LAMK Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

International Comparability of the Climate Indicators of the Helsinki Region Environmental Services Authority (HSY)

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Päivi Kivistö

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KIVISTÖ, PÄIVI:

Helsingin seudun ympäristöpalvelut kuntayhtymän (HSY) ilmastoindikaattoreiden kansainvälinen vertailtavuus

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TIIVISTELMÄ

Helsingin seudun ympäristöpalvelut kuntayhtymän (HSY) rooli on valvoa ilmastostrategian täytäntöönpanoa. Ilmastonmuutoksen hillintää seuraavat ilmastoindikaattorit ovat yksi väline seurata ilmastotyön edistymistä pääkaupunkiseudulla. HSY haluaa varmistaa ilmastotyönsä korkean laadun ja siksi toiminnan jatkuva kehittäminen on tärkeää. Ilmastotyönsä kannalta edelläkävijöinä nähtävien kansainvälisten kaupunkiseutujen ilmastotyön ja sen mittareiden seuranta on tärkeää, jotta HSY saavuttaa strategisen tavoitteensa olla innovatiivinen edelläkävijä, sekä toteuttaakseen visiota vuodelle 2020 olla vastuullinen, tehokas ja kehittyvä.

Tämän tutkimuksen tavoitteena on selvittää, miten HSY:n ilmastoindikaattorit pärjäävät kansainvälisesti. Tarkoituksena on tutkia ovatko valittujen kaupunkialueiden kestävää kehitystä mittaavat indikaattorit samankaltaisia kuin HSY:n ilmastoindikaattorit, ja punnita, onko joitakin HSY: n ilmastoindikaattoreita aiheellista muuttaa kansainvälisesti vertailukelpoisemmiksi.

HSY: n ilmastoindikaattoreita verrataan European Green Capital -palkinnon indikaattoriluetteloon sekä ilmastotyönsä ansiosta edelläkävijöinä nähtäviin Hannoverin ja Vancouverin kaupunkeihin.

On hyödyllistä vertailla ja oppia edelläkävijä kaupungeilta, mutta on melko vaikea tehdä kaupunkien sijoittelua toisiinsa nähden perustuen indikaattorimittaukseen. Tulokset eivät ole välttämättä vertailukelpoisia, koska laskennat ja mittausmenetelmät vaihtelevat suuresti. On järkevää mitata vastaavia asioita ja valita samanlaisia indikaattoreita. On myös tärkeää yhtenäistää kestävän kehityksen indikaattoreita, jotta kaupungit löytävät kestävän kehityksen suunnan sekä ohjenuorat onnistuneeseen ilmastotyöhön.

Asiasanat: Ilmastonmuutos, ilmastoindikaattorit, kestävän kehityksen indikaattorit, kaupunkiseudut

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ABSTRACT

The role of the Helsinki Region Environmental Services Authority (HSY) is to monitor the implementation of the Climate Strategy. Climate indicators describing the climate change mitigation in the region are one tool to monitor the progress in climate work in the Helsinki Metropolitan Area. HSY wants to ensure the high quality of the on-going climate work, therefore continuous development of operations is significant. It is important to benchmark international city regions' climate work and their tools of measuring the climate work for HSY to achieve the strategic goal to be an innovative forerunner and implement a vision for the year 2020 to be responsible, effective and evolving.

The aim of this study is to find out how the HSY's climate indicators measure up internationally. The purpose is to study if the indicators measuring the sustainability of the selected city regions are similar and to weigh whether it is appropriate to change some of the HSY's climate indicators to be better internationally comparable.

The HSY's climate indicators are compared to the list of indicators for the European Green Capital Award study of factors influencing urban sustainability in 2014-2015, and the cities of Hannover and Vancouver were selected as benchmarking targets in this study because their long-term success in climate work.

It is useful to benchmark and learn from cities around the world, but it is rather difficult to do ranking based on the indicator measurements. The results are not necessarily comparable because of the variation in the calculation and measurement methods. It is useful to measure similar matters and select similar indicators to unify the sustainability indicators, giving the cities the right development direction towards sustainability and guidelines to successful climate work.

