional trees.
7. **Lighter footprint:** reduce Vancouver's ecological footprint by 33% over 2006 levels.
8. **Clean water:** meet or beat the most stringent of Canadian and international drinking water quality standards; reduce per capita water consumption by 33% from 2006 levels.
9. **Clean air:** meet or beat the most stringent air quality guidelines from Canada and the World Health Organization.
10. **Local food:** increase city-wide and neighbourhood food assets by a minimum of 50% over 2010 levels (e.g. farmers markets, urban farms, and community garden plots, orchards, kitchens and composting facilities).

Another strength of Vancouver is most definitely the innovative operating environment that it provides for cleantech business (Vancouver Clean Technology, 2014). The city requires that all new municipal facilities achieve LEED (Leadership in Energy and Environmental Design) Gold, which is the highest standard. This inspires new innovative solutions and supports the emerging green building industry. In the world of architecture and urban planning, "Vancouverism" has become shorthand for "sustainable urban development". The industry and universities have joined forces to provide research laboratories, testing platforms and funding instruments to support the emergence of sustainable technologies. These include the National Research Council for Fuel Cell Innovation, Sustainable Development Technology Canada and state funding like, for example, the Innovative Clean Energy Fund (Vancouver Clean Technology, 2014).

3 Benchmarking and positioning the Helsinki Capital Region

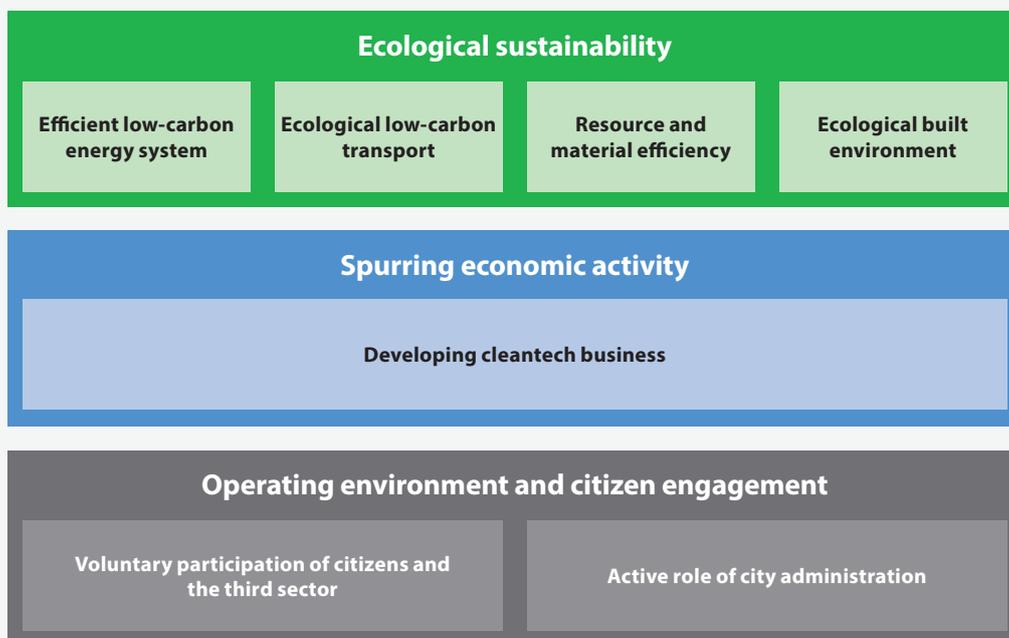
3.1 Dimensions selected for the benchmarking study

The main focus was not on the current status. Instead, the study primarily focused on clean energy and cleantech business development goals set for the future, as well as any planned development measures for which commitment has been given, and the related performance.

Based on the key underlying concepts of clean energy and the development of cleantech business, the seven dimensions listed below were selected for this benchmarking study.

For each of the seven dimensions, the common interpretation of those participating in the study was used as basis for classifying the selected seven cities or regions into three groups: *leading*, *main group* and *developing*. The *leading* group comprises cities or regions which have set ambitious goals for a specific dimension, such as a low-carbon energy system, and demonstrated through their performance and communication that progress has been made in achieving them. In the group of *developing*

Figure 6. The benchmarking dimensions.



cities, goal-setting and performance regarding a specific dimension have probably been on a more modest level, which has also been reflected in their communication. The *main group* is somewhere between these two. Sections 3.3 to 3.9 discuss the benchmarking and the related grounds separately for each dimension.

The benchmarking study and its conclusions do not represent a comprehensive and in-depth data analysis. They are indicative, and primarily meant to serve as input for further steps in the goal-setting process and planning of future actions.

3.2 The selected dimensions compared to the C40 framework

The C40 Cities Climate Leadership Group has established eleven networks across seven initiative areas with a global staff to support collaborative problem-solving, promote the exchange of programmes and policies developed by cities and facilitate targeted peer-to-peer dialogue among city staff.

The innovative megacities of the C40 network are committed to reducing their emissions and promoting an environmentally friendly strategy and technology. These cities also exchange best practices. The C40 has 68 member cities around the world. At the moment, the C40 Steering Committee comprises Tokyo, Hong Kong, Johannesburg, Buenos Aires, Houston, Jakarta, London, Berlin, Seoul, Los Angeles, Copenhagen and Rio de Janeiro.

The C40 networks are organised around seven initiative areas, listed below using C40 terminology. These initiative areas have some similarities with the dimensions selected for this benchmarking study:

1. Adaptation and Water
2. Energy
3. Finance and Economic Development
4. Measurement and Planning
5. Solid Waste Management
6. Sustainable Communities
7. Transportation.

The C40 network has three types of members. These are described below using C40 terminology.

1. Megacities (42)

- Population: city population of 3 million or more, and/or metropolitan area population of 10 million or more, either currently or projected for 2025. OR
- GDP: One of the top 25 global cities, ranked by current GDP output, at purchasing-power parity (PPP), either currently or projected for 2025.

2. Innovator Cities

- Cities that do not qualify as Megacities but have shown clear leadership in environmental and climate change work.
- An Innovator City must be internationally recognized for barrier-breaking climate work, a leader in the field of environmental sustainability and a regionally recognized "anchor city" for the relevant metropolitan area.

3. Observer Cities

- A short-term category for new cities applying to join the C40 for the first time; all cities applying for Megacity or Innovator membership will initially be admitted as Observers until they meet C40's year-one participation requirements, for up to one year.

Source: C40 Cities Climate Leadership Group (C40), <http://www.c40.org/>

3.3 Efficient low-carbon energy system

The evaluation of how low-carbon and efficient the energy system was focused on the following factors: CO₂ emissions, share of renewable energy and energy savings. Special attention was paid to the cities' setting of goals for the future and the planned development measures with respect to each factor. The evaluation covered

direct energy generation and/or use, which does not include energy imports, for example. Copenhagen, Vienna and Stockholm were the top performers in this category, particularly thanks to their determined and ambitious goal-setting and the measures they have implemented to ensure that these goals are achieved.

Group	City	Grounds
Leading	Copenhagen	<ul style="list-style-type: none"> The starting point: extensive use was made of coal in energy production. Copenhagen has set ambitious climate and energy-saving targets aimed at changing citizens' ways of life and thinking, and has engaged in highly active communications on this subject. Copenhagen aims to become a carbon-neutral city by 2025 (if this goal is met, it will be the first of its kind in Europe). The national goal is to have 30% of all energy derived from renewable sources by 2025.
	Vienna	<ul style="list-style-type: none"> The City of Copenhagen, energy companies, architectural offices, construction companies and other interested parties have jointly launched two flagship projects for building carbon-neutral residential areas. One is the neighbourhood of Amager Faelled, south of Copenhagen. The other is Nordhavn, a 200-hectare area in the city's harbour district. Copenhagen is a member of the C40 Cities Climate Leadership Group. The C40 cities are committed to combating climate change. They aim to reduce greenhouse gases through co-operation, information exchange, and goal-oriented actions.
	Stockholm	<ul style="list-style-type: none"> Smart City Wien – Vienna Smart City Initiative has ambitious goals, supported by various programmes: 50% renewable energy by 2050; CO₂ emission reduction per capita: 21% by 2020 (to 2.95 tonnes per capita), 80% by 2050 (0.75 tonnes per capita) (from the 1990 baseline); energy efficiency: 60% reduction in energy end-use per capita (from the 2005 baseline). The Smart City Wien programme is an extensive undertaking which has been effectively structured into easily implemented parts of varying duration. It includes various parallel umbrella themes/projects such as: <ul style="list-style-type: none"> - the Climate Protection Programme KLIP - the Urban Energy Efficiency Programme SEP - the Urban Development Plan STEP.

3.3 Efficient low-carbon energy system

Group	City	Grounds
Main group	Bristol	<ul style="list-style-type: none"> The goal set by Bristol in 2004 was to reduce CO₂ emissions by 60% by 2050 (from the 1990 baseline). New, more stringent goals were set in 2010: 40% by 2020 and 80% by 2050 (from the 2005 baseline). The goal for reducing energy use was set at 30% (from the 2005 baseline). <ul style="list-style-type: none"> These goals are included in Bristol's Sustainable Energy Action Plan, which was updated in 2012.
	Amsterdam	<ul style="list-style-type: none"> Renewable sources' share of total energy production currently stands at 6%. The goal is to reduce CO₂ emissions by 40% by 2025. Amsterdam is a member of the C40 Cities Climate Leadership Group. <ul style="list-style-type: none"> Planned measures: <ol style="list-style-type: none"> 1) AC cold/cooling energy from the reservoir (energy company Nuon), and 2) renewable energy from city-owned waste incineration plants (biomass and waste).
Developing	Vancouver	<ul style="list-style-type: none"> The goal is to reduce CO₂ emissions by 33%, from the 2007 level, by 2020. The long-term goal is to be free of fossil fuels. The Neighbourhood Energy Strategy presents a means of allocating funding to the promotion of renewable energy systems in high-density neighbourhoods. Vancouver is a member of the C40 Cities Climate Leadership Group. <ul style="list-style-type: none"> Planned measures: <ol style="list-style-type: none"> 1) promoting green energy use, e.g. share of water power 2) Vancouver's Community Climate Change Action Plan 1992–2012 (land use, green construction standards, promotion of walking and cycling, reduction of waste) 3) Vancouver's Neighbourhood Energy Utility (NEU) provides space heating and hot water for the Vancouver Olympic and Paralympic Village. NEU uses the waste heat derived from untreated municipal waste water (innovative green solutions demonstrating 60% reductions in emissions by residential heating systems) 4) The City of Vancouver offered financial support (50% or max. CAD 3,500) to the Residential Solar Water Heating Pilot.
	Helsinki Capital Region	<ul style="list-style-type: none"> The City of Helsinki's goal is to reduce emissions by 30% by 2020, and become carbon-neutral by 2050. The City of Espoo's goal is to reduce GHG emissions by 39% by 2030, in line with the strategy for the Helsinki Capital Region. In addition to the goals of the capital region's climate strategy, the City of Vantaa has set itself the goal of becoming carbon-neutral by 2050 (environmental policy). The new waste-to-energy plant will help reduce Vantaa's GHG emissions by 20%, and the share of fossil fuels by 30%. The 2020 target for reducing emissions caused by energy production is 20% from the 1990 level (set by Helsingin Energia) The Helsingin Energia power company's electricity and heat production systems will be changed to make the share of renewable energy sources approximately 20% by 2020. <ul style="list-style-type: none"> In 2015, Helsinki City Council will decide whether to build a new biofuel-based power plant in Vuosaari, or to invest in the Hanasaari and Salmisaari power plants in order to switch from coal to biomass (this would take Helsinki's emission rate below 40%). Helsinki will investigate the various implementation options, including a cost analysis, by the end of 2013. The key tool in implementing a responsible energy policy is energy savings. The City of Helsinki bases its energy-savings goal-setting on the recommendations of the Energy Efficiency Committee.
	Tampere	<ul style="list-style-type: none"> Tampere has set the goal of reducing its carbon dioxide emissions by 40% by 2025.

3.4 Ecological low-carbon transport

This category, dealing with the issue of ecological transport, evaluated issues such as public vehicle use over private, green modes of transport and the level of transport CO₂ emissions. The main focus was on the future: goals and planned measures. Stockholm, Amsterdam,

Copenhagen and Bristol were ranked in the leading group; Stockholm for its ambitious goal-setting, Amsterdam and Copenhagen for their cycling-oriented development and Bristol for its investment performance.

Group	City	Grounds
Leading	Stockholm	<ul style="list-style-type: none"> • A good starting point: as it stands, Stockholm residents are cycling, walking or taking public transport to work (93% in total). This number covers the centre of the city and has been strongly influenced by the congestion charges introduced in 2007. • In order to increase the share of ecological transport, major targets have been set for the city organisations' own activities. • The Clean Vehicles in Stockholm Initiative promotes the use of hybrid and biofuel vehicles and expansion of the use of clean energy in transport. The goal is for all municipal vehicles and 35% of new vehicles to become carbon-neutral.
	Amsterdam	<ul style="list-style-type: none"> • A good starting point. Little heavy transport in the city centre, but a high number of cycling paths. Of total traffic, the proportion represented by cycling and walking is 38% and the proportion represented by public transport is 24%.
	Copenhagen	<ul style="list-style-type: none"> • Increasing cycling is emphasised. Copenhagen has a strong cycling culture and the City is striving to make cycling as attractive as possible. The City has set itself the goal of becoming "the world's best city for cycling" and aims to increase the proportion of residents who cycle to work from 36% to 50% by 2015.
	Bristol	<ul style="list-style-type: none"> • Bristol has made major investments in reducing traffic emissions. GBP 420 million has been earmarked for the period 2012–2026, based on the following measures: <ul style="list-style-type: none"> - Reduce demand for heavy vehicles in the city centre - Develop the public transport system and add to the existing routes - Build new railway stations and improve rail sections - Campaigns to support walking and cycling - A smart traffic management system - Electric vehicle charging points and management system

3.4 Ecological low-carbon transport

Group	City	Grounds
Main group	Vienna	<ul style="list-style-type: none"> The current situation is good: 68% of residents walk, cycle or take public transport to work. The 2050 target for the modal split is 77%. The Smart City Wien target is Zero-Emission-Transport from 2025 onwards. From 2025 onwards, the Smart City Wien transport target includes cutting emissions to zero and increasing the number of electric vehicles (86% nicht-MIV, 14% MIV – motorisierten Individualverkehrs).
Developing	Vancouver	<ul style="list-style-type: none"> Actions include improving the cycling network and the public bike share system (2015). Downtown Street Car development programme.
	Helsinki Capital Region	<ul style="list-style-type: none"> Sustainable transport will be promoted by increasing walking, cycling and the use of public transport as a proportion of total traffic. The target is one percentage point per year. The public transport system will be developed in line with, e.g. the HSL Area Trunk Route Plan and Crosstown Transport Development Plan. Park and Ride services and the functionality of terminals will be improved. Arrangements required in the prioritisation of public transport in the Helsinki city region (e.g. public transport lanes and traffic light programming) will be implemented. The flow and safety of Helsinki's pedestrian and cycling networks will be improved. A community bike sharing programme will be integrated to the public transport system, and people's awareness on the health and environmental benefits of cycling will be increased. The creation of an extensive electric vehicle charging network will be promoted. Projects that increase the use of public transport, cycling or walking as a proportion of total transport will be prioritised.
	Tampere	<ul style="list-style-type: none"> Target 2050: Tampere will have low-emission transport and energy systems. This target will be pursued through actions such as emission reduction measures within the transport and energy sectors.
		<ul style="list-style-type: none"> Ongoing projects include raising the public transport service level and increasing the number of gas-powered buses.
		<ul style="list-style-type: none"> The City of Helsinki has adopted criteria for low-emission vehicles, granting them a 50% discount on parking fees. Under these criteria, the carbon dioxide emission limit for petrol and diesel-powered vehicles (including hybrids) is less than 100 grams/km, and for gas and ethanol-powered vehicles it is less than 150 grams/km. Regulated emissions of this type must also meet the Euro 5 level. All-electric vehicles and electric moped cars are also entitled to the parking discount. Vehicles procured by city organisations must comply with these emission criteria. (City of Helsinki, Finnish Environment Institute) The recommendations put forth by cycling promotion programmes will be applied in the capital region (e.g. City of Espoo, 2013-2024); in Espoo the goal is to increase the share of cycling to 15% of all modes of transport by 2024. A cross-functional tram project will be launched for the development of the tram system and in preparation for its expansion. An attempt will be made to expedite the implementation of the Jokeri rail. New rail projects, the Ring Rail Line and West Metro, are under construction and will raise the utilisation rate of public transport.
		<ul style="list-style-type: none"> The City of Tampere will increase the modal share of electric vehicles in its own activities, and promote the development and introduction of low-emission vehicles through participation in development projects. Tampere is currently piloting hybrid buses.

3.5 Resource and material efficiency

The evaluation of resource and material efficiency covered issues such as the recycling rate, landfill activities and water consumption of each benchmark city. Special attention was paid to future goals and planned measures

within these categories. The leading cities were Vienna and Amsterdam. These two benchmark cities have set the most stringent restrictions on landfill activities, and aim to create new business opportunities based on waste recovery.