Key words: Climate change, climate indicators, sustainability indicators, city regions

CONTENTS

1 INTRODUCTION

The importance of cities and city regions in mitigating climate change is significant. The main reason for global warming and climate change is greenhouse gas emission, and a significant source of greenhouse gas emissions is energy use in urban areas. Increasing amount of the global population lives in the urban areas. Hence the cities are at the center of global climate change and sustainability challenges.

The goal of the international climate negotiations is to limit the greenhouse gas emissions in the atmosphere to mitigate climate change. The long-term global goal has been to limit the global warming to below two degrees Celsius above the pre-industrial levels. Limiting the global warming to two degree Celsius or to even new tougher target of 1.5 degrees Celsius by the end of the century will require drastic measures. In 2050, the world's greenhouse gas emissions should be no more than about a tenth of the current level. The emission reduction targets and the climate actions of the Helsinki Metropolitan Area strive to respond to this challenge. The Helsinki Metropolitan Area is formed by the municipalities of Helsinki, Espoo, Vantaa and Kauniainen. There are over 1.1 million people living in the Helsinki Metropolitan Area.

Over 20 years of climate work in the Helsinki Metropolitan Area is active and widely covers city sectors and administrative units. The Helsinki Metropolitan Area Climate Strategy 2030 was adopted in Helsinki, Espoo, Vantaa and Kauniainen in 2008. The strategy has integrated mitigating climate change as a key part of the cities' planning and decision-making processes. The aim is to reduce emissions by 39 percent per capita by 2030 compared to the 1990 baseline. According to the new, revised targets, the metropolitan area is also aiming at carbon neutrality by 2050. At least a 20 per cent reduction of the emissions in the region by 2020 is set as a milestone. Achieving these goals requires continued strong determination and good cooperation.

Helsinki Region Environmental Services HSY is a municipal authority that provides waste management and water services, and regional and environmental information of the Helsinki Metropolitan Area (HMA). HSY is responsible for organizing waste management for residential properties and the public administrations in the HMA and in Kirkkonummi. HSY is also responsible for supplying drinking water for the inhabitants of the HMA, and for treating the waste water generated by households and industry of the HMA and the greater Helsinki region. The regional and environmental division of the HSY monitors for example the air quality of the HMA and promotes the implementation of the HMA Climate Strategy 2030 and the HMA Climate Change Adaptation Strategy.

Helsinki Region Environmental Services Authority (HSY) collects the data on climate indicators describing climate change mitigation. Climate indicators are used to monitor the progress in climate work in the Helsinki Metropolitan Area, which is part of the HSY's role in monitoring the implementation of the Helsinki Metropolitan Area Climate Strategy 2030.

The aim of this thesis is to compare HSY's climate indicators to the list of indicators for the European Green Capital Award study on factors influencing urban sustainability in between 2014-2015. The purpose is also to benchmark the chosen cities of Hannover and Vancouver, and learn from their way of measuring sustainability, and possibly take good practices into action in the Helsinki region. As a conclusion of this thesis, an analysis of how the HSY's climate indicators measure up internationally is provided. The purpose is also to study if the indicators measuring the sustainability of the city region are similar and to weigh whether it is appropriate to change some of the HSY's climate indicators to be better internationally comparable.

2 RESEARCH METHODS

This thesis is a background report of the international climate change indicator reporting in the city regions. The objective is to look for factors that make difference in meeting the emission reduction targets. The study is based on the Helsinki Region Environmental Services Authority's (HSY) strategy and on the Regional and Environmental Information division's targets in the Plan of Action 2015.

The research method used in the thesis is the comparative method. The aim is to bring into focus suggestive similarities and contrasts among the cases. This thesis analyses the similarities and differences between HSY's list of 56 climate indicators and the list of indicators for the European Green Capital Award study of factors influencing urban sustainability in 2014-2015. In addition, the HSY's key climate indicators are compared with the selected cities' key indicators, and suggestions are made to further develop the HSY's key climate indicators.

The comparison is based on the data and information found from the internet and publications of the case cities of Hannover and Vancouver. The city officials responsible of their climate work were also interviewed via email.

The background information of the HSY's climate work is based on the fact that I work in the HSY's Regional and Environmental Information division's climate unit as a Special Planner. The climate indicators of the HSY are one of my tasks.

2.1 Climate indicators

Climate indicators mean indicators used to measure a city's performance on actions in mitigating climate change. The indicators show several years' development, and a trend of a certain sector in the city region.