Group	City	Grounds
Leading	Vienna	<ul style="list-style-type: none"> • Direct landfilling is prohibited; only waste incineration and recycling rejects go to landfill sites. • Under Vienna's Waste Management Plan, methods of reducing CO₂ emissions arising from waste treatment include waste incineration, the recovery of landfill gases, and recycling and composting. • A gravity-powered water supply system that generates energy. • Repair Network Vienna (with 50 member companies) provides consumers with an alternative for the disposal of refuse.
	Amsterdam	<ul style="list-style-type: none"> • On a global scale, Amsterdam is recognised as a pioneer in the reduction of waste disposal in landfill sites and in the treatment and incineration of waste. • Amsterdam has set the world's most stringent restrictions on landfilling, most of which entered into force in 1995. According to most estimates, roughly 1–2% of the waste generated in Amsterdam goes to landfill sites. However, the recycling rate of waste is "merely" 43% (Green City Index number two after Helsinki) due to the significant role played by incineration. The goal is to further reduce the amount of waste going to landfill sites and incineration plants. • The City of Amsterdam's Waste and Energy Company's (Afval Energie Bedrijf, AEB) newest installation is a fourth-generation waste-fired power plant (WFPP). This is the largest single-location waste-to-energy (WtE) plant in the world, processing 530,000 tonnes of waste per year. The plant has the highest energy efficiency rate in the world. 48% of the plant's total treatment volume is biomass, i.e. renewable. The WtE plant provides district heating for some 50,000 households and electricity for around 300,000 households (1,000 GWh of electricity). The waste treatment plant is integrated with a sewage treatment plant, forming a symbiosis: sludge and biogas derived from the sewage treatment process are used to power the WtE plant. • Amsterdam's buses mainly run on fuel produced by the Waste and Energy Company. • The city has organised an extensive information campaign (Platform for Information about Waste products) aimed at reducing the amount of household waste.

3.5 Resource and material efficiency

Group	City	Grounds
Main group	Helsinki Capital Region	<ul style="list-style-type: none"> • A high waste recycling rate of 57.6%. Once complete, the new waste-to-energy plant in Vantaa will help bring about a significant reduction in the amount of landfilling. • A national energy saving campaign by Helsinki Regional Environmental Services Authority (HSY), <i>Älä ole apina</i> (literal translation: don't be a monkey), has been launched in Vantaa's schools.
	Copenhagen	<ul style="list-style-type: none"> • Recycling rate of household waste, 23.6% (2009), and all waste, 55% (2009). • The Copenhagen City Council spends roughly EUR 270,000 a year on programmes and projects aimed at reducing water consumption.
	Tampere	<ul style="list-style-type: none"> • The material and resource efficiency of public purchases is a key criterion in all investments made by the City of Tampere. • Resource-efficiency is also encouraged by the city's public purchasing guidelines and the framework programme for environmental investments.
	Bristol	<ul style="list-style-type: none"> • Recycling rate of waste approximately 50%. • The Household Waste Strategy is aimed at increasing recycling and reducing waste. • The city will develop recycling services and centralised composting facilities.
	Vancouver	<ul style="list-style-type: none"> • Recycling rate 55%; the 2020 target is 80%. • Metro Vancouver Zero Waste Challenge provided practical examples of how to minimise waste generation and maximise recycling and reuse (e.g. new recycling regulations, an infrastructure for the collection and processing of recycled materials, waste charges, and communication programmes).
Developing	Stockholm	<ul style="list-style-type: none"> • Overall recycling rate 31%; Stockholm generates rather considerable amounts of waste. • In accordance with the Stockholm Environment Programme for 2012–2015, the City's units observe environmental requirements on packaging, in order to minimise the amount of waste arising from public purchasing.

3.6 Ecological built environment

The evaluation of the cities from the viewpoint of the built environment paid special attention to the energy-efficiency of the building stock and to the related standards and classifications. Once again, the main focus was on the setting of goals for the future and measures planned by

the city. The energy-efficiency standards set for buildings and the implementation of various ecological construction and pilot projects made Stockholm, Copenhagen and Amsterdam stand out as leading cities.

Group	City	Grounds
Leading	Stockholm	<ul style="list-style-type: none"> Sweden is a pioneering country with respect to energy-efficiency standards for buildings, as seen in the city of Stockholm's successful energy-efficient built environment. Building stock energy-efficiency requirements and construction incentives are effective steering instruments in the encouragement of energy-efficient construction and the modernisation of existing buildings.
	Copenhagen	<ul style="list-style-type: none"> In construction and land use, the main goal is to make active use of existing spaces: old industrial zones are being converted into residential areas, and 80% of new developments are built on "brownfield sites", such as harbours. The City of Copenhagen aims to actively exploit the existing urban space and environment in order to reduce energy consumption and the need for public transport. In Copenhagen, the energy consumption of residential buildings is low.
	Amsterdam	<ul style="list-style-type: none"> The goal is that all municipal buildings will be carbon-neutral by 2015. The energy-efficiency of the city's old buildings is being improved through renovations, and strict requirements have been set for new buildings. A key goal is to reduce the need for heating.

- In accordance with the Stockholm Environment Programme 2012–2015, the city aims to reduce the energy consumption of new buildings, limiting it to a maximum of 55 kWh/m².
- All construction work must comply with at least one of the following environmental monitoring criteria used to ensure that construction work and buildings are environmentally friendly: BASTA, Svaven, Bra Miljöval and EU Ecolabel.

- Amsterdam has numerous on-going multi-partner built environment projects, such as
 - the piloting of smart meters for monitoring energy consumption in the Geuzenveld district, and
 - alliance co-operation with housing companies: energy-efficiency metrics and saving energy.

3.6 Ecological built environment

Group	City	Grounds
Main group	Helsinki Capital Region	<ul style="list-style-type: none"> • Building a home on a residential plot transferred by the city requires compliance with class A energy-efficiency standards. The ultimate goal is net zero energy buildings. • Goal-oriented renovation of the municipal building stock is aimed at meeting the requirements of energy-efficiency class C.
	Bristol	<ul style="list-style-type: none"> • Projects: Kalasatama (a pilot, forming part of the Witty City programme, by the Finnish Funding Agency for Innovation Tekes) and the Jätkäsaari, Kuninkaantammi and Honkasuo neighbourhoods of Helsinki.
Developing	Bristol	<ul style="list-style-type: none"> • An action plan for reducing CO₂ emissions (The City's Directors of Finance and of Housing Strategy), e.g. continuous guidance and support in improving the insulation of buildings, and the installation of solar power heating systems in municipal housing. • Energy efficiency has improved by 15% from the 2004 level, through the Bristol Energy Efficiency Scheme (BEEES).
	Vancouver	<ul style="list-style-type: none"> • Communications campaigns and programmes: Bristol has provided more than 100,000 residents with tailored instructions on energy-efficiency, through telephone services and other communication channels.
	Vienna	<ul style="list-style-type: none"> • The City's goal is that all new homes will be fully carbon-neutral by 2030 (the Green Homes Programme). • New buildings must attain the Leadership in Energy and Environmental Design (LEED) certificate: strict requirements related to water efficiency, saving energy, reducing CO₂ emissions and improving indoor air quality.
	Tampere	<ul style="list-style-type: none"> • The expectation is that 20 to 30 fully green new buildings will appear each year. • The targeted reduction in the energy consumption of the old building stock is 20% compared to the 2007 level.
	Vienna	<ul style="list-style-type: none"> • Programmes supporting the sustainable development of built environments, such as the Urban Energy Efficiency Programme (SEP) and the Urban Development Plan (STEP) • Smart City Wien, or Vienna's Smart City Initiative, will allocate support for basic improvements aimed at enhancing ecological aspects.
	Tampere	<ul style="list-style-type: none"> • Instructions for environmentally friendly construction. • The construction of wooden passive multi-storey buildings has been possible since 2001. • The Seestadt Aspern project (high ecological standards during planning and construction).
	Tampere	<ul style="list-style-type: none"> • Preparation of a local plan for energy-efficient construction in accordance with the national ERA17 programme. • Rane – support and advice on any construction-related issues.
	Tampere	<ul style="list-style-type: none"> • Projects: The residential district of Vuores (high-quality architecture, ecological, high-tech, and respecting nature's values); zero-energy area in Härmälänranta (by Skanska); renovation project in Tesoma; Nurmi-Sorila, a carbon-neutral "Sun City".

3.7 Developing cleantech business

With a special emphasis on goals and planned measures, the evaluation focused on cities' activeness in generating new cleantech business that is both ecological and sustainable. The following areas were studied in order to determine the level of activeness: from research to business, spin-offs, think tanks, ecosystems, showcases, international co-operation, funding, and commitment by major firms. The three leading cities in this category are Vancouver, Copenhagen and Stockholm.

Vancouver is a clear leader in Canada's cleantech industry. An excellent example of this leading position is the Vancouver Fuel Cell and Hydrogen Technologies Cluster. Companies such as Ballard Power Systems Inc., Plug Power Canada and Hydrogenics, which originated from the cluster, are now global leaders. The Vancouver Fuel Cell Vehicle programme is a joint effort with

international corporations, such as the Ford Motor Company and Linde Gases.

The Copenhagen Region is home to more than 500 cleantech companies, which provide jobs for more than 34,000 people. Copenhagen has set three clearly defined focus areas of development: Smart Grid, Water and Wind. The partners of Copenhagen's cleantech cluster include IBM, Ramboll, Siemens and PwC.

The Stockholm Cleantech network has been operating since 2005. The city boasts the largest cleantech cluster in Scandinavia. Its priority areas include biogas, ocean energy and Smart Grid. The City of Stockholm has harnessed its public purchasing in support of development of the cleantech business. The three key areas for promoting the cleantech business are: Stockholm Royal Seaport, Hammarby Sjöstad and Högdalen.

3.7 Developing cleantech business

Group	City	Grounds
Leading	Vancouver	<ul style="list-style-type: none"> Vancouver is a pioneer in sustainable urban development, setting an example for other cities. The Vancouver “model” has been applied in Houston, Dubai, Sao Paolo and Abu Dhabi. The Corporate Climate Leaders programme is encouraging businesses to partner up with each other and make specific environmental commitments. Vancouver’s businesses are pioneers in cleantech, and the area is home to various development organisations and projects. The Province of British Columbia (BC) grants a 30% tax credit for first-stage capital venture investments in SMEs. The BC Innovative Clean Energy (ICE) Fund supports the development of new sources of clean energy and technologies. The federal government and the province have invested CAD 89 million in a demonstration project for hydrogen fuel cell buses and fuelling stations. <ul style="list-style-type: none"> Vancouver has set hydrogen fuel cell technology as one of its spearhead activities. BC companies such as Ballard Power Systems Inc., Plug Power Canada and Hydrogenics, which originated from the Vancouver Fuel Cell and Hydrogen Technologies Cluster, are now global leaders. Case: The City of Vancouver put 20 hydrogen fuel cell buses into operation for the 2010 Olympic Winter Games. The Vancouver Fuel Cell Vehicle programme is a joint effort alongside international corporations, such as Ford Motor Co. and Linde Gases. Solid R&D investments in clean energy and cleantech: Some 193 million dollars, invested by 80 organisations, generated 133 million in revenues a year a decade later; Vancouver is a national R&D&I hub, accounting for nearly 70% of jobs in the cleantech sector (1,400); 11 H2/FC start-ups.
	Copenhagen	<ul style="list-style-type: none"> The Copenhagen region is home to more than 500 cleantech companies. Copenhagen has set three clearly-defined development focus areas: Smart Grid, Water and Wind. The partners of Copenhagen’s cleantech cluster include IBM, Ramboll, Siemens and PwC. Worldwide visibility is attracting cleantech investors to Copenhagen, where visibility is guaranteed by the City’s strong commitment to promoting low-carbon solutions, which is emphasised in public image campaigns. Investors are interested in seeing the use of the products and solutions in practice. <ul style="list-style-type: none"> The City of Copenhagen, energy companies, architectural offices, construction companies and other interested parties have jointly launched two flagship projects for the construction of carbon-neutral residential areas. These two pioneering areas are Amager Fælled and Nordhavn. The construction work emphasises low-energy solutions, renewable energy sources and environmental modes of transport. There has been a major increase in green technology exports from the Copenhagen region. In 2004–2009, the 77% growth rate was unparalleled by other sectors. In 2011, the cleantech sector employed 34,000 people in total.
	Stockholm	<ul style="list-style-type: none"> The Stockholm Cleantech business network was established in 2005. The city boasts the largest cleantech cluster in Scandinavia. Its priority areas include biogas, ocean energy and smart grids. The City of Stockholm has harnessed its public purchasing in support of development of the cleantech business. The three key areas in the promotion of the cleantech business are: Stockholm Royal Seaport, Hammarby Sjöstad and Högdalen. Cutting edge ecological city districts have been built in Stockholm, with more on the way. The City has made substantial investments in their construction.¹ The construction costs have been significant. An ongoing project is the Stockholm Royal Seaport area. The City managed to partner with major firms for this project. The newly established local Innovation Centre helps to link the partners, which include major players such as Ericsson, Fortum, ABB and Electrolux. These firms regard participation in the development of this area as important to aspects of their own operations –product development, for example. Collaboration of this kind is characterised by the emergence and search for new types of consortia. Technological innovators, urban planners, ICT experts and City staff need to find a way of working together. The implemented projects are referred to as demonstrations. <ul style="list-style-type: none"> New technological solutions are being extensively applied in the project areas. Businesses have noted that Hammarby Sjöstad serves as an important reference around the world. The area is widely considered a “best practices” showcase, attracting worldwide attention. There is demand for extensive projects, such as Hammarby Sjöstad, which make use of new technologies and solutions, because they enable companies to develop new technologies. The costs associated with such development work are huge. Luckily, the City of Stockholm has been able to support the product development of companies by bearing some of the risks. The overall brand of Sweden as a green technology country has also boosted Swedish companies’ export activities. (Floater et al., 2013) The City of Stockholm’s strong commitment to a low-carbon policy is important to fostering green thinking in the city region in the assessment of the environmental impact of city organisations. Strengthening the integration of environmental aspects in the City’s daily decision-making processes is just what is required to boost demand for new and innovative low-carbon solutions. For local businesses, the City’s commitment to opting for low-carbon options in its purchasing, construction and other activities will mean growing markets for their products and solutions. The Stockholm Environment Programme 2012–2015 lists ambitious goals for steering the City’s public purchasing processes towards the improvement of resource and material efficiency.

1 E.g. it is estimated that the City of Stockholm has invested around 0.9–1.1 billion US dollars in construction in the Hammarby Sjöstad area. (Floater et al., 2013)

3.7 Developing cleantech business

Group	City	Grounds
Main group	Vienna	<ul style="list-style-type: none"> Investments in Vienna's Climate Protection Programme 1999–2011 totalled over EUR 20 billion. It is estimated that the programme secured 58,000 jobs in 2011. The Environmental Cluster Vienna was established in 2011 (cf. Stockholm in 2005). It comprises educational institutions, research institutes and businesses. Vienna is home to 400 environmental companies and 14 R&D&I organisations. The focus areas of development selected by Vienna are: energy-efficient construction, smart grids, biofuels and environmental monitoring. The new cleantech business showcase is the Seestadt Aspern (Vienna's Urban Lakeside) project. Led by the Vienna Business Agency, an ecological "aspern IQ" Technology Centre and hot spot were created in the area for clean energy and cleantech actors. Another example is the Treibhaus 1010, a community of SMEs, which has dubbed itself a cleantech hot spot. A part of the Eco Buy Vienna project, the City is promoting sustainable business through its public procurement system. The City has set 63 ecological criteria for its purchases, which amount to roughly EUR 5 billion each year. The Smart City Wien 2050 programme comprises action packages intended to stimulate the environmental business.
	Bristol	<ul style="list-style-type: none"> Businesses are provided with advice on how to become low-carbon. Training is provided in support of the sustainable energy industry. District heating projects. The development of a low-carbon industrial zone, aimed at creating thousands of jobs. The smart grid pilot project. Bristol is a testing ground for new ideas and green innovations: local food, a local currency (Bristol Pound) and energy cooperatives. The Bristol Green Capital Partnership for businesses and organisations. Partners are expected to attend regular meetings and be actively involved in supporting the partnership's work. The City of Bristol offers interest rate discounts to businesses. A strong cleantech value chain and companies that act as driving forces, such as Garrad Hassan, Rolls Royce and Siemens. Existing value chains and transport connections are important considerations when setting up new business. Bristol's BIG Green Week (held in June 2013) focused on sustainable development innovations. The Siemens-owned Marine Current Turbines Ltd (MCT) is Bristol-based. MCT was ranked fifth overall among Europe's most innovative cleantech firms.