The Helsinki Metropolitan Area climate indicators illustrate the key development trends in the region and describe the progress in the climate

work. They give an overview of the development of the operating environment in the region, the amount of carbon emissions in the different sectors, and factors affecting them. The objective of monitoring is to help decision-makers and city officials to assess the adequacy and effectiveness of the mitigation measures.

The HSY's climate indicators were compiled for the first time in 2011. The 56 climate indicators were selected by HSY's experts on climate change together in cooperation with the cities in the Helsinki Metropolitan Area. These indicators were seen to be the best to measure the Helsinki Metropolitan Areas' performance on actions in mitigating climate change in the region. (Appendix 1).

As part of this thesis, all of the climate indicators of the HSY are compared with the list of indicators for the European Green Capital Award study of factors influencing urban sustainability in 2014-2015. The purpose of the list of indicators for the European Green Award study of factors influencing urban sustainability is to investigate differences in sustainability performance between EU cities. It is carried into execution by Tillburg University with assistance of DG Environment of the European Commission and the European Environmental Agency's European Topic Center for Spatial Information and Analysis. (Zoeteman, Van der Zande & Smeets 2015, 5).

This list of the European Green Award is comprehensive and an up to date list of indicators measuring the sustainability of cities. The list aims to unify the indicators for sustainability among the EU cities, and therefore works as a good basis of comparison in this study.

2.2 Comparison between the lists of indicators

Most of the HSY's climate indicators can be found or placed under some parallel category from the list of indicators for the European Green Capital Award study of factors influencing urban sustainability in 2014-2015. (Appendix 2). Only a few of the HSY's transportation and buildings

category indicators are not compatible with any of the indicators in the European Green Capital list.

Themes of energy and climate, resources and waste, and infrastructure and accessibility on the European Green Capital list of indicators are the themes from where most of the HSY's climate indicators find correspondences. These themes include factors measuring cities' performance towards mitigating climate change, and therefore are well monitored in the Helsinki Metropolitan Area. The rest of the compatible indicators are placed under the themes of economic structure, residential environment, and nature and landscape.

In addition to the HSY's climate indicators, a broad range of indicators are used in HSY altogether to measure the Helsinki Metropolitan Area's performance in sustainability. There can be found several similarities when compared all of the HSY's climate indicators with the European Green Capital list of sustainability indicators. For example, the themes of soil and groundwater, drinking water and sanitation, air, and nature and landscape contain several parallel indicators widely monitored in the Helsinki Metropolitan Area by the HSY.

3 CLIMATE CHANGE AND CITIES

Human-caused climate change is widely considered the most serious environmental problem that the Earth has faced. Global average temperature has already increased significantly compared to the pre-industrial era. The main reason for global warming is greenhouse gas emissions. Deforestation and land-use change are also considerable driving forces of climate change, but a significant source of greenhouse gas emissions is energy usage in urban areas. The scientific and political communities progressively acknowledge that cities and urban areas play a vital role in global climate change and sustainability challenges.

The EU has set a target for limiting the mean temperature rise to +2 degrees Celsius compared to the pre-industrial era. The EU's official commitment is to reduce emissions and increase energy efficiency by at least 20 per cent by 2020, which is a good milestone towards sustainable emission levels. (EU. 2008, 2.)

Over half of the world's population lives in cities, and it is estimated that the world's urban population will almost double by 2050 evermore increasing the cities' role in climate change. (ICLEI 2014, 4.) Cities also contain a large proportion of economic activities producing greenhouse gas emissions (GHG) across multiple sectors having a warming effect on climate. Cities consume two-thirds of the world's energy and are responsible for over 70 per cent of the global GHG-emissions. (World Bank 2015.)

Cities, municipalities and communities may be the primary cause of the well-recognized global problem of climate change, but they are also the key players in tackling it. For example, by tackling energy and electricity consumption, adding renewable energy sources, forming a sustainable community structure and transportation system, and focusing on material and energy efficiency, cities can effect on their impact on climate change. Hence significantly reduce the GHG emissions of their actions.

No single mitigation strategy or option will be sufficient enough to keep the temperature change under 2 degrees Celsius below the pre-industrial levels. Mitigating greenhouse gas emissions in the city regions vary, but is most effective when different policy instruments are used together (ICLEI 2014, 5). In the urban areas the main focus is on energy efficiency improvements and increasing the share of renewable energy, and investing on new clean technologies (IPCC. 2014, 569).