3.7 Developing cleantech business

Group	City	Grounds
Developing	Amsterdam	<ul style="list-style-type: none"> Amsterdam Smart City (ASC) serves as a co-operation platform for the private and public sector, and a think tank for ASC projects. Many of the related projects are aimed at saving energy. The Climate Street project, for example, tests new and innovative sustainable technologies focusing on three areas: entrepreneurs, the public space and logistics. The City of Amsterdam and the Amsterdam Innovation Motor (AIM) have formed Eco Cluster Amsterdam, which brings together firms, organisations and the municipalities of the Amsterdam Metropolitan Area to generate new business in the region.
	Tampere	<ul style="list-style-type: none"> Pilot projects of RESCA – Renewable Energy Solutions in City Areas (e.g. solar technology, wind power and biogas as vehicle fuel). The target is to create ten new operating models or technologies that can also be used in other areas. The total budget for RESCA is EUR 1.3 million. Tampere is an active partner in the Innovative Cities programme (INKA). It leads the programme's Smart cities and industrial regeneration theme. INKA is aimed at generating new companies from high-quality expertise and spurring the creation of innovation clusters.
	Helsinki Capital Region	<ul style="list-style-type: none"> In line with Helsinki's strategy, partnerships are being built with business and industry in order to enhance the competitiveness and environmental responsibility of companies while promoting the creation of new, innovative business models around smart technologies, resource-efficiency and carbon-neutral products, for example. The development and deployment of new types of environmental and energy technologies will be promoted in co-operation with companies and R&D bodies. Helsinki Business Hub will apply for foreign investments in the financing of Finland's cleantech sector. Private venture capital investors will mainly be active in Helsinki. The Climate Partners network was formed by the City of Helsinki in 2012. A total of 47 major firms, universities and research institutes have so far signed their own climate commitments. The Helsinki Capital Region is home to 300 cleantech companies and 20 R&D centres. Helsinki Region Environmental Services Authority HSY is a participant in the RESCA project and has developed the EcoCompass, a lighter environmental management tool for SMEs. The EcoCompass is a systemic method of managing environmental issues. The aim is to improve the state of the environment and support companies in providing their costumers with the most environmentally friendly services possible. (Climateinfo/EcoCompass). Green Net Finland has been promoting the cleantech business for more than ten years. The Vantaa Innovation Institute's methods of supporting the environmental technology sector's growth and development include the provision of demonstration environments and implementation of projects, both independently and in co-operation with partner universities, universities of applied science and R&D organisations.

3.8 Voluntary participation of citizens and the third sector

In the case of this dimension, the evaluation focused on the methods of activation used by the city, the joint projects of various parties and the extent of the city's interaction with respect to commitment and goals. Copenhagen,

the Helsinki Capital Region and Amsterdam were the three leading cities in this respect; the first two particularly due to their use of open data and digitisation.

Group	City	Grounds
Leading	Copenhagen	<ul style="list-style-type: none"> The City of Copenhagen makes active use of the information resources provided by its citizens. The City develops ways of effectively harnessing citizens' expertise, knowledge and suggestions for practical application. Digitalisation of the interaction between civil society and policy-making is an effective way of ensuring that citizens' voices and opinions are heard. Copenhagen has identified the following methods of doing this: <ul style="list-style-type: none"> All communications between the authorities, public administration and companies are being digitised. Public and private information is being made easier to access, for example, by increasing the openness of data. The Danish people are in favour of sharing the information that they generate for the purposes of supporting decision-making. An open data infrastructure, which gathers publicly available information produced by citizens and that can be utilised in urban development, is an important mechanism for responding to citizens' needs in various ways using an extensive information base. (Copenhagen Cleantech Cluster, 2013) The people of Copenhagen are active promoters of a low-carbon future. Half of the wind turbines of the Middelgrunden wind farm near the Harbour of Copenhagen were funded by individual shareholders. (Gerdes, 2013)
	Helsinki Capital Region	<ul style="list-style-type: none"> For decades, the City of Helsinki has been working actively towards enhancing the level of environmental responsibility among its residents through means such as maintaining forest school activities, organising events and exhibitions, and producing environmental education materials for schools and day care centres. Helsinki has implemented several EU projects which have promoted the environmental responsibility of local residents and businesses. Helsinki employs the Living Lab approach and other types of open innovation platforms, which are an excellent way of testing products and solutions in practice and then fine tuning them, based on user feedback, to suit the urban environment. In this context, user-oriented testing is a crucial mechanism for ensuring that products and solutions are smart, and of guaranteeing their suitability for wider use. The Helsinki Region Infoshare is an excellent example of widely applied activation methods aimed at committing citizens to developing their home towns. Helsinki is a pioneer in this. A project aimed at providing citizens with energy-related information (ASIAA! – Asukkaiden ilmastoteot asualueilla) is currently being implemented in Helsinki, Espoo and Vantaa. The aim of the ASIAA! project is to harness counselling, steering, dissemination of information and communal action to help citizens reduce their household energy consumption, particularly through their purchases of appliances, selection of heating methods and devices and their preferred modes of transport, as well as by providing them with instructions on new and renovation construction. The carbon emission reduction project "Hiilineutraali Harakka" involved the implementation of an energy-themed nature path on the island of Harakka, for the showcasing of various practical applications of renewable energy solutions. The Helsinki Climate site, www.stadinilmasto.fi, presents the City of Helsinki's climate work. It is designed to serve both citizens and city organisations. The Vantaa Innovation Institute has Living Lab platforms for cleantech product testing.
	Amsterdam	<ul style="list-style-type: none"> Amsterdam has encouraged its residents to become active through several small-scale development projects implemented throughout the city. Citizens participate actively in these projects. An excellent example is the Smart City Amsterdam programme, a joint effort by the City and local residents and companies which was launched in 2009 to support joint pilot projects including: <ol style="list-style-type: none"> smart meters for monitoring energy consumption in the Geuzenveld district the smart shopping street Utrechtsestraat: smart solutions for business owners charging stations along the coast so that boaters and commercial ships gain access to the City's power grid and avoid the use of diesel generators. (Economist Intelligence Unit, 2009) The projects with the greatest impact will be selected. The projects are popular and have led to smart grid solutions, smart electric vehicle charging methods, smart transport solutions, and various other solutions that are helping to pave the way towards a low-carbon society. The City of Amsterdam provides open access to data; this is encouraging the city to develop innovations, such as smart phone applications, which can assist in meeting carbon emission reduction targets.

3.8 Voluntary participation of citizens and the third sector

Group	City	Grounds
Main group	Stockholm	<ul style="list-style-type: none"> The city organisations' activities are aimed at encouraging local residents to participate actively in the development of their home towns. Through various campaigns, the city is providing local residents with information on its activities. One of the main goals of Vision 2030 for Stockholm is "the citizens' Stockholm". The goal is a Stockholm with abundant with green areas and which is accessible to everyone. The vision of a low-carbon Stockholm of the future places citizens in a key role.
	Vienna	<ul style="list-style-type: none"> Realised examples include: <ul style="list-style-type: none"> - <i>EcoBuy Vienna public procurement policy</i> - <i>Citizens' Solar Power Plants, through which citizens are participating in increasing the use of solar power</i> - <i>Smart City Wien 2050; the strategy includes several packages of measures for increasing participation in the form of various working groups under the theme "Die BürgerInnen zu PartnerInnen machen".</i>
	Bristol	<ul style="list-style-type: none"> The Community Challenge Fund; community projects funded by the City of Bristol and aimed at reducing CO₂ emissions.
Developing		<ul style="list-style-type: none"> The impact of various policy actions on the everyday lives of citizens will be systematically assessed as part of the process of developing towards a "Green Stockholm".
	Tampere	<ul style="list-style-type: none"> Examples of projects: <ul style="list-style-type: none"> - <i>Transition Neighbourhoods – community led local initiatives; dissemination of information on energy security issues, supporting communal action and community spirit.</i> - <i>Community groups; e.g. joint efforts to improve the insulation of buildings.</i> - <i>Energy systems owned by communities and cooperatives.</i> - <i>Interaction in the social media; the Bristol Green Capital website for sharing daily green ideas; the best ideas are rewarded.</i> - <i>Bristol Green Capital is also active on Twitter and YouTube.</i> - <i>Not-for-profit Bristol Green Doors: open house events held in homes that have been made more energy-efficient.</i>
		<ul style="list-style-type: none"> The city-driven aspect is emphasised.

3.9 Active role of the city administration

The factors evaluated under this dimension include the steering and support mechanisms applied by the city, the role of public procurements, city-level strategies and actions plans, the use of campaigns, and land-use planning and its related measures. The top performers were

Copenhagen, Stockholm and Vienna. All three cities are characterised by active goal-setting and well co-ordinated and planned measures. In the case of Copenhagen and Stockholm, the emphasis is on interaction, while a city-driven project scene is at the forefront in the case of Vienna.

Group	City	Grounds
Leading	Copenhagen	<ul style="list-style-type: none"> The City of Copenhagen’s decision-making processes are characterised by firm and widely co-ordinated actions taken towards meeting low-carbon and energy-efficiency targets. Each city departments’ person responsible for environmental affairs ensures that procedures are coherent and best practices are shared. The city is carrying out various projects and schemes to reduce its CO₂ emissions by 10%. These include improvements to the old building stock and the retrofitting of all municipal buildings to enhance their energy-efficiency. Copenhagen is steering its residents towards a more ecological lifestyle. The goal is to become “the world’s best city for cycling” – to increase the proportion of residents who cycle to work from 36% to 50% by 2015. The climate and environmental expertise of the City of Copenhagen is receiving special attention. The City has striven to integrate environmental management into all of its functions and the administration.
	Stockholm	<ul style="list-style-type: none"> The environmental aspect has long been embedded in Stockholm’s decision-making processes. Public purchases play a key role in promoting green growth. The Stockholm Environment Programme 2012–2015 comprises several targets regarding green public purchasing. Stockholm is a pioneer in ecological residential areas. The City of Stockholm’s active participation and strong commitment to development using the PPP (public-private-partnership) model has encouraged businesses to invest their own resources in projects. (Floater et al., 2013, p. 140). Businesses regard the City’s long-term commitment to development projects as the key deciding factor when they consider joining a project.
	Vienna	<ul style="list-style-type: none"> The Smart City Wien Initiative is ambitious and promotes low-carbon energy production, transport, and urban planning and development. A wide range of operators have committed to the low-carbon targets of Smart City Wien. The initiative features many sub-programmes and sub-projects, including EU-funded projects. The Smart City Wien programme consists of three parts: <ol style="list-style-type: none"> 1) Vision 2050: reduction of CO₂ emissions, energy-efficiency, renewable energy, the “modal split” 2) Roadmap for 2020: action packages for promoting a low-carbon society 3) Action Plan for 2012–2015: deployment of demo and pilot sites.

3.9 Active role of the city administration

Group	City	Grounds
Main group	Helsinki Capital Region	<ul style="list-style-type: none"> The Climate Strategy 2030 for the Helsinki Capital Region was completed in 2007. The former Helsinki Metropolitan Area Council YTV (now: HSY) jointly drew the strategy up with Helsinki, Espoo, Vantaa and Kauniainen. The main focus of the strategy was on the functions that generate the most GHG emissions, functions and measures under the control of the cities, and the reduction of energy consumption. The City of Espoo is committed to the common climate strategy for the capital region and its goals of reducing GHG emissions by 39% (from the 1990 baseline) by 2030, and embedding climate change mitigation in urban planning and policy-making. Espoo also has its own, short-term action plan which comprises around one hundred practical measures for combating climate change. Helsinki City Council approved the City of Helsinki environmental policy at a Council meeting held on 26 September 2012. Environmental policy goals have been set for both the long term to 2050 and for the medium term to 2020. These goals fall into the following eight categories: <ul style="list-style-type: none"> - Climate protection - Air protection - Noise control - Protection of the sea and water bodies - Nature and soil conservation - Purchases, waste and material-efficiency - Environmental awareness and responsibility - Environmental management and partnerships. The climateinfo service of HSY runs campaigns aimed at activating citizens.
	Bristol	<ul style="list-style-type: none"> The City of Bristol sets a strong example through its own activities for promoting a low-carbon economy. Investments in the renewable energy programme: e.g. biomass, wind and solar energy. Modernisation of street lighting. Energy-efficiency of public buildings.
	Tampere	<ul style="list-style-type: none"> Low-carbon support programmes. Effective environmental policy and governance. Eco-efficient practices and impact assessment: EIA procedures, Sustainable Energy Action Plan (SEAP), Environmental Strategy, Eco-support, ECO2, ILMANKOS.
	Amsterdam	<ul style="list-style-type: none"> Amsterdam Smart City (ASC) serves as co-operation platform for the private and public sector, and a think tank for ASC projects. Land use is guided by the Main Green Structure urban plan. Ambitious targets and measures are set in the environmental strategy Milieubeleidsplan.
Developing	Vancouver	<ul style="list-style-type: none"> Vancouver grants loans for improving the energy-efficiency of the existing building stock. The city also offers environmental training and enables the utilisation of green spaces. Corporate Climate Leader programme for companies. Vancouver the Greenest City Action Plan. Air Quality Management Plan for Greater Vancouver. The challenges of transparency: limited availability of public monitoring data.

3.10 Summary of the results

The benchmarking and positioning discussed in sections 3.3 to 3.9 is summarised in the following graphs. The results are presented by category, separately for each city or region. The results and graphs present a common interpretation by those participating in this study of the position of each city or region with respect to the dimensions selected for this study. It should also be emphasised that, rather than the current status, the study focused on comparing the cities or regions with respect to their development, or in other words, the development goals they have set for the future and measures that will support the achievement of those goals.

Chart 2. A summary of the Helsinki Capital Region’s position with respect to development of the selected dimensions.

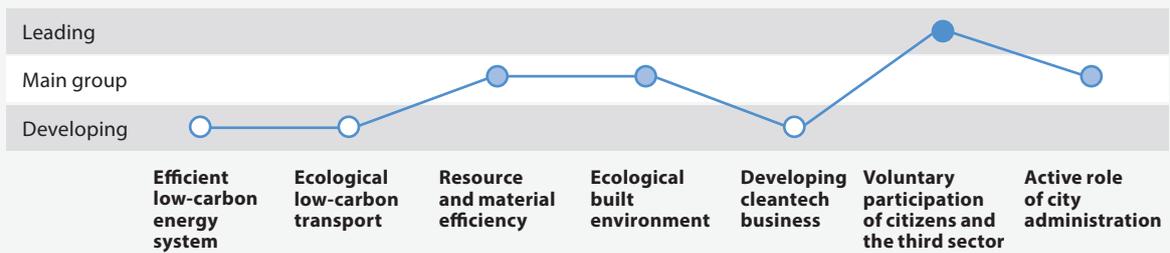


Chart 3. A summary of Copenhagen’s position with respect to development of the selected dimensions.

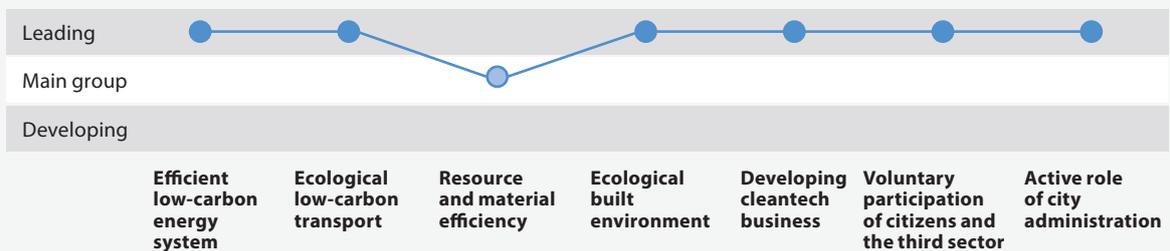


Chart 4. A summary of Stockholm's position with respect to development of the selected dimensions.

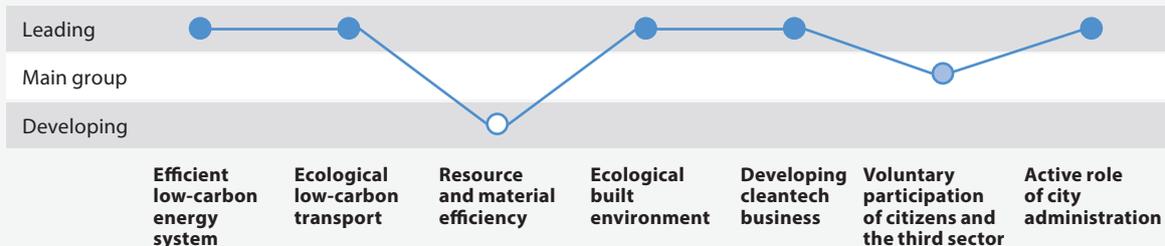


Chart 5. A summary of Amsterdam's position with respect to development of the selected dimensions.

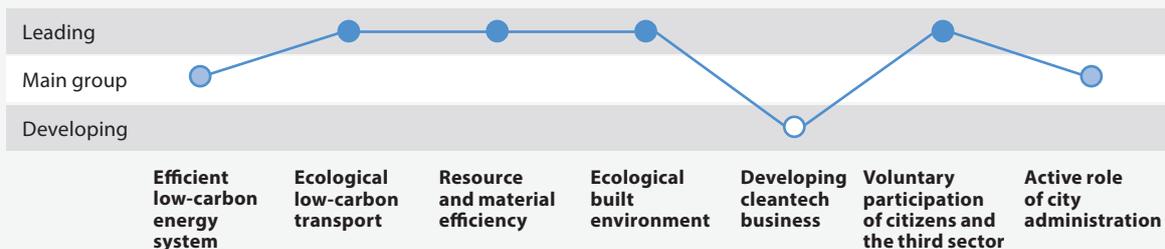


Chart 6. A summary of Vienna's position with respect to development of the selected dimensions.

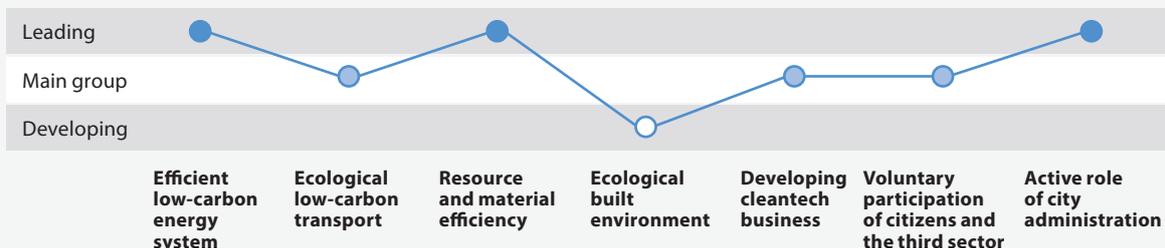


Chart 7. A summary of Bristol’s position with respect to development of the selected dimensions.

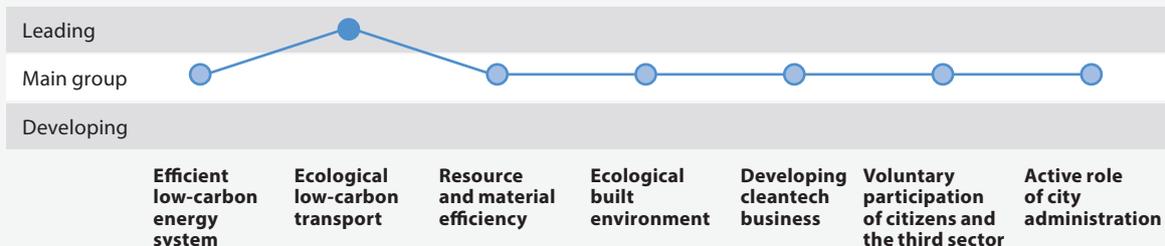


Chart 8. A summary of Tampere’s position with respect to development of the selected dimensions.

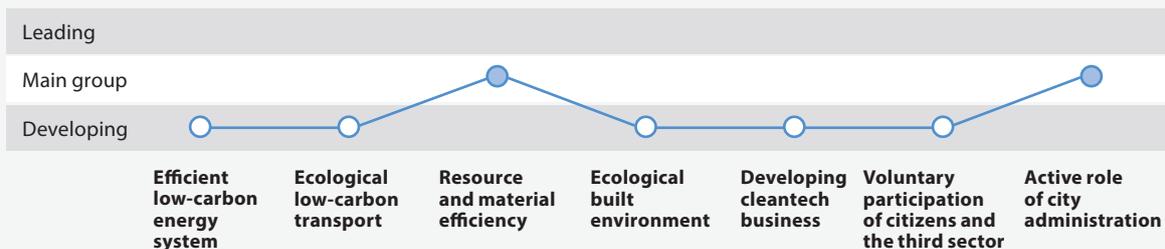
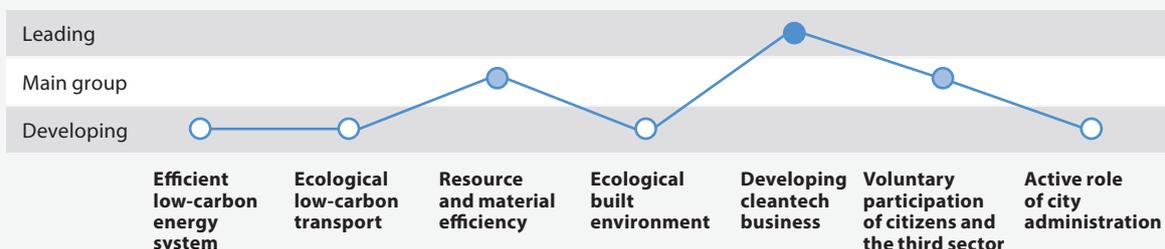


Chart 9. A summary of Vancouver’s position with respect to development of the selected dimensions.



The overall results of the benchmarking study are presented in the following table.

Table 2. A summary of the results: the position of each city/region with respect to development within each benchmarking category.

	Efficient low-carbon energy system	Ecological low-carbon transport	Resource and material efficiency	Ecological built environment	Developing cleantech business	Voluntary participation of citizens and the third sector	Active role of city administration
Leading	Copenhagen, Stockholm, Vienna	Copenhagen, Stockholm, Amsterdam, Bristol	Amsterdam, Vienna	Copenhagen, Stockholm, Amsterdam	Copenhagen, Stockholm, Vancouver	Helsinki Capital Region, Copenhagen, Amsterdam	Copenhagen, Stockholm, Vienna
Main group	Amsterdam, Bristol	Vienna	Helsinki Capital Region, Copenhagen, Vancouver, Bristol, Tampere	Helsinki Capital Region, Bristol	Vienna, Bristol	Stockholm, Vienna, Vancouver, Bristol	Helsinki Capital Region, Amsterdam, Bristol, Tampere
Developing	Helsinki Capital Region, Vancouver, Tampere	Helsinki Capital Region, Vancouver, Tampere	Stockholm (only minor differences with the main group)	Vienna, Vancouver, Tampere	Helsinki Capital Region, Amsterdam, Tampere	Tampere	Vancouver

4 Development plan for the Helsinki Capital Region

The starting point for this benchmarking study was the development of the Helsinki Capital Region into a global champion in clean energy and cleantech business. To that end, there follows a summary of the focus of the draft vision and proposed development plan. There are various dimensions upon which cities or regions are benchmarked, and various aspects to select as the main focus, such as citizens, culture, or social factors.

4.1 Proposed development plan for the Helsinki Capital Region

Based on this study, the measures necessary for the development of the Helsinki Capital Region into a leading cleantech metropolis can be classified under four cornerstones of development. The vision and four cornerstones of development are presented in figure 7.

The aim is to develop the Helsinki Capital Region into a global leader and testing ground for clean energy and

cleantech. A key issue will be the setting of ambitious, common goals by various parties (the Finnish state, the cities in the region, major companies and third sector organisations). An example of such goal-setting could be “joining the ranks of the top three cities in selected categories within international benchmarking studies of metropolitan areas during 2020-2030”.

Figure 7. Vision and cornerstones of development



It is crucial that the Helsinki Capital Region as a whole commits to the goal-setting process and that all “sing from the same hymnbook”, particularly when interacting with the international community. From the viewpoint of implementation, seamless co-operation within the capital region is of utmost importance.

The proactiveness of companies is essential in generating new cleantech business. Major companies have an important role to play, but the ultimate goal should be to

spur strong growth in the cleantech business, which will also pull SMEs and micro-sized companies along in its wake.

The key method for making the vision a reality is the joint implementation of a major programme or project that will provide the key actors with practical means to co-operate in pursuit of a common goal.

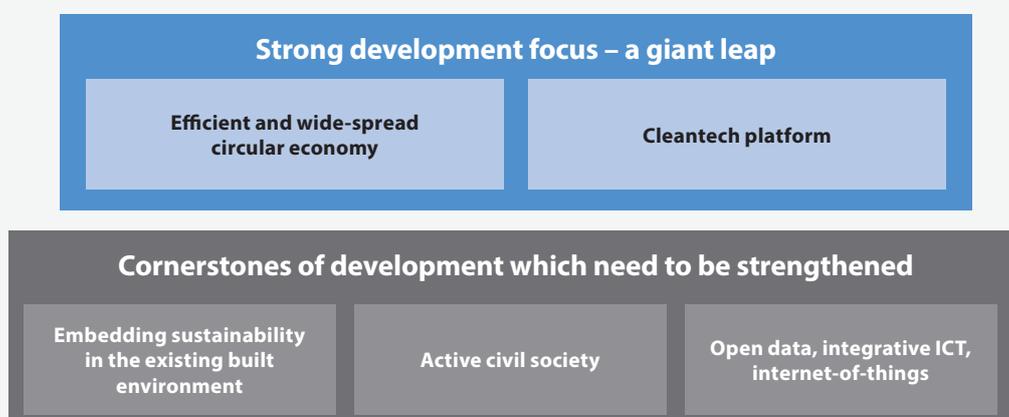
The measure options, derived from the materials used in this benchmarking study, are discussed in section 4.3.

4.2 Proposal for the Helsinki Capital Region on how to differentiate itself

Based on the strengths of the Helsinki Capital Region and the results of this benchmarking study, the proposal on how the capital region can differentiate itself from other metropolitan areas, includes five focus areas. These are presented in figure 8.

Possible measures for implementing the differentiation in practice are discussed in section 4.3.

Figure 8. Proposals for the Helsinki Capital Region on how to differentiate.



4.3 Examples and best practices derived from this comparison

Examples and best practices derived from various cities are presented in this section. These can be selectively applied to making the development vision into a reality and to differentiate the Helsinki Capital Region.

Development goal: Efficient low-carbon energy system

Examples, best practices and suggestions

- Commit companies, cities, the third sector and households to achieving ambitious goals and promoting low-carbon solutions.
- Pursue goals and targets through resolute and extensive measures that are optimised and in line with regional financial policy.
- Engage the state in key regional energy solutions.

Development goal: Low-carbon ecological transport

Examples, best practices and suggestions

- Use ICT solutions to improve the usability of public transport services and the related user experience to world-class standards.
- Step up the cultural transition towards making cars less of a status symbol.
- Increase the offering and use of car-sharing services.
- Support renewable transport fuels and expand the filling station network.

Development goal: Resource and material efficiency

Examples, best practices and suggestions

- Use communications to promote energy-sharing and a sharing economy: introduce examples from the Helsinki Capital Region and around the world; organise events.
- Highlight success stories in communications and use urban spaces to boldly showcase innovative solutions; create an operating model and provide systemic support for the active dissemination of best practices.
- Engage the third sector and reward it for generating new business functions.
- Embed resource-efficiency in public procurement processes.
- Practical examples from the public administration.

Development goal: Ecological built environment

Examples, best practices and suggestions

- Exploit the hype around eco-district developments by expanding the use of low-carbon and energy-saving solutions to cover the existing publicly and privately owned building stock and other nearby built areas.
- Significantly improve the material and energy-efficiency of old residential areas.
- Employ various projects and support mechanisms to make the best use of the existing building stock and increase its energy-efficiency.
- Introduce complementary construction as a means of increasing the self-sufficiency of areas and reducing transport-related energy use.
- Improve the resource-efficiency of new and renovation construction and recycle/reduce the generation of construction waste.
- Remove administrative barriers to the modernisation of the existing building stock.
- Promote environmental land-use planning.
- Make use of innovative funding solutions – e.g. recoup the investment from the savings generated.

Development goal: Developing cleantech business

Examples, best practices and suggestions

- Extensive commitment to advancing the achievement of short and long-term development goals for clean energy and cleantech and the related communications – create a broad-based home market and ensure that it still exists ten years from now.
- Define cleantech business focus areas in co-operation with the related actors. Identify and develop the focus area hot spots.
- Increase co-operation between companies, higher education institutions and research institutes. Activate research institutes and financial institutions in common focus areas within cleantech subareas.
- Regular “cleantech business forums” that bring together major firms, start-ups, developer communities, funders and third sector actors. Roles include brainstorming, sharing of best practices, and/or co-operation in cleantech subareas.
- Embed sustainability in public procurement processes. Innovative public acquisitions that support new business functions. Make eco-friendliness the norm!
- Make it easier to start a new business (licensing process, etc.).
- Promote and support open innovations and business ideas (e.g. through open data); identifying scalable business functions would be a priority.
- Define the brand and image of the Helsinki Capital Region, and make use of them in luring capital investment to the region.
- Highlight success stories in communications and use urban spaces to boldly showcase innovative solutions in order to lure investors and new capital.
- Acknowledge the significance of urban density in generating innovations and take account of its effect on urban planning. For example, eco-districts should be viewed as worldwide references for the companies that participate in their construction.
- Conduct user-oriented testing of the suitability of technological solutions for the urban environment.
- Use various ways of securing funding, including crowdfunding.

Development goal: Voluntary participation of citizens and the third sector

Examples, best practices and suggestions

- Significantly enhance co-operation among citizens, companies, the city and the third sector.
- Embrace digitisation and make use of open data; facilitate and support the development of applications.
- Create open innovation platforms and various living lab environments.
- Aim urban development at dense city structures – create diversity and a sufficient basis for a “buzz” to develop.
- Showcase success stories; systematic municipal support for the expansion of successful solutions.

Development goal: Active role of city administration

Examples, best practices and suggestions

- Strengthen the enabler role of cities – companies, citizens and the third sector act, with the city administration creating the platform.
- Provide companies, citizens and the third sector with the opportunity to influence decision-making and take effective advantage of their special competencies.
- Transparency of the city administration’s development goals and results.
- Systematic and active communications. Educational and motivational campaigns on how to become environmentally friendly in one’s action and lifestyle.
- Low-carbon options chosen by public administration. Embed environmental policy in the practical, everyday activities of the city’s administration.
- Exchange of low-carbon best practices between local government administrations. Motivate employees to become environmentally conscious both at work and during leisure time.

5 Concluding remarks and further steps

The main focus of this study was on evaluating the current status of the Helsinki Capital Region in terms of the development of clean energy and cleantech business, and to identify areas in which the region can play a pioneering role. Some obvious development targets were also identified. The Helsinki Capital Region was benchmarked against the world's leading cities and regions in the fields of clean energy and cleantech. On the basis of the resulting ranking, a development plan was proposed for the Helsinki Capital Region.

Towards the end of the study, the first further steps were identified in a joint workshop attended by the representatives of Ramboll Management Consulting Oy, who conducted the study, and some key persons from the Finnish Innovation Fund Sitra.

- The goal-setting process will be crystallised by key actors in the Helsinki Capital Region. As a firm foundation for the definition of a goal-setting process that is as ambitious as possible, it is recommended that a summary be drawn up of the opinions of city leaders and key firms and operators (e.g. regional bodies HSL and HSY).
- At the same time, the study recommends the creation of structures and operating models aimed at creating cohesion and co-operation within the Helsinki Region, while promoting clean energy and the cleantech business and firming up the related common goals.
- It is essential that a major action plan or project covering the entire Helsinki Capital Region be launched without delay – for the practical implementation of the common goals set – which includes demonstrations of co-operation structures and operating models within the capital region. An integral part of implementation is communication within the Helsinki Capital Region, but external communication is also of utmost importance.

It should be noted that the results presented and the conclusions made by those participating in this study are primarily intended to serve as guidelines and input for further steps in the goal-setting process and planning of future action for the Helsinki Capital Region. However, it should also be noted that although the preliminary results of this study have passed through several rounds of discussion, no changes to the main conclusions have been proposed. The same applies to the commenting rounds associated with this report. We would therefore be justified in using the “big picture” derived from this study as a basis for planning further steps.

Whatever lies ahead, the vision and spirit that will guide us as we move forward can be summarised in the words of one of the workshop participants: “Yes we can. The Helsinki Capital Region has taken its cue from others – and we will soon leave them all far behind us.”

Why not indeed?