The increasing temperatures of land areas and oceans have critical consequences on nature and societies. Metropolitan areas are vulnerable for example to flooding, heavy rains, storms and prolonged heat waves. The built infrastructure, economic activities and population concentration in the cities highly increase the threats caused by climate change. Rapidly growing cities are increasingly exposed to changing climate and disaster risks. Climate change impacts for cities include, for instance, rising temperatures, heat stress, water scarcity and pollution, sea level rise, inland flooding, food scarcity, potential spread of disease, extreme weather events such as storms and heavy rainfall. In most of the cities the climate change is expected to have major impacts on local energy systems, water supply, water demand, wastewater treatment, transportation and public health (UCCRN. 2011, xvii).

National, local, and city governments have a vital role in taking actions towards climate change and shaping the development to be sustainable. Focusing on sustainability in city management, and understanding how to implement a sustainable urban area are important. City governments' and policymakers' responsibility is to understand the impacts, and to develop mitigation and adaptation strategies, and find the right tools to measure the development of cities towards the set climate goals.

Shaping the infrastructure of the city regions' to be more sustainable, investing in low-carbon urban planning and development strategies can significantly reduce GHG emissions. A city's performance in sustainability and the climate change mitigation actions can be measured using different indicators.

4 KEY INDICATORS IN THE HELSINKI METROPOLITAN AREA

From the collection of 56 indicators nine key indicators were selected together with the cities various administrative experts and Helsinki Region Transport (HSL) (Appendix 3). The key indicators illustrate the progress of the climate work in the Helsinki Metropolitan Area, and show the actions in different sectors of the Helsinki Metropolitan Area Climate Strategy 2030 are proceeding. The key indicators are summarized in the indicator fan that illustrates the progress of a single indicator in traffic light colors. The traffic lights evaluate the direction of development, and the adequacy of the measures.

The colors of the key indicators describe the change from the previous year. Green says the situation has improved, for example, that greenhouse gas emissions have decreased, or that the amount of household waste has decreased. Yellow indicates that climate change mitigation has not advanced in that sector. Finally red color warns of climate-poor development.