Appendix 1

European Green City Index (EIU/Siemens, 2009) results by category

Overall		CO ₂		Energy		Buildings	
City	Score	City	Score	City	Score	City	Score
1 Copenhagen	87.31	1 Oslo	9.58	1 Oslo	8.71	=1 Berlin	9.44
2 Stockholm	86.65	2 Stockholm	8.99	2 Copenhagen	8.69	=1 Stockholm	9.44
3 Oslo	83.98	3 Zurich	8.48	3 Vienna	7.76	3 Oslo	9.22
4 Vienna	83.34	4 Copenhagen	8.35	4 Stockholm	7.61	4 Copenhagen	9.17
5 Amsterdam	83.03	5 Brussels	8.32	5 Amsterdam	7.08	5 Helsinki	9.11
6 Zurich	82.31	6 Paris	7.81	6 Zurich	6.92	6 Amsterdam	9.01
7 Helsinki	79.29	7 Rome	7.57	7 Rome	6.40	7 Paris	8.96
8 Berlin	79.01	8 Vienna	7.53	8 Brussels	6.19	8 Vienna	8.62
9 Brussels	78.01	9 Madrid	7.51	9 Lisbon	5.77	9 Zurich	8.43
10 Paris	73.21	10 London	7.34	10 London	5.64	10 London	7.96
11 London	71.56	11 Helsinki	7.30	11 Istanbul	5.55	11 Lisbon	7.34
12 Madrid	67.08	12 Amsterdam	7.10	12 Madrid	5.52	12 Brussels	7.14
13 Vilnius	62.77	13 Berlin	6.75	13 Berlin	5.48	13 Vilnius	6.91
14 Rome	62.58	14 Ljubljana	6.67	14 Warsaw	5.29	14 Sofia	6.25
15 Riga	59.57	15 Riga	5.55	15 Athens	4.94	15 Rome	6.16
16 Warsaw	59.04	16 Istanbul	4.86	16 Paris	4.66	16 Warsaw	5.99
17 Budapest	57.55	=17 Athens	4.85	17 Belgrade	4.65	17 Madrid	5.68
18 Lisbon	57.25	=17 Budapest	4.85	18 Dublin	4.55	18 Riga	5.43
19 Ljubljana	56.39	19 Dublin	4.77	19 Helsinki	4.49	19 Ljubljana	5.20

Transport		Water		Waste and land use		Air quality		Environmental governance	
City	Score	City	Score	City	Score	City	Score	City	Score
1 Stockholm	8.81	1 Amsterdam	9.21	1 Amsterdam	8.98	1 Vilnius	9.37	=1 Brussels	10.00
2 Amsterdam	8.44	2 Vienna	9.13	2 Zurich	8.82	2 Stockholm	9.35	=1 Copenhagen	10.00
3 Copenhagen	8.29	3 Berlin	9.12	3 Helsinki	8.69	3 Helsinki	8.84	=1 Helsinki	10.00
4 Vienna	8.00	4 Brussels	9.05	4 Berlin	8.63	4 Dublin	8.62	=1 Stockholm	10.00
5 Oslo	7.92	=5 Copenhagen	8.88	5 Vienna	8.60	5 Copenhagen	8.43	=5 Oslo	9.67
6 Zurich	7.83	=5 Zurich	8.88	6 Oslo	8.23	6 Tallinn	8.30	=5 Warsaw	9.67
7 Brussels	7.49	7 Madrid	8.59	7 Copenhagen	8.05	7 Riga	8.28	=7 Paris	9.44
8 Bratislava	7.16	8 London	8.58	8 Stockholm	7.99	8 Berlin	7.86	=7 Vienna	9.44
9 Helsinki	7.08	9 Paris	8.55	9 Vilnius	7.31	9 Zurich	7.70	9 Berlin	9.33
=10 Budapest	6.64	10 Prague	8.39	10 Brussels	7.26	10 Vienna	7.59	10 Amsterdam	9.11
=10 Tallinn	6.64	11 Helsinki	7.92	11 London	7.16	11 Amsterdam	7.48	11 Zurich	8.78

Categories, indicators and their weightings (EGCI)					
Category	Indicator	Type	Weighting	Description	Normalisation technique
CO ₂	CO ₂ emissions	Quantitative	33%	Total CO ₂ emissions, in tonnes per head.	Min-max.
	CO ₂ intensity	Quantitative	33%	Total CO ₂ emissions, in grams per unit of real GDP (2000 base year).	Min-max; lower benchmark of 1,000 grams inserted to prevent outliers.
	CO ₂ reduction strategy	Qualitative	33%	An assessment of the ambitiousness of CO ₂ emissions reduction strategy.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Energy	Energy consumption	Quantitative	25%	Total final energy consumption, in gigajoules per head.	Min-max.
	Energy intensity	Quantitative	25%	Total final energy consumption, in megajoules.	Min-max; lower benchmark of 8MJ/€GDP inserted to prevent outliers (in euros, 2000 base year).
	Renewable energy consumption	Quantitative	25%	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption, in terajoules.	Scored against an upper benchmark of 20% (EU target).
	Clean and efficient energy policies	Qualitative	25%	An assessment of the extensiveness of policies promoting the wise use of clean and efficient energy.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Buildings	Energy consumption or residential buildings	Quantitative	33%	Total final energy consumption in the residential sector, per square metre of residential floor space.	Min-max.
	Energy-efficient buildings standards	Qualitative	33%	An assessment of the extensiveness of cities' energy efficiency standards for buildings.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
	Energy-efficient buildings initiatives	Qualitative	33%	An assessment of the extensiveness of efforts to promote energy efficiency of buildings.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Transport	Use of non-car transport	Quantitative	29%	The total percentage of the working population travelling to work on public transport, by bicycle and by foot.	Converted to a scale of 0 to 10.
	Size of non-car transport network	Quantitative	14%	Length of cycling lanes and the public transport network, in km per square metre of city area.	Min-max. Upper benchmarks of 4 km/km ² and 5 km/km ² inserted to prevent outliers.
	Green transport promotion	Qualitative	29%	An assessment of the extensiveness of efforts to increase the use of cleaner transport.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
	Congestion reduction policies	Qualitative	29%	An assessment of efforts to reduce vehicle traffic within the city.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Water	Water consumption	Quantitative	25%	Total annual water consumption, in cubic metres per head.	Min-max.
	Water system leakages	Quantitative	25%	Percentage of water lost in the water distribution system.	Scored against an upper target of 5%.
	Waste water treatment	Quantitative	25%	Percentage of dwellings connected to the sewage system.	Scored against an upper benchmark of 100% and a lower benchmark of 80%.
	Water efficiency and treatment policies	Qualitative	25%	An assessment of the comprehensiveness of measures to improve the efficiency of water usage and the treatment of wastewater.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Waste and land use	Municipal waste production	Quantitative	25%	Total annual municipal waste collected, in kg per head.	Scored against an upper benchmark of 300 kg (EU target). A lower benchmark of 1,000 kg inserted to prevent outliers.
	Waste recycling	Quantitative	25%	Percentage of municipal waste recycled.	Scored against an upper benchmark of 50% (EU target).
	Waste reduction and treatment policies	Qualitative	25%	An assessment of the extensiveness of measures to reduce the overall production of waste, and to recycle and reuse waste.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
	Green land use policies	Qualitative	25%	An assessment of the comprehensiveness of policies to contain the urban sprawl and promote the availability of green spaces.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Air quality	Nitrogen dioxide	Quantitative	20%	Annual daily mean of NO ₂ emissions.	Scored against a lower benchmark of 40 ug/m ³ (EU target).
	Ozone	Quantitative	20%	Annual daily mean of O ₃ emissions.	Scored against a lower benchmark of 120 ug/m ³ (EU target).
	Particulate matter	Quantitative	20%	Annual daily mean of PM ₁₀ emissions.	Scored against a lower benchmark of 50 ug/m ³ (EU target).
	Sulphur dioxide	Quantitative	20%	Annual daily mean of SO ₂ emissions.	Scored against a lower benchmark of 40 ug/m ³ (EU target).
	Clean air policies	Qualitative	20%	An assessment of the extensiveness of policies to improve air quality.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
Environmental governance	Green action plan	Qualitative	33%	An assessment of the ambitiousness and comprehensiveness of strategies to improve and monitor environmental performance.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
	Green management	Qualitative	33%	An assessment of the management of environmental issues and commitment to achieving international environmental standards.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.
	Public participation in green policy	Qualitative	33%	An assessment of the extent to which citizens may participate in environmental decision-making.	Scored by Economist Intelligence Unit analysts on a scale of 0 to 10.

Appendix 2

Benchmark city fact sheets

Appendix 2.1 Fact Sheet: Copenhagen

- CO₂ emissions per capita: 5.38 tonnes a year
- Share of municipal waste recycled: 23.61%
- Energy consumption per capita: 80.63 gigajoules
- Share of waste recycled: 55%
- Percentage of renewable energy consumed by the city: 18.76%

In general, this information is based on the European Green City Index (Economist Intelligence Unit, sponsored by Siemens, 2009). The main focus here is on the development goals set and how well they were met. The data may relate to a city or region; in some cases, it is possible that the data sources used in this study made no distinction between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- Improvement of energy-efficiency has been a long-term goal in Copenhagen. In the 2009 climate strategy, the target for reducing CO₂ emissions was set at 20% by 2015 (from the 2005 level). Special attention should be paid to Copenhagen's ambitious goal of becoming a carbon-neutral city by 2025 (if this goal is met, it will be the first of its kind in Europe).
- Denmark's energy policy is about becoming less carbon and oil intensive and moving towards renewable energy sources. Setting national goals is important, and one of these key goals concerns deriving 30% of all energy from renewable sources by 2025.
- The climate and low-carbon targets set by Copenhagen exceed the national target levels. In terms of national policy, Copenhagen is a forerunner. Copenhagen aims to be a carbon-neutral city by 2025. The transition to low-carbon energy production means an increase in energy prices. Old buildings are being retrofitted to improve their energy efficiency, and various methods are being used to reduce energy consumption in order to curb the cost of the transition.
- It is estimated that 75% of the emission reductions required to meet the 2025 target will be achieved by switching to low-carbon energy sources for heating and electricity. Copenhagen's district cooling plant in Adelgade is an example of a new low-carbon solution. The plant uses seawater in its district cooling system for buildings. The projected outcome of the Copenhagen Climate Plan is that all district heating will be carbon-neutral by 2025. (Gerdes, 2013) Some 60,000 square metres of solar panels will be installed on city-owned buildings by 2025 (City of Copenhagen, 2012a).
- Copenhagen has listed the following 2025 targets for reducing energy consumption:
 - 20% less consumption for heating;
 - 20% less electricity consumed by retail and service sector companies;
 - 10% less electricity consumed by households;
 - 1% of demand for electricity met using solar panels.

The baseline for the reduction targets is the 2010 level. (City of Copenhagen, 2012c)
- The goal is that, by 2025, power generated in Copenhagen for electricity and heating will be based on wind power, biomass, waste (e.g. incineration) and geothermal energy (City of Copenhagen, 2012a).
- The use of diverse energy sources is emphasised in energy generation. Target 2025:
 - district heating will be carbon-neutral;
 - electricity generation from wind power and biomass will exceed demand for electricity;
 - plastic waste from households and businesses will be sorted;
 - the possibility will be investigated of using organic waste in biomass production. (City of Copenhagen, 2012a)
- The goal is that heating in Copenhagen will be carbon-neutral by 2025, with a switch to mainly using biomass and geothermal energy. The Amager and Avedøre power plants will be converted into biomass plants and a new biomass-based CHP plant will be built in Copenhagen. (City of Copenhagen, 2012a)
- Copenhagen has an extensive district-heating network. Water from the harbour is used in district cooling systems for office spaces, shopping centres, hotels and data centres. (Gerdes, 2013)
- The City of Copenhagen aims to build more than 100 new wind turbines by 2025, both on land and at sea. The city is striving to engage local residents in wind power projects, urging them to become shareholders. The intention is to build wind turbines in other municipalities too. (City of Copenhagen, 2012a)
- In August 2012, Copenhagen City Council approved plans to convert coal-fired power plants into biomass plants, to increase wind and solar power's share of overall power generation, and to begin repairing old buildings.

Appendix 2.1 Fact Sheet: Copenhagen

More facts:

- CO₂ emissions: 2.12 million tonnes a year (C40 Cities, 2014)
- CO₂ emissions per capita: 5.38 tonnes (Economist Intelligence Unit, 2009)
- Energy consumption per capita: 80.63 gigajoules
- Percentage of renewable energy consumed by the city: 18.76% (Economist Intelligence Unit, 2009)
- Between 2005 and 2011, Copenhagen managed to reduce its emissions by 21%. The city's carbon dioxide emissions currently amount to approximately two million tonnes a year. In line with the emission targets approved in 2012, the goal is to reduce that amount to approximately 400,000 tonnes by 2025. (City of Copenhagen, 2012c)
- Wind power accounts for some 30% of current total electricity production in Denmark. The aim is to raise that share to 50% by 2020. (Gerdes, 2013)
- It should be noted that energy for electricity and heating in Copenhagen is sourced from coal-fired power plants in Amager and Avedøre. The heat generated by these plants is fed into the district-heating network. The plants operate at 90% of their capacity. (Gerdes, 2013)

Ecological low-carbon transport

- Copenhagen has a strong cycling culture and the city authorities are striving to make cycling as attractive as possible. The city has set the goal of becoming “the world’s best city for cycling”, and aims to increase the proportion of residents who ride their bikes to work from 36% to 50% by 2015.
- It has been estimated that, during peak hours, there are 20,000 cyclists on the city’s streets. Copenhagen has roughly 400 kilometres of bicycle routes (Gerdes, 2013). A key method used to promote cycling is the construction of bike corridors, of which the 17 km connection between Albertslund and Copenhagen is a prime example.
- Copenhagen has an excellent public transport infrastructure and services. Copenhagen has a high-quality cycling infrastructure.
- The City of Copenhagen aims to increase the use of biofuels in public transport buses (Gerdes, 2013).
- The aim is that, by 2025, 20-30% of all small vehicles will be powered by electricity, hydrogen, biogas or bioethanol. The corresponding number of heavy vehicles is 30-40%. (Gerdes, 2013)
- The aim is that, by 2025, all vehicles in Copenhagen will be powered by electricity, hydrogen, or another alternative fuel option (City of Copenhagen, 2012a).
- The aim is that, by 2025, all city-owned vehicles will be powered by electricity or hydrogen. The City of Copenhagen will build an electric and hydrogen vehicle-charging network. (City of Copenhagen, 2012a)
- The goal is to develop Copenhagen into a piloting platform for heavy vehicles powered by alternative fuels (City of Copenhagen, 2012a).
- The goal is to implement all transport services contracted out to external service providers on the basis of vehicles that are not powered by fossil fuels (City of Copenhagen, 2012a).

More facts:

- Total percentage of citizens walking, cycling or using public transport to get to work: 68%.
- Copenhagen has an extensive public transport network. Nearly every resident of Copenhagen lives within 350 metres of public transport (Economist Intelligence Unit, 2009).

Resource and material efficiency

- Development goal: Copenhagen aims to reduce the per capita water consumption of its households from the 2007 level of 114 litres a day to 100 litres a day by 2012.
- Measures: the City of Copenhagen spends roughly EUR 270,000 a year on programmes and projects aimed at reducing water consumption.
- Incineration of waste for energy generation is viewed as an example of resource-efficiency. A new waste incineration plant to be built in Copenhagen will generate enough heat and electricity to satisfy the needs of 150,000 households (Gerdes, 2013).
- Target 2025:
 - *new high-tech waste treatment plant;*
 - *organic waste collection and its processing into biogas;*
 - *plastics sorted for recycling (City of Copenhagen, 2012d).*

More facts:

- Share of municipal waste recycled: 23.61%.
- Share of waste recycled: 55%.
- Annual water consumption per capita: 147 m³ (Economist Intelligence Unit, 2009).

Appendix 2.1 Fact Sheet: Copenhagen

Ecological built environment

- Copenhagen's land use and construction policy favours the exploitation and re-purposing of old city districts. In construction and land use, the main goal is to make active use of existing spaces. Old industrial sites are being converted into residential areas and 80% of new developments are being built on "brownfield sites", such as harbours. The City of Copenhagen aims to actively exploit the existing urban space and environment in order to reduce energy consumption and the need for public transport. (Economist Intelligence Unit, 2009)
- Despite its advanced age, Denmark's building stock is energy-efficient. The annual energy consumption of residential buildings is 554 megajoules per square metre. Nearly all buildings in Copenhagen are connected to the district heating network.
- The aim is to enhance the energy-efficiency of old buildings. Improvements will be made to the old building stock, and the city aims to upgrade the energy-efficiency of its own buildings. Around DKK 1.4 billion (EUR 187 million) will be invested in enhancing the energy-efficiency of old buildings. It is estimated that energy savings will generate EUR 80 million in financial savings.
- New buildings constructed in Copenhagen must comply with the national regulations on low-energy construction. According to the 2020 energy standards for construction, new buildings must be highly energy-efficient. (Gerdes, 2013)
- The city aims to reduce the energy consumption of municipal buildings by 40% by 2025 (City of Copenhagen, 2012a).
- The energy consumption reduction target for street lighting is 50% by 2025 (City of Copenhagen, 2012a). LEDs will be installed in all street lighting. The estimated cost of the changes is DKK 270 million (EUR 36 million). It is estimated that energy savings will generate financial savings of DKK 140 million (EUR 19 million) (City of Copenhagen, 2012a).
- Regarding its own operations, the City of Copenhagen is carrying out various projects and schemes to achieve a 10% reduction in CO₂ emissions.

Developing cleantech business

- Foundations for the success of the cleantech business in Denmark include Copenhagen's ambitious climate targets and sustainable development strategies. These have created new opportunities for the cleantech business throughout the country.
- Green technology exports have increased markedly in the Copenhagen region. Between 2004 and 2009, the industry's 77% growth rate was unparalleled by other sectors.
- In 2004-2009, the green technology sector's turnover outstripped that of other sectors (OECD, 2012, p. 3).
- The City of Copenhagen, energy companies, architectural offices, construction companies and other interested parties have jointly launched two flagship projects for building carbon-neutral residential areas. The outcome will be two pioneering city districts. Construction work emphasises low-energy solutions, renewable energy sources and environmental modes of transport. One of these pioneering districts is the neighbourhood of Amager Faelled, south of Copenhagen. Plans for the areas include the construction of 300,000 square metres of residential and office spaces and buildings. The other is Nordhavn, a 200-hectare area in the city's harbour district.
- Copenhagen promotes cleantech business ventures by local companies, through the Copenhagen Cleantech Cluster's Complex Cleantech Solutions project. The related activities are formed around a cluster, with the aim of combining the offering of individual companies in order to provide a solution suitable for solving the target city's problem.
- The Copenhagen region is home to more than 500 cleantech companies. Copenhagen has set three clearly-defined development focus areas: Smart Grid, Water and Wind. The partners of Copenhagen's cleantech cluster include IBM, Ramboll, Siemens and PwC.
- In 2011, the cleantech sector employed 34,000 people. According to the OECD (2012), in 2012 approximately EUR 12 billion of the turnover of companies operating in the Copenhagen region was based on the cleantech business. The OECD states that the Copenhagen Cleantech Cluster is the key to cleantech business growth in Copenhagen.
- A key role is played by companies' contacts with funding sources. Funding represents a key challenge for cleantech companies. The Copenhagen Investment Agency ("Copenhagen Capacity") is a key funder. Small and medium-sized enterprises (SMEs) have a hard time securing funding. They also find it hard to obtain information and advice. Another challenge facing SMEs lies in finding venture capital. The Nordic Investment Bank (NIB) has issued guarantees for the purpose of supporting the development of new technologies related to energy-efficient processes and emission reduction, for example. According to the OECD (2012), the Copenhagen Cleantech Cluster has increased the number of foreign direct investments (FDI) in cleantech companies operating in Copenhagen. The OECD also states that Copenhagen's brand and image in the cleantech sector are a key component in attracting venture capital investments to the city. (OECD, 2012)
- Copenhagen showcases the city's new green symbols, such as the well-established bicycle use and harbour swimming basins. The idea is that showcasing the city's achievements will attract more investment, bringing new capital and thereby contributing to the emergence of other new technologies and solutions. The objective is to paint a picture of Copenhagen as a laboratory for creating new products and solutions, thereby attracting more actors and financing to the city. Copenhagen's ambitious environmental goals are promoting the achievement of this objective.

Appendix 2.1 Fact Sheet: Copenhagen

Voluntary participation of citizens and the third sector

- The people of Copenhagen are active promoters of a low-carbon future. Half of the wind turbines at the Middelgrunden wind farm near the Harbour of Copenhagen were financed through private investments (Gerdes, 2013). Citizens' knowledge capital is an important element in the development of the city. Copenhagen actively develops ways of effectively harnessing inhabitants' expertise, knowledge and suggestions for practical use.
- Copenhagen makes use of smart phones and ICT, and aims to establish various feedback mechanisms for the use of its residents. Residents are provided with services for reporting on graffiti, litter, or infrastructure failures. Applications are one way of committing citizens to taking care of their home towns. Residents are provided with a service through which they can suggest ways of increasing energy-efficiency and promoting a low-carbon society.
- Copenhagen aims to give citizens a voice through the following methods:
 - *Digitising all communications between the authorities, public administration and companies.*
 - *Easing access to public and private information, for example by increasing the openness of data (Copenhagen Cleantech Cluster, 2013).*

Active role of city administration

- Copenhagen is a member of the C40 Cities Climate Leadership Group. The C40 cities are committed to combating climate change. They aim to reduce greenhouse gases through co-operation, information exchange, and goal-oriented actions.
- Regarding its own operations, the City of Copenhagen is engaged in various projects and schemes aimed at achieving a 10% reduction in CO₂ emissions. These include improvements to the old building stock and retrofitting all municipal buildings.
- Copenhagen is steering its residents towards a more ecological lifestyle. The city has set itself the goal of becoming "the world's best city for cycling", and aims to increase the proportion of residents who cycle to work from 36% to 50% by 2015.
- The City of Copenhagen aims to actively exploit its existing urban space and environment in order to reduce energy consumption and the need for public transport.
- Copenhagen's climate commitments are widely recognised in various city indices. The City of Copenhagen's decision-making processes are characterised by determined and widely co-ordinated action towards meeting low-carbon and energy-efficiency targets. Each city department has a municipally appointed person responsible for environmental affairs, who ensures that procedures are coherent and best practices are shared.
- The climate and environmental expertise of the City of Copenhagen receives special attention. The city has striven to integrate environmental management into all of its functions and the administration. A person responsible for environmental affairs has been appointed within each administrative unit. These officers meet on a regular basis to share their expertise and experiences. The city council also has an environmental department, which citizens can contact directly to present environmentally related complaints, concerns and ideas.
- Copenhagen actively encourages its residents to participate in the promotion of a low-carbon society. Campaigns for boosting citizen engagement are one way of motivating the city's residents to change their lifestyles. Trying to influence people's lifestyles is an important method of promoting sustainable development.
- It is estimated that attaining Copenhagen's 2025 climate targets will cost the City of Copenhagen USD 472 million (in direct investments). Add in private funding, and the total investment will amount to roughly USD 4.78 billion. (City of Copenhagen, 2012b; Gerdes, 2013)
- Several cross-border networks among municipalities have been formed in the Copenhagen region, for the promotion of low-carbon solutions and sustainable development.
- The City of Copenhagen is aware of the impact that public procurement can have. Its purchases are aimed at promoting low-carbon solutions and making the markets more environmentally friendly. These efforts include enhancing the energy-efficiency of old buildings. (City of Copenhagen, 2012a)
- The city strives to step up environmental awareness through close co-operation with universities and institutions of higher education, in order to promote the achievement of low-carbon targets. Best practices are disseminated on the broadest possible basis. The city strives to form partnerships with the private and public sectors and institutions of higher education, thus promoting the introduction of new technologies, new services and low-carbon expertise. Communications on climate targets, educational campaigns and campaigning aimed at encouraging pro-environmental behaviour are used in the promotion of a low-carbon lifestyle. The city also encourages its 45,000 employees to be environmentally friendly, both at work and during leisure time. (City of Copenhagen, 2012a)

Appendix 2.2 Fact Sheet: Stockholm

- CO₂ emissions per capita: 3.62 tonnes (in 2007)
- Energy consumption per capita: 104.88 gigajoules
- Over 60% of electricity consumed by the city, and approximately 20% of overall energy consumption, comes from renewable sources.
- Total percentage of citizens walking, cycling or taking public transport to work: 93%
- Share of waste recycled: 31%

In general, the data is based on the European Green City Index (Economist Intelligence Unit, sponsored by Siemens, 2009). The main focus here is on the development goals set and how well they were met. The data may relate to a city or a region; in some cases, it is possible that the data sources used in this study make no distinction between the two. A list of references is provided in appendix 3.

Efficient low-carbon energy system

- Stockholm has set itself the long-term goal of becoming a fossil fuel-free city by 2050. This includes specific requirements related to residential and office buildings, as well as transport and the energy production sector.
- The aim is to reduce construction industry energy consumption by 50% by 2050, compared to the 1990 baseline (Environment and Health Administration, 2012).
- Based on various methods of improving energy efficiency, the energy consumption of Stockholm's city organisation will be reduced by at least 10% by 2015 (compared to the 2011 level).
- CO₂ emissions: Stockholm will seek to reduce its annual emissions to a maximum of three tonnes of CO₂ per capita by 2015.

Other goals:

- At least 50% of energy is derived from renewable sources.
- Greenhouse gas emissions will be reduced by at least 40%, compared to the 1990 baseline (Environment and Health Administration, 2012).
- Under the Stockholm Environmental Programme 2012-2015, the city has set the following low-carbon targets:
 - Various methods of improving energy-efficiency will be used to reduce the energy consumption of Stockholm's city organisation by at least 10% by 2015 (compared to the 2011 level).
 - Electricity purchased by the city must comply with the Swedish Environmental Management Council's criteria:
 1. *Minor climate impact*
 2. *Clean air*
- The renewable energy support models in use in Sweden include the green certificate system, investment systems and aids for supporting wind power and solar energy, as well as tax relief granted to renewable energy producers. Tax relief is granted in support of the use of biofuels in heat production (Finnish Energy Industries, 2011). Sweden adopted the green certificate system and wind power investment aid system in 2003, and introduced solar energy subsidies in 2009. Based on reports submitted to the EU, it can be roughly estimated that while Finland's renewable energy subsidies have ranged between EUR 50 and 100 million in recent years subsidies received by Sweden have totalled up to five times as much. (European Commission, 2013)

Current state:

- Estimate 1: CO₂ emissions per capita: 3.62 tonnes (Economist Intelligence Unit, 2009).
- Estimate 2: CO₂ emissions: 3.19 million tonnes a year (C40 Cities, 2014).
- Energy consumption per capita: 104.88 gigajoules (Economist Intelligence Unit, 2009).
- Percentage of renewable energy consumed by the city: 20.08% (Economist Intelligence Unit, 2009).
- Over 60% of electricity consumed by the city and approximately 20% of overall energy consumption is based on renewable sources (Economist Intelligence Unit 2009; C40 Cities 2014).

Appendix 2.2 Fact Sheet: Stockholm

Ecological low-carbon transport

- Stockholm is a pioneer in the field of green public transport. It was the third major city in the world, after London and Singapore, to introduce a congestion charge for drivers. The congestion charge system was successfully implemented and now covers the whole city. Based on the successful introduction of the congestion charge, Stockholm was a 2013 City Climate Leadership Awards finalist in the Urban Transportation category. The introduction of the congestion charge has led to a 20% drop in the total flow of traffic in and out of the inner city, and a reduction in CO₂ emissions related to vehicle use of between 10 and 14% (C40 Cities & Siemens, 2013).
- 75% of Stockholm's public transport equipment is powered by renewable energy (Economist Intelligence Unit, 2009).
- Stockholm is guided by Sweden's national low-carbon targets. In terms of transport, the goal is for Sweden's vehicle stock to become carbon-neutral by 2030, i.e. to end the use of fossil fuels (Environment and Health Administration, 2012).
- The Stockholm Environment Programme 2012-2015 includes several ways of promoting green public procurement. The environmental programme includes the following transport-related goals:
 - *Municipal vehicles, whether owned or leased, will be environmentally certified.*
 - *Biofuel-powered and hybrid vehicles should use at least 85% renewable fuels.*
 - *When the city contracts transport services out to an external partner, at least 55% of the transport/vehicles in question should be green.*
- The Clean Vehicles in Stockholm Initiative promotes the use of hybrid and biofuel vehicles and expansion of the use of clean energy in transport. The initiative's goals are as follows: by the end of 2010 all of the municipality's own vehicles will be clean and 35% of new-car sales will comprise clean vehicles.

Other facts:

- Total percentage of citizens walking, cycling or taking public transport to get to work: 93%
- 75% of Stockholm's public transport fleet is powered by renewable energy (Economist Intelligence Unit, 2009).

Resource and material efficiency

- The Stockholm Environment Programme 2012-2015 lists the following ambitious goals for steering the city's public purchasing processes towards improving resource and material efficiency:
 - *The departments of Stockholm's city organisation aim to minimise the amount of waste generated through their procurement activities, by requiring the use of packaging materials that produce the minimum amount of waste.*
 - *At least 25% of food purchases made by the City of Stockholm must constitute organically produced foods.*
 - *Hazardous materials and pollutants, such as PVC, will be avoided in new buildings. The City aims to minimise the environmental impact arising from hazardous materials and pollutants in old buildings.*
- Stockholm's long-term goal is to be free of fossil fuels by 2050 at the latest. This includes specific requirements for residential and office buildings, as well as transport and the energy production sector.
- In 2006, Stockholm City Council approved a water strategy that listed methods of reducing water consumption in the city.
- Departments in Stockholm's city administration must avoid the use of environmentally hazardous chemicals and substances. The purchasing processes of the city council and its external suppliers must comply with the Bra Miljöval and EU Ecolabel environmental labelling criteria of the Swedish Environmental Management Council.
- Considerable amounts of waste are generated in Stockholm.

More facts:

- Share of waste recycled: 31% (Economist Intelligence Unit, 2009).

Ecological built environment

- Sweden is a pioneering country with respect to energy-efficient building standards, as seen in the City of Stockholm's successful creation of an energy-efficient built environment. Building stock energy-efficiency requirements and construction incentives are effective steering instruments in encouraging a shift towards more energy-efficient construction and the modernisation of existing buildings. By 2030, the energy-efficiency of buildings will be improved by 20%, compared to the 1990 baseline. (Environment and Health Administration, 2012)
- The Stockholm Environment Programme 2012-2015 lists the following goals:
 - *The City of Stockholm aims to reduce the energy consumption of new buildings, limiting such consumption to a maximum of 55 kWh/m².*
 - *The city is a major client of construction, renovation and maintenance contractors. All construction work must comply with at least one of the following environmental monitoring criteria used to ensure that construction work and buildings are environmentally friendly: Basta, Svaven, Bra Miljöval, EU Ecolabel.*

Appendix 2.2 Fact Sheet: Stockholm

Developing cleantech business

- The Stockholm Cleantech business network was established in 2005. The city boasts the largest cleantech cluster in Scandinavia. Its focus areas include biogas, ocean energy and smart grids.
- The City of Stockholm has harnessed its public procurement in support of the network. Three key areas for promoting cleantech business are: Stockholm Royal Seaport, Hammarby Sjöstad and Högdalen.
- Cutting-edge ecological city districts have been built in Stockholm, with more on the way. The city has invested significant sums of money in the construction of these areas. The related construction costs have been substantial. The City of Stockholm has invested almost USD 1 million in the construction of Hammarby Sjöstad. This represents around 15% of the total investment. (Floater et al., 2013)
- One of the ongoing projects is the Stockholm Royal Seaport area. The City managed to partner with major firms for this project. A newly established local innovation centre is helping to link the partners together. They include major players such as Ericsson, Fortum, ABB and Electrolux. These firms view participation in the development of this area as important to their own operations, for reasons such as product development. Such co-operation is characterised by the emergence of and the search for new types of consortia. Technological innovators, urban planners, ICT experts and city administration staff need to find a way of working together. Implemented projects are referred to as demonstrations.
- New technological solutions are being widely applied in the project areas. Businesses have noticed that Hammarby Sjöstad serves as an important reference around the world. The area is widely considered a "best practice" showcase, attracting worldwide attention. There is demand for broad-based projects such as Hammarby Sjöstad, which make use of new technologies and solutions, because they enable companies to develop new technologies. The costs associated with such development work are huge. Luckily, the City of Stockholm has been able to support product development among companies by bearing some of the risks.
- The overall brand of Sweden as a green technology country has also boosted Swedish companies' export activities (Floater et al., 2013). The City of Stockholm's strong commitment to a low-carbon policy is important to fostering green thinking in the city region's assessment of the environmental impact of city organisations. Strengthening the integration of environmental aspects into the city's daily decision-making processes is crucial to boosting demand for new and innovative low-carbon solutions. For local businesses, the city's commitment to low-carbon options in procurement, construction and other activities will mean growing markets for their products and solutions. The Stockholm Environment Programme 2012-2015 lists ambitious goals for steering the city's procurement processes towards greater resource and material efficiency.

Voluntary participation of citizens and the third sector

- City organisations' activities are aimed at encouraging local residents to commit to the development of their home town. The city uses various campaigns to provide local residents with information on its activities. One of the main goals of Vision 2030 for Stockholm is "the citizens' Stockholm". The aim is to create a Stockholm with abundant green areas and which is accessible to everyone. Citizens are playing a key role in the vision of a low-carbon Stockholm of the future. The impact of various policy actions on the everyday lives of citizens will be systematically assessed as part of the development process towards a "Green Stockholm".
- As it stands, the overwhelming majority of Stockholm residents already cycle, walk or take public transport to work (93% in total).