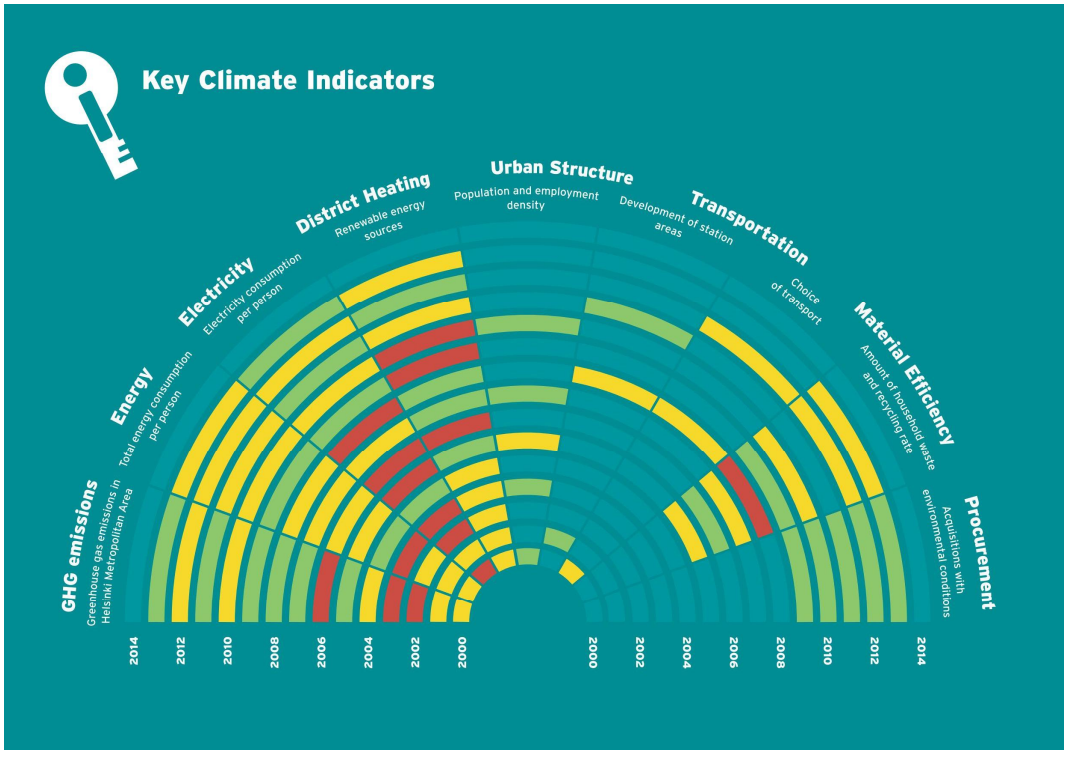

Figure 1. The 2013 key indicators of the Helsinki Metropolitan Area (HSY, 2014).

4.1 Greenhouse gas emissions in the Helsinki Metropolitan Area

The Vision of the Helsinki Metropolitan Area's climate strategy is energy efficiency and minimizing the use of natural resources, which leads to a reduction in greenhouse gas emissions in the region, as well as to the strengthening of competitiveness.

The annual monitoring of greenhouse gas emissions explains how sustainable the development of the metropolitan area is to the climate, how climate work has progressed, and how the objectives met the set targets. The calculation takes into account all the direct emissions from buildings, electricity consumption, transport, waste, and industrial machinery.

The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by sector. The indicator also describes the trend in relation to the reduction targets of the Helsinki Metropolitan area's climate strategy.

4.2 Total energy consumption per person

Measuring the total energy consumption is based on the climate strategy's vision of energy efficiency. The Helsinki Metropolitan Area's cities serve as examples to the design, purchase and usage of buildings to be guided by the life cycle costs, energy efficiency, versatility, and utilization. Energy consumption causes about 98 percent of the direct greenhouse gas emissions in the Helsinki Metropolitan area. The objective of the climate strategy of the Helsinki Metropolitan Area is to reverse the decline in energy consumption.

The total energy consumption includes transportation, heating of the buildings, electricity consumption, and industries and working machines' fuel usage in the cities in the Helsinki metropolitan area.

The EU's objective is to improve energy efficiency by 20 percent by 2020. The development of energy efficiency can be monitored by the ratio of the region's overall energy consumption to the population growth.

4.3 Electricity consumption per person

The Vision of Helsinki Metropolitan Area’s climate strategy is that the electricity consumption per capita is declining in the region. Electricity consumption causes a fifth of greenhouse gas emissions in the region. Consumption may be affected in a number of ways by the individual choices of the residents.

The electricity consumption indicator describes the amount of electricity used in one year per capita in the Helsinki Metropolitan Area. The power grid companies supply energy to the municipalities in the Helsinki Metropolitan Area, from this supplied energy is reduced calculated electricity consumed for heating.

4.4 Renewable energy sources in district heating

The Vision of Helsinki Metropolitan Area’s climate strategy is that the heat, power and cooling production is competitive and mainly combined, and emissions are low-cost. In addition, the long-term climate targets of the Helsinki Metropolitan Area require the abandonment of fossil fuels.

By monitoring the fuels used in district heat production, can be described the amounts and relationship between fossil and renewable fuels. Heat production is the single largest source of emissions at the Helsinki Metropolitan Area, and is still based almost entirely on fossil fuels. Finland's aim is to increase the use of renewable fuels in the amount of 38 percent of the final energy consumption by 2020. The energy policies of the City of Helsinki, for example, aim to increase the share of renewable energy to 20 per cent in 2020.

4.5 Population and employment density

The Vision of the Helsinki Metropolitan Area's climate strategy is that the development of sustainable community structure is based on the renewal and complementary construction relying on rail transport. The Helsinki region is growing intensively despite the economic downturn. It is essential to condense and complement the existing community structure, and to follow the development of the condensation of the community structure, which is central when making the structure and land-use development understandable. A compact community structure is more effective and economical, and generates fewer greenhouse gas emissions.

The indicator measures the condensation of the community structure and the potential to organize the public transport. The indicator takes into consideration the positive population growth expected in the region.