Appendix 2.2 Fact Sheet: Stockholm

Active role of city administration

- Stockholm is a member of the C40 Cities Climate Leadership Group. The C40 cities are committed to combating climate change. They aim to reduce greenhouse gases through co-operation, information exchange, and goal-oriented actions.
- The environmental aspect has long been embedded in Stockholm's decision-making processes. For the City of Stockholm, public purchases play a key role in promoting green growth. The Stockholm Environment Programme 2012-2015 includes several goals aimed at promoting green public procurement. In 2012, the service contracts and product purchases of the City of Stockholm totalled USD 2.86 billion. (Floater et al., 2013)
- The City of Stockholm's strong commitment to a low-carbon policy is important to fostering green thinking in the city region, with respect to assessing the environmental impact of city organisations. Strengthening the integration of environmental aspects with the city's daily decision-making processes is critical to boosting demand for new and innovative low-carbon solutions. For local businesses, the city administration's commitment to low-carbon options in procurement, construction and other activities will mean growing markets for their products and solutions. (Floater et al., 2013)
- Stockholm is a pioneer in ecological residential areas. The City of Stockholm's active participation and strong commitment to development based on the PPP (public-private partnership) model has encouraged businesses to invest in projects (Floater et al., 2013, p. 140). Businesses regard the city's long-term commitment to development projects as a key factor in their project participation. In this respect, they refer to periods ranging from five to ten years. The depth of the city's participation can be measured on the basis of its broad-based environmental targets, its commitment to realising its goals, and financial investments in early-stage technologies. (Floater et al., 2013)
- The construction of the Stockholm Royal Seaport area has not yet been launched, but the city has already managed to convince some major firms to join the project. The newly established local innovation centre is helping to link the partners together. They include major players such as Ericsson, Fortum, ABB and Electrolux. These firms regard participation in the development of this area as important to their own operations, for reasons such as product development. Such co-operation is characterised by the emergence of and the search for new types of consortia: technological innovators, urban planners, ICT experts and the city's administration staff must find a way to work together. Implemented projects are referred to as demonstrations.
- The city's long-term commitment to a development project and climate targets, a co-operation forum combining know-how and the promotion of networking, and the certainty of long-term demand for cleantech are key criteria for firms when joining cleantech development projects.
- The development of Stockholm is part of Sweden's broader orientation towards renewable energy and a low-carbon future. The renewable energy support models used in Sweden include the green certificate system, investment systems and grants for wind power and solar energy, and tax relief granted to renewable energy producers. Tax relief is granted in support of using biofuels in heat production. (Finnish Energy Industries, 2011)

Appendix 2.3 Fact Sheet: Amsterdam

- CO₂ emissions per capita: 6.66 tonnes a year
- Energy consumption per capita: 74.51 gigajoules
- Percentage of renewable energy consumed by the city: 5.8%
- Total percentage of citizens walking, cycling or taking public transport to work: 62%
- Share of waste recycled: 43%
- Share of waste disposed of in landfills: 1-2% (several estimates)

In general, the data is based on the European Green City Index (Economist Intelligence Unit, sponsored by Siemens, 2009). The main focus is on the development goals set and how well they were met. The data may relate to a city or a region; in some cases, it is possible that the data sources used in this study make no distinction between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- Renewable energy sources currently account for 6% of total power generation.
- The 2025 target involves reducing CO₂ emissions by 40%.
- Measures for developing energy systems include:
 - AC cold/cooling energy from the reservoir (N.V. Nuon Energy)
 - Renewable energy from the city's waste incineration plants (biomass and waste)
- CO₂ emissions: 5.09 million tonnes a year (source: C40 Cities, 2014).
- Energy consumption per capita: 74.51 gigajoules
- Percentage of renewable energy consumed by the city: 5.8%.
- Total percentage of citizens walking, cycling or taking public transport to work: 62%.
- Amsterdam is a member of the C40 Cities Climate Leadership Group.
- According to the City of Amsterdam's Waste and Energy Company (Afval Energie Bedrijf, AEB), the city's waste-fired power plant (WFPP) is the world's largest single-location waste-to-energy (WtE) plant and has the highest energy efficiency rate in the world. 48% of the plant's total treatment volume is biomass, i.e. renewable. The WtE plant provides district heating to some 50,000 households and electricity to around 300,000 households.
- With a budget of EUR 30 million, the project City Zen in the Nieuw-West district is promoting the development of innovative energy solutions by Amsterdam's water, energy and waste management companies, under the theme "Smart Energy". Project sub-areas include:
 - Smart Grid, which includes solar energy storage solutions
 - Solar thermal energy
 - Utilisation of sludge-based biofuels
 - Energy-saving solutions for buildings
 - Interactive communications and activation of citizens through games

Ecological low-carbon transport

- There is little heavy traffic in the city centre, but many cycling paths. Cycling and walking account for 38% and public transport for 24% of all transport.
- Amsterdam has 2.8 km of cycling paths and 3.4 km of public transport routes per square kilometre.
- Measures for the development of ecological transport:
 - smart solutions that increase walking and cycling, such as smart traffic lighting
 - affordable and supervised parking for bikes
- Amsterdam is placing a strong emphasis on green and electric transport, and has been recognised worldwide for its efforts in this regard. By 2011, the city already had 100 charging points. The supply of electricity for water transport is under development. The related goals include:
 - 2009: trams and the subway powered by green energy
 - 2015: 10,000 emission-free vehicles (5% of mileage)
 - 2040: 200,000 emission-free vehicles (100% of mileage)

Appendix 2.3 Fact Sheet: Amsterdam

Resource and material efficiency

- Amsterdam has the world’s most stringent restrictions on the use of landfill. However, the recycling rate of waste is “merely” 43% (Green City Index; on second place after Helsinki) due to the significant role played by incineration. Starting from the 2008 level, the goal is to keep halving the amount of waste going to landfills and incinerators.
- Amsterdam has a long history of processing and incinerating waste. According to AEB, this amounts to 120 years. AEB processes more than 1.4 million tonnes of waste a year, and reuses 99% of this in the form of energy or through recycling. AEB sorts waste in order to recover metals, such as iron, copper and aluminium, and delivers it to recycling centres. Rejects are used in earthworks.
- Amsterdam’s buses mainly run on fuel produced by the Waste and Energy Company.
- According to AEB, its newest installation, a fourth-generation waste-fired power plant (WFPP), is the largest single-location waste-to-energy (WtE) plant in the world, processing 530,000 tonnes of waste per year. The plant has the highest energy efficiency rate in the world; 48% of the plant’s total treatment volume is biomass, i.e. renewable. The WtE plant provides district heating to some 50,000 households and electricity to around 300,000 households (1,000 GWh of electricity). The WtE plant is integrated with a sewage treatment plant, forming a symbiosis: sludge and biogas derived from the sewage treatment process are used to power the WtE plant.
- The city is running a widespread information campaign (Platform for Information about Waste products) with the aim of reducing the amount of household waste.

Ecological built environment

- Implemented solutions
 - *all street lighting is powered by green energy*
 - *two thirds of municipal buildings use green energy*
- The goal is for all municipal buildings to be carbon-neutral by 2015.
- The energy-efficiency of the city’s old buildings is being improved and energy-efficiency requirements have been set for new buildings. A key goal is to reduce the need for heating.

Measures and piloting:

- Use of smart meters to monitor energy consumption is being piloted in the Geuzenveld district, including an alliance with housing companies: this refers to the use of energy savings and energy-efficiency meters.
- Amsterdam has invested in making several public buildings ecologically sustainable. One example is the RAI Exhibition and Convention Centre. Its Elicium building uses geothermal energy and claims to be the most ecological building of its kind in Europe.
- The City of the Sun: 2,900 carbon-neutral and fully energy-self-sufficient residential buildings in the Heerhugowaard district, which use solar panels and wind power.

Developing cleantech business

- Amsterdam Smart City (ASC) serves as a co-operation platform for the private and public sector, and a think tank for ASC projects. Many of the projects are aimed at saving energy. The Climate Street project, for example, tests new and innovative sustainable technologies focusing on three areas: entrepreneurs, public spaces and logistics.
- Amsterdam Innovation Motor (AIM) was founded to enable the Amsterdam region to take a leadership position in the knowledge-based economy. Eco Cluster Amsterdam focuses on the development of sustainable business, bringing together firms, organisations and the municipalities of the Amsterdam Metropolitan Area to generate new business in the region.
- *De Groene Bocht* (DGB, The Green Curve) is an operating and innovation environment, located in the centre of Amsterdam, for companies working towards a sustainable economy. The DGB is currently home to a dozen companies. There are plans for a second DGB building.

Other projects led by companies working towards a sustainable economy include:

- Amsterdam’s Waste and Energy Company AEB (Afval Energie Bedrijf) is a waste incineration plant with one of the world’s highest rates of energy efficiency. The entire Amsterdam subway and tram network is powered by electricity provided by AEB. The district heating network of N.V. Nuon Energy and AEB provides heating for 55,000 households.
- Shell Technology Centre Amsterdam develops new technologies and innovations for the identification of clean and affordable alternatives to fossil fuels, such as second-generation biofuels (made from non-food produce) and the capture and storage of carbon dioxide. The related gasification technology was developed in Amsterdam.
- Evoswitch is a fully carbon-neutral data centre. Evoswitch designed “Free Cooling” – a new energy-efficient cooling concept that intelligently utilises the cooler outside air.

Appendix 2.3 Fact Sheet: Amsterdam

Voluntary participation of citizens and the third sector

- Amsterdam has encouraged its residents to become active through several, small-scale development projects implemented throughout the city. Citizens are taking part in these projects.
- An excellent example is the Smart City Amsterdam programme, a joint effort by the city, local residents and businesses, launched in 2009 to support joint pilot projects:
 - 1 *smart meters for monitoring energy consumption in the Geuzenveld district*
 - 2 *smart shopping street Utrechtsestraat: the street is used for testing technologies and smart grid solutions that help reduce CO₂ emissions, as well as for the use of sustainable and ecological transport and open public spaces.*
 - 3 *electricity distribution points have been installed along waterways to provide boaters and ships with access to the city's electric grid as an alternative to diesel use (Economist Intelligence Unit, 2009).*
 - 4 *Some of the residents of the Amsterdam Noord district have opted to become shareholders in a wind power company, which intends to build seven wind turbines for commercial use.*
- The projects are popular and have led to smart grid solutions, smart electric vehicle charging methods, smart transport solutions, and various other solutions that are helping to pave the way towards a low-carbon society.
- The City of Amsterdam provides open access to data and encourages activities such as smartphone applications that can help in meeting carbon emission reduction targets.

Active role of city administration

- Main Green Structure urban planning steers land use.
- Milieubeleidsplan is a comprehensive environmental programme, updated every few years, which has the aim of defining the city's broad-based goals and measures.
- The Amsterdam Smart City platform, facilitated by the city, serves as a co-operation network for the public and private sectors, and as a think tank for Smart City projects.
- Amsterdam takes an active part in international co-operation projects, including:
 - Eurocities
 - ICLEI – Local Governments for Sustainability
 - Connected Urban Development
 - European Commission – Green Capital Award
 - Covenant of Mayors
 - C40 Cities Climate Leadership Group

Appendix 2.4 Fact Sheet: Bristol

- CO₂ emissions per capita: 4.7 tonnes a year
- Recycling rate of waste approximately 50%.
- Britain's most bicycle-friendly city

In general, the above data was obtained from the City of Bristol's website. The main focus here is on the development goals set and how well they were met. The data may relate to a city or region; in some cases, it is possible that the data sources used in this study did not differentiate between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- Bristol has set itself the goal of reducing energy consumption by 30% and CO₂ emissions by 40% by 2020, and a further 80% by 2050 (from the 2005 baseline). These targets are included in Bristol's Sustainable Energy Action Plan.
- GBP 140 million has been allocated to energy-efficiency improvement measures to be enacted under an energy investment programme.
- Energy consumption by households has fallen by 16% (2005-2010), and the energy-efficiency of homes has improved by 25% (2000/2001-2011).
- CO₂ emissions per capita: 4.7 tonnes a year (European Commission, 2014).

Ecological low-carbon transport

- The reduction of CO₂ emissions is a priority in the Joint Local Transport Plan 2011-2026.
- CNG and biodiesel pilot by the city's main private operator First Bus, aimed at reducing fuel consumption, e.g. through the award-winning DriveGreen system.
- Britain's most bicycle-friendly city (Moonen, Clark & Feenan, 2013).
- The budget is GBP 420 million (2012-2026), allocated as follows:
 - Reducing demand for heavy vehicles in the city centre.
 - Developing the public transport system and supplementing existing bus routes.
 - New train stations and upgrading of rail sections.
 - Campaigns to support walking and cycling.
 - A smart traffic management system.
 - Electric vehicle charging points and management system.

Resource and material efficiency

- Recycling rate of waste approximately 50%.
- The Household Waste Strategy is aimed at increasing recycling and reducing the amount of waste.
- The City of Bristol is developing its recycling services and promoting composting and centralised composting facilities and functions.
- By 2013, all waste will be processed in a mechanical biological sewage treatment plant, whose end product is currently delivered for use as fuel to a district heating plant in the Netherlands. A new energy recovery plant is under construction, in order to make use of household waste in the city's own energy production.

Ecological built environment

- An action plan for reducing CO₂ emissions (The City's Directors of Finance and of Housing Strategy). For example, continuous guidance and support for improving the insulation of buildings; external wall insulation; more efficient boilers; and the installation of solar energy heating systems in social housing.
- Through the Bristol Energy Efficiency Scheme (BEES), energy efficiency has improved by 15% from the 2004 level (20,000 homes).
- Communications campaigns and programmes: Bristol has provided more than 100,000 residents with tailored instructions on energy-efficiency, through telephone services and other communication channels.
- 80% of city residents promote energy-efficiency in their homes.
- In 2014, Bristol was named Britain's best city in which to live by the Sunday Times. The comparison of UK cities cited success factors such as Bristol's future plans to improve the atmosphere of the living environment and built environment and to promote sustainable lifestyles.

Appendix 2.4 Fact Sheet: Bristol

Developing cleantech business

- Businesses are being provided with advice on how to become low-carbon.
- Training is being provided in support of the sustainable energy industry.
- District heating projects.
- The development of a low-carbon industrial zone, aimed at creating thousands of jobs.
- The smart grid pilot project.
- Bristol is a testing ground for new ideas and green innovations: local food, local currency (Bristol Pound) and energy co-operatives.
- The Bristol Green Capital Partnership for businesses and organisations. Partners are expected to attend regular meetings and be actively involved in supporting the partnership's work.
- The City of Bristol offers interest rate discounts to businesses.
- A strong cleantech value chain and companies that act as driving forces, such as Garrad Hassan, Rolls Royce and Siemens. Existing value chains and transport connections are important considerations when setting up a new business.
- Bristol's BIG Green Week (held in June 2013) focused on sustainable development innovations.
- The Siemens-owned Marine Current Turbines Ltd (MCT) is Bristol-based. MCT came fifth overall in a ranking of Europe's most innovative cleantech firms.

Voluntary participation of citizens and the third sector

- The Community Challenge Fund; community projects funded by the City of Bristol and aimed at reducing CO₂ emissions. Examples include:
 - *Transition Neighbourhoods: community-led local initiatives, dissemination of information on energy security issues, supporting communal action and community spirit*
 - *Community groups: for example, joint efforts to improve the insulation of buildings*
 - *Energy systems owned by communities and co-operatives.*
- Interaction in the social media: the Bristol Green Capital website for sharing daily green ideas, best ideas are rewarded.
- Bristol Green Capital is also active on Twitter and YouTube.
- Not-for-profit Bristol Green Doors: open-house events held in homes that have been made more energy-efficient.

Active role of city administration

- The City of Bristol sets a strong example through its own activities for promoting a low-carbon economy:
 - *Investments in the renewable energy programme: e.g. biomass, wind and solar energy.*
 - *Modernisation of street lighting.*
 - *Energy-efficiency of public buildings.*
- The programmes and strategies of the City of Bristol: Bristol Climate Protection and Sustainable Energy Strategy, the Local Transport Plan to 2026.

Appendix 2.5 Fact Sheet: Vienna

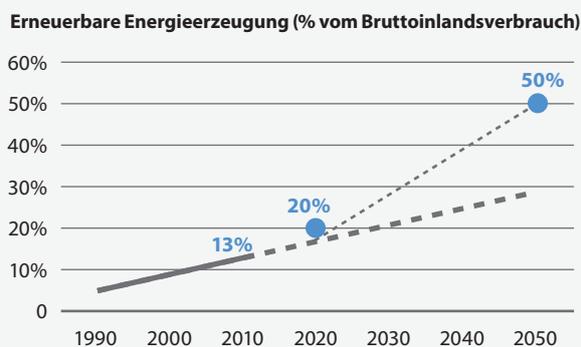
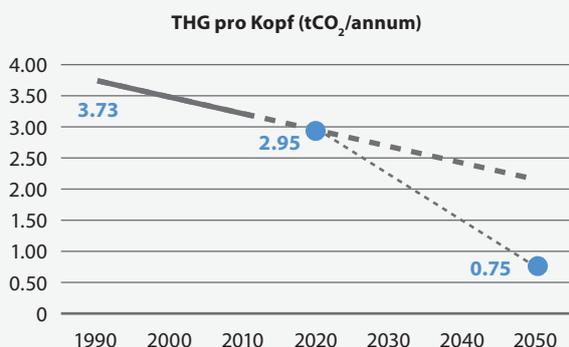
- CO₂ emissions per capita: 5.19 tonnes a year
- Energy consumption per capita: 78.74 gigajoules
- Percentage of renewable energy consumed by the city: 13.18%
- Share of waste recycled: 33.35%

In general, the above data is based on the European Green City Index (Economist Intelligence Unit, sponsored by Siemens, 2009). The main focus here is on the development goals set and how well they were met. The data may relate to a city or region; in some cases, it is possible that the data sources used in this study did not differentiate between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- Per-capita energy consumption by the city of Vienna is only half of the European average. Vienna's CO₂ emissions are only one third of the European standard levels. The percentage of renewable energy consumed by the city equals 13% of total consumption (30-city average of 7%), based on water power and extensive incineration of waste.
- Vienna's Smart Vision: 50% renewable by 2050, 80% less CO₂ emissions, and 60% reduction in energy end-use per capita (from the 2005 baseline).
- Ongoing umbrella themes/projects:
 - the Climate Protection Programme KLIP
 - the Urban Energy Efficiency Programme SEP
 - the Urban Development Plan STEP
 - the Guidelines for Environmentally Friendly Construction Site Management RUMBA
- A high-publicity programme, Smart City Wien (SCW), was launched in 2011.
- SCW examples
 - Solar-powered air conditioning research project
 - District heating
 - Citizens' Solar Power Plants
- CO₂ reduction target ("ohne ETS"): 80%, 0.75 tonnes per head by 2050
- Development goal for the percentage of renewables: 50% by 2050
- CO₂ emissions per head: 5.19 tonnes¹
- Energy consumption per head: 78.74 gigajoules¹
- Percentage of renewable energy consumed by the city: 13.18%¹

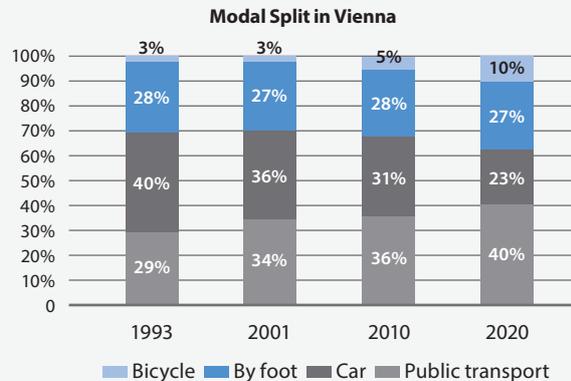
¹ Economist Intelligence Unit, 2009



Appendix 2.5 Fact Sheet: Vienna

Ecological low-carbon transport

- 68% of the working population take public transport, ride a bike or walk to work (“96% of residents have excellent access to public transport”). Target 2050 (“Modal Split”) is 77%. From 2025 onwards, the Smart City Wien transport target will include cutting emissions to zero and increasing the number of electric vehicles (86% nicht-MIV, 14% MIV – motorisierten Individualverkehrs).
- Ongoing projects:
 - enhancing the service level of public transport;
 - increasing the number of gas-powered buses.



More facts:

- Total percentage of citizens walking, cycling or taking public transport to work: 68%

Resource and material efficiency

- Direct landfilling of waste is prohibited and incineration is a widely used waste treatment method.
- Waste treatment causes and annual equivalent of 420,000 metric tons of CO₂, while 550,000 tons of potential emissions are avoided due to measures such as waste incineration, the collection of landfill gas for electricity generation, waste separation, recycling, and using compost in organic farming.
- A waste management plan has helped in the curbing of CO₂ emissions.
- An excellent example of resource-efficiency lies in energy from waste supply networks: drinking water extracted from the Alps is used to run 13 hydroelectric power plants (65 GWh/a).
- Ongoing projects.
- Share of waste recycled: 33.35%.

Ecological built environment

- The construction of wooden apartment buildings (passive houses) has been permitted since 2001.
- Energy-efficiency standards and certificates for new buildings have been a requirement since 2006; a certificate required for all transactions (sales, leasing) as of 2009.
- A programme for construction sites: Friendly Construction Site Management RUMBA.
- Smart City Wien 2050 – social housing programme, under which 7,000 homes are built and 10,000 homes renovated each year. Ecological improvements are supported through direct financial support.

Developing cleantech business

- Investments in Vienna’s Climate Protection Programme 1999-2011 totalled more than EUR 20 billion. This helped to secure an estimated 58,000 jobs in 2011.
- The Environmental Cluster Vienna was established in 2011 (cf. Stockholm in 2005). This comprises educational institutions, research institutes and businesses. Vienna is home to 400 environmental companies and 14 R & D & I organisations.
- The focus areas of development selected by Vienna are:
 - Energy-efficient construction
 - Smart Grid
 - Biofuels
 - Environmental monitoring
 - Water management
- The new cleantech business showcase is the Seestadt Aspern (Vienna’s Urban Lakeside) project. Led by the Vienna Business Agency, an ecological “aspern IQ” Technology Centre and hot spot were created as an area housing clean energy and cleantech firms. Another example is the Treibhaus 1010, a community of SMEs which has dubbed itself a cleantech hot spot.
- In the Eco Buy Vienna project, the city is promoting sustainable business through its public procurement system. The city has set 63 ecological criteria for its purchases, which amount to roughly EUR 5 billion each year.
- The Smart City Wien 2050 programme comprises action packages for stimulating environmental business.

Appendix 2.5 Fact Sheet: Vienna

Voluntary participation of citizens and the third sector

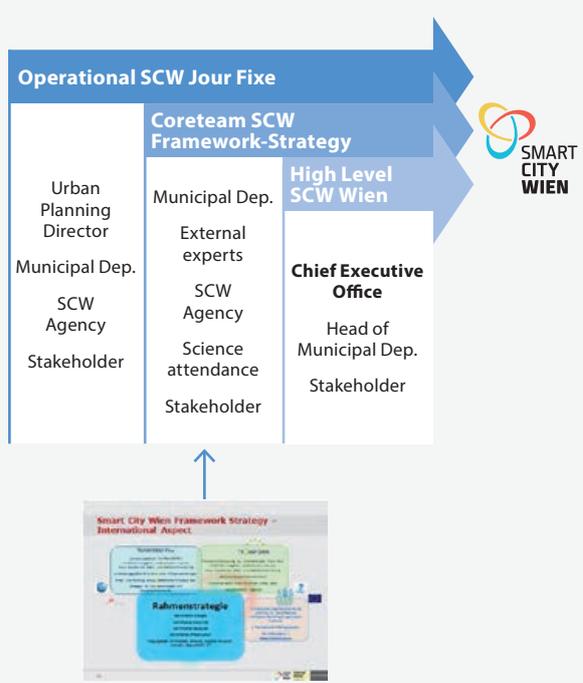
- Realised examples include:
 - EcoBuy Vienna public procurement policy
 - Citizens' Solar Power Plants; citizens participate in increasing the use of solar power
 - Smart City Wien 2050; the strategy includes several action packages for increasing participation, in the form of various working groups under the theme "Die BürgerInnen zu PartnerInnen machen"

Active role of city administration

- Underlying aspects include preparing for population growth resulting from immigration and urbanisation:
 - Programmes are given a high profile as development tools
 - Participation in many EU-level programmes
- Goal-oriented and comprehensive Smart City Wien (SCW) Initiative – 2050 targets based on impact, steering and commitment.
- High-publicity, vivid Smart City Wien Initiative since 2011:
 - The vision: a sustainable future
 - The commitment: transformation into a Smart City
 - Vienna wants to take the opportunity to position itself as a city of expertise in research and technology in Europe
- SCW has three parts:
 - 1 Vision 2050: reduction of CO₂ emissions, energy-efficiency, renewable energy, the "Modal Split"
 - 2 Roadmap for 2020 and beyond: action packages for promoting a low-carbon society
 - 3 Action Plan for 2012-2015: deployment of demo and pilot sites
- SCW has been integrated with previously launched development programmes:
 - The City Development Plan (STEP)
 - The Climate Change Programme (KLIP)
 - The Energy Efficiency Programme (SEP)
 - EU programmes CLUE – Climate Neutral Urban Districts in Europe and TRANSFORM +
- SCW has a wide range of committed participants:
 - Municipal Department 18 – Urban Development and Planning supported by Tina Vienna Urban Technologies & Strategies GmbH (project management)
 - Municipal Department 20 – Energy Planning
 - Wiener Stadtwerke Holding AG (Vienna Public Utilities)
 - Wien 3420 Aspern Development AG
 - Siemens AG Österreich
 - Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H.
 - raum & kommunikation GmbH (Arsenal Research Centre)
 - Vienna University of Technology
 - Energieinstitut der Wirtschaft GmbH
 - Austrian Institute of Technology GmbH
- SCW is very well structured and co-ordinated by the city.



Vienna's Smart City Initiative



Appendix 2.6 Fact Sheet: Tampere

- CO₂ emissions per head: 4.6 tonnes a year
- The modal share of bicycle trips of 1-2 km is 8%, and of trips of 2-3 km, 6%

In general, the above data was obtained from the City of Tampere's website. The main focus here is on the development goals set and how well they were met. The data may relate to a city or a region; in some cases, it is possible that the data sources used in this study did not differentiate between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- Tampere has set the goal of reducing its carbon dioxide emissions by 40% by 2025.
- Target 2050: Tampere will be a carbon-neutral city. The city will adapt to ever-progressing climate change and prepare for any risks arising from it. A carbon-neutral Tampere will mean an 80% reduction in greenhouse gas emissions by 2050, compared to the 1990 baseline. The other 20% will be compensated for by means of plant sequestration and emissions trading.
- Implementation: ECO2 – Eco-efficient Tampere 2020 continues; the Covenant of Mayors' Sustainable Energy Action Plan (SEAP) is progressing as planned.
- Estimate 1:
In 2012, Tampere's CO₂ emissions were 4.6 tonnes per head (Soini, 2014).
- Estimate 2:
In 2011, Tampere's greenhouse gas emissions totalled 1,047.0 ktCO₂e, excluding industry. Of this amount, 227.0 ktCO₂e was caused by consumers' electricity consumption, and 46.9 ktCO₂e by electric heating. (Benviroc, 2013)

Ecological low-carbon transport

- Target 2050: Tampere will have low-emission transport and energy systems.
- The target is being pursued through emission reduction measures in the transport and energy sectors, among others. The City of Tampere will increase the modal share of electric vehicles within its own activities and promote the development and introduction of low-emission vehicles through participation in development projects.
- Development of the transport system will favour walking, cycling and using public transport. Park and Ride services along public transport routes will be improved and more parking spaces will be provided for bikes. Regional cycling corridors will be built.
- Practical testing of hybrid buses.
- Tampere's RATU alliance project (highway tunnel construction): the tunnel will eliminate congestion problems caused by the city centre's through-traffic. It will also enable residential planning in the Ranta-Tampella area, the expansion of the city centre towards Lake Näsijärvi, and the reduction of noise and pollution problems.
- In the Tampere region, private cars are used for nearly half of all trips of 1-2 km (47%) and for nearly two thirds of all trips of 2-3 km (62%). The modal share of cycling for trips of 1-2 km is 8%, and for trips of 2-3 km, 6% (Vaismaa, 2014).

Resource and material efficiency

- Target 2050: Material and eco-efficiency is a key criterion in all of the City of Tampere's investments, projects and purchases. Significant improvement has taken place in the material and eco-efficiency of the city's functions.
- Implementation: the city's guidelines on purchasing, the framework programme for environmental investments and a joint project (2012-2014) on sustainable development criteria for service production and purchasing.
- The Finnish Environment Institute and other research bodies and industrial policy actors will jointly assess the link between purchases and environmental business between 2013 and 2015.
- The City of Tampere's environmental financial statement, which is redrafted each year, is under further development.
- Resource-efficiency is also encouraged by the guidelines for public procurement and the framework programmes for environmental investments.
- A new waste-to-energy (WtE) plant, scheduled for completion in Tarastenmäki in 2015, will supplement the recycling of waste materials.

Appendix 2.6 Fact Sheet: Tampere

Ecological built environment

- A local plan for energy-efficient construction will be prepared in accordance with the national ERA17 programme.
- Rane – support and advice on any construction-related issues.
- Projects: the residential district of Vuores (high-quality architecture, ecological, high-tech, and respecting nature's values); zero-energy area in Härmälänranta (by Skanska); renovation project in Tesoma; Nurmi-Sorila, a carbon-neutral "Sun City".

Developing cleantech business

- Pilot projects of RESCA – Renewable Energy Solutions in City Areas (e.g. solar technology, wind power and biogas as vehicle fuel).
 - *The target is to create ten new operating models or technologies that can also be used in other areas.*
 - *The total budget for RESCA is EUR 1.3 million.*
- Tampere is an active partner in the Innovative Cities programme (INKA). It leads the programme's Smart cities and industrial regeneration theme. INKA is aimed at generating new companies based on high expertise and spurring the creation of innovation clusters.
- Intelligent Transport System (ITS) development environments; purchasing of trams and gas-powered buses.
- Vuores, a wooden smart-city living lab.
- ITS Factory (a national ITS innovation and development environment).
- Smart solutions for the station area.

Voluntary participation of citizens and the third sector

- Communications and information campaigns, e.g. "Minä poljen" ("I pedal"; to promote cycling).

Active role of city administration

- Efficient environmental policy and governance; the ECO2 project launched jointly by the City of Tampere and the Finnish Innovation Fund Sitra.
- Programmes, eco-efficient practices and impact assessment: EIA procedures, Sustainable Energy Action Plan (SEAP), Environmental Strategy, Eco-support, ILMANKOS.
- ILMANKOS project: Tampere region's ILMANKOS is a four-year ESF-funded project implemented in seven residential districts and their surrounding areas. The project is aimed at increasing citizens' participation in their local community and steering them to make environmentally friendly choices in their everyday life. The project themes include housing, mobility, food, consumerism, and waste. The project's main focus is on a broad-based activation and learning process through which people will learn to think about the impact on the environment of their actions and behaviour.

Appendix 2.7 Fact Sheet: Vancouver

- CO₂ emissions per capita: 4.2 tonnes a year
- 41% of Vancouverites walk, cycle or take public transport to work

In general, the above data was obtained from the City of Vancouver's website. The main focus here is on the development goals set and how well they were met. The data may relate to a city or region; in some cases, it is possible that the data sources used in this study did not differentiate between the two. A list of references is provided in Appendix 3.

Efficient low-carbon energy system

- The goal is to reduce CO₂ emissions by 33% by 2030, from the 2007 level.
- The long-term goal is to become free of fossil fuels.
- The Neighbourhood Energy Strategy: funding to promote renewable energy systems in high-density neighbourhoods.

Measures:

- Promoting green energy use, for example water power providing a major share of energy generation
- Vancouver's Community Climate Change Action Plan 1992-2012 (land use, green construction standards, promotion of walking and cycling, reduction of waste)
- Vancouver's Neighbourhood Energy Utility (NEU) provides space heating and hot water for the Vancouver Olympic and Paralympic Village. NEU uses the waste heat derived from untreated municipal waste water (innovative green solutions demonstrating 60% reductions in emissions by residential heating systems)
- City of Vancouver offered financial support (50% or max. CAD 3,500) to the Residential Solar Water Heating Pilot
- Estimate 1:
CO₂ emissions: 2.69 million tonnes a year (C40 Cities, 2014)
- Estimate 2:
CO₂ emissions per capita (in metric tons): 4.2 (Economist Intelligence Unit, 2011)

Ecological low-carbon transport

- Improving the cycling network and the public bike-share system (launch in 2015)
- Vancouver's Downtown Street car
- 415 km of cycling routes
- 41% of Vancouverites walk, ride a bike or take public transport to work (Canada's Coolest Cities 2012)

Resource and material efficiency

- The goal is to reduce the amount of solid waste going to landfills or incinerators by 50% by 2020, from the 2008 level.
- Businesses charged fees for non-recycled waste

Ecological built environment

- The city's goal is that all new homes will be fully carbon-neutral by 2030 (the Green Homes Programme).
- New buildings must attain the Leadership in Energy and Environmental Design (LEED) certificate: strict requirements for water efficiency, as well as saving energy, reducing CO₂ emissions and improving indoor air quality. Projected outcome: 20-30 fully green new buildings a year.

Appendix 2.7 Fact Sheet: Vancouver

Developing cleantech business

- Vancouver is a clear leader in Canada's cleantech industry. Of 18 Canadian cleantech businesses that ranked high in international competitions, 11 were Vancouver-based. Vancouver is also home to many development organisations and venture capital investors specialising in cleantech.
- Vancouver is a pioneer in sustainable urban development, showing an example to other cities. The Vancouver "model" has been applied in Houston, Dubai, Sao Paolo and Abu Dhabi.
- The Corporate Climate Leaders programme is encouraging businesses to partner with each other and make specific environmental commitments.
- Vancouver's businesses are pioneers in cleantech, and the Vancouver region is home to many development organisations and projects.
- The Province of British Columbia (BC) grants a 30% tax credit on first-stage capital venture investments in SMEs. The BC Innovative Clean Energy (ICE) Fund supports the development of new sources of clean energy and technologies. The federal government and the province invested CAD 89 million in a demonstration project for hydrogen fuel cell buses and fuelling stations.
- The industry and universities have joined forces to provide research laboratories, testing platforms and funding instruments to support the emergence of sustainable technologies. These include National Research Council for Fuel Cell Innovation, Sustainable Development Technology Canada, and state funding (e.g. Innovative Clean Energy Fund).
- Vancouver has decided that hydrogen fuel cell technology will be one of its spearheads. BC companies such as Ballard Power Systems Inc., Plug Power Canada and Hydrogenics, which originated from the Vancouver Fuel Cell and Hydrogen Technologies Cluster, are now global leaders.
- An example: the City of Vancouver ordered 20 hydrogen fuel cell buses for the 2010 Olympic Winter Games.
- The Vancouver Fuel Cell Vehicle programme is a joint effort alongside international corporations, such as the Ford Motor Company and Linde Gases
- Solid R & D investments:
 - CAD 193 million invested by 80 organisations generate CAD 133 million in revenues per year a decade later
 - Vancouver is a national R & D & I hub, accounting for nearly 70% of jobs in the cleantech sector (1,400)
 - 11 H2/FC start-ups
- The City requires that all new municipal facilities achieve LEED (Leadership in Energy and Environmental Design) Gold, which is the highest standard. This has inspired new innovative solutions and is supporting the emerging green building industry.

Voluntary participation of citizens and the third sector

- The One Day programme offers households free energy-efficiency measurements and financial incentives for making energy-efficient improvements to homes.
- The City of Vancouver provides materials and resources for teachers in support of environmental education (e.g. workshops, games and competitions)
- Vancouver Green Streets programme: an opportunity for Vancouverites to do volunteer gardening around the city (e.g. traffic circles and corner bulges)

Active role of city administration

- Corporate Climate Leader programme for companies
- Vancouver the Greenest City Action Plan
- Air Quality Management Plan for Greater Vancouver
- The challenges of transparency: limited availability of public monitoring data

Appendix 3

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Cities play a crucial role in building a carbon-neutral future. They can create an operating environment for companies to develop innovations in clean energy and cleantech, thus enabling low-carbon solutions.

Sitra wanted to study, how the best cities around the world have succeeded in doing this. Does the Helsinki Capital Region have what it takes to become a global driver of cleantech?

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The Finnish Innovation Fund Sitra is a future-oriented organisation that is building a successful Finland for tomorrow's world. Sitra anticipates social change, tries out new operating models in practice and accelerates business activities aimed at generating sustainable well-being.