4.6 Development of station areas

The Vision of the Helsinki Metropolitan Area's climate strategy is that the development of sustainable community structure is based on the renewal and complementary construction relying on rail transport, and that the public transport, cycling and walking attract as primary transportation.

The indicator measures the population in the rail station areas and employment change in the region in relation to the average population and job growth in each period of time. This way, the status of regional land use and the growth of attractiveness can be viewed. The aim is to increase the share of rail transit and enhance the utilization of the stations. The analysis is made of both the 600 m and 1000 m radius of the stations.

A trend review describes the change of potential users of the land-use and rail transport in the station areas in relation to the growth of the region. One of the regional goals is to intensify the usage of rail transportation as a low-emission mode of transport. Another goal is to improve the station areas as part of a smart transportation chain and service net.

4.7 Choice of transport

The Vision of the Helsinki Metropolitan Area's climate strategy is that the greenhouse gas emissions per capita of transportation will decrease by at least 20 per cent. And that the public transport, cycling and walking attract as primary transportation.

This indicator measures the percentage of public transport, walking and cycling, as well as passenger traffic percentages of trips made in daily traffic. With the changes in the residents' modal distribution, the development and changes in the public transportation, walking, cycling and passenger traffic can be estimated.

4.8 Household waste and recycling rate

The Vision of the Helsinki Metropolitan Area's climate strategy is that the procurement and consumption are at a sustainable level. The amount of waste in relation to the production and to the number of inhabitants is decreased. The improved and intelligent material efficiency is a tool to mitigate climate change, and at the same time significant financial savings can be achieved.

The amount of household waste per person describes the damage caused by waste to the environment and society, and the consumption behavior of the society. Together with the recycling rate, the indicator reflects the effectiveness of material efficiency in the Helsinki Metropolitan Area. The recycling rate does not include the recyclable waste exploited for energy production.

4.9 Acquisitions with environmental conditions

The Vision of the Helsinki Metropolitan Area's climate strategy is that the procurement and consumption are at a sustainable level. Sustainable public procurement can significantly reduce greenhouse gas emissions. In

order to achieve the climate objectives the ecological thinking must be connected into the normal procurement process.

The indicator can be used to keep track of the impact of purchases and consumptions on the environment. The indicator measures the number of environmental aspects of procurements in euros of the cities purchases.

Environmental acquisitions are such products and services in which an environmental criterion is required in the technical specification or in which environmental issues are included in the scoring of the tender. The indicator does not reflect the effectiveness of environmental criteria in relation to other procurement criteria and not on eco-friendliness of the actual purchase decision.

5 COMPARISON OF CASE CITIES' KEY INDICATORS

The key climate indicators of the Helsinki Region Environmental Services Authority HSY were compared to the key indicators of the city of Hannover, Germany and the city of Vancouver, Canada. The case cities, Hannover and Vancouver, were selected after discussing with several different specialists who have worked with city sustainability indicators. Furthermore, the selected cities have a long and successful history in climate work, and therefore are good targets to benchmark and learn from.

The selected cities are completely new targets of benchmarking for the HSY. Compared to HSY's climate work, Hannover and Vancouver have succeeded in theirs, and therefore can be seen as forerunners. After all, the main purpose of this thesis is to learn from the forerunners and to find new, more effective ways to influence decision-makers and city officials by selecting the right indicators to measure a city regions' performance in mitigating climate change.

In Hannover and Vancouver, the selected city indicators are "green indicators", or, sustainability indicators that illustrate the city's development towards environmental sustainability. In comparison, the HSY's climate indicators are also sustainability indicators, but have a more compact meaning of describing the progress in the climate work in the region.

5.1 Hannover

Hannover is a city of circa 520 000 inhabitants in Northern Germany. It is the capital of the surrounding Hannover region that is 204 square kilometers by total area. The greater Hannover region has over a million inhabitants.

Figure 2. Hannover on the map of Germany.

Over 20 years Hannover has regularly published environmental reports showing the sustainability level of the city region. The reports illustrate the development of the city performance and evaluate the realization of the environmental policy targets. Measuring the city region's sustainability with different indicators provide a truthful basis for political decision-making, and also give a tool to monitor their success. (Landeshaupstadt Hannover 2012, 4.)

Hannover city's indicators are environmental-related sustainability indicators that describe the city's development towards sustainability. The indicators show the need for environmental policy actions and also describe the success of environmental policy actions towards sustainable development. Hannover's sustainability indicators have been selected carefully, and have specified requirements. The indicators must have a link to practice and communicability, there has to be a relationship to the overall concept of sustainable development. Transparency, data availability and reliability are important as well as compatibility with nationally or internationally recognized indicator systems. Hannover city's indicators are selected to be open to further development as control and planning instruments. (Landeshaupstadt Hannover 2012, 4.)

Hannover has 29 key indicators that are divided into eight different sectors enabling to overview the city's development trend in the individual sectors of action. The sectors are: Energy and climate protection; Mobility and traffic; Air; Noise; Soil and land-take; Recreational space, nature conservation, agriculture and forestry; Water, groundwater, surface waters and wastewater, and Waste. (Appendix 4.)

Category	Indicator
Energy and Climate protection	Use of renewable energy sources
	Use of Combined Heat and Power
	Domestic electricity
	CO_2-emissions due to thermal energy cinsumption by the city administration
	CO_2-emissions due to thermal energy production by the city administration
Mobility and traffic	Car stock
	Modal split (choice of transport)
	CarSharing
	Public transport offer
	Demand for local public transport
	Public transport development
Air	General air pollution
	Traffic-related air pollution
Noise	Noise exposure
Soil and land-take	Land utilization
Recreational space, nature conservation, agriculture and forestry	Green and open spaces
	Agricultural land
	Protected areas
	Roadside trees
	Tree adoptions
Water, groundwater, surface waters and wastewater	Drinking-water consumption
	Drinking-water consumption by the city administration
	Biological quality of watercourses
	Water quality of the River Leine
	Wastewater purification
	Pollutant content of sewage sludge
Waste	Waste volume
	Quantity of recyclables
	Waste disposal volume

Table 1. Environment-related sustainability indicators of the city of Hannover (2012).

Hannover city's key indicators are sustainability indicators, and therefore cover more than HSY's key climate indicators. Hannover city's indicators are chosen to address the priorities that are sustainable and impact the everyday lives of city's residents, whereas the HSY's climate indicators are chosen to address the actions most significant in mitigating climate change.

Six of the HSY's key climate indicators are similar to Hannover city's key indicators. Hannover city's energy and climate sector covers HSY's greenhouse gas emissions (GHG), energy, electricity and district heating sectors. HSY has 'Total energy consumption per person' as a key climate indicator when in Hannover the parallel indicator is 'CO2-emissions due to thermal energy consumption by the city administration'. GHG emissions from energy consumption in Helsinki Metropolitan Area (HMA) are also calculated in the HSY, but it is not chosen to be a key indicator. In HSY, the GHG emissions have been chosen to be displayed as one indicator to show the total GHG emissions in the HMA.

Hannover city monitors the use of renewable energy sources measuring the percentage of renewable energy sources in the overall electricity consumption and percentage of photovoltaic installations. HSY's key climate indicator 'Renewable energy sources' is quite similar measuring the fuels used in district heat production, and describes the amounts and the relationship between fossil and renewable fuels in the region. Hannover city's key indicator 'Use of combined heat and power' measures the number and output of combined heat and power (CHP) plants in a town area and their percentage contribution to electricity supply. Similarly, as one of the 56 climate indicators, HSY monitors the district heating consumption in GWh by form of production, power plants and heating plants. Hannover city's indicator 'Domestic electricity' measuring the domestic electricity consumption of private households in kWh per inhabitant per year is parallel to the HSY's indicator 'Electricity consumption per person' which monitors the amount of electricity used in one year per capita in the HMA.

Both Hannover city's Mobility and Traffic sector and HSY's Transportation sector cover the indicator 'Choice of transport' measuring the share of means of transport (on foot, by bicycle, by car, by local public transport) in the region. HSY's transportation sector also includes an indicator 'Development of station areas' monitoring the rail station areas population and employment change in the region in relation to the average population and job growth in each time period. A similar indicator cannot be found from Hannover's key indicators. Closest of the meaning to this indicator is Hannover's 'Public transport development', which measures the share of residents (in percent) within the city of Hannover living within 300m of the next bus stop and/or maximum 500m of the next S-Bahn/Stadtbahn-stop. Hence it can be seen that the development of public transportation and forming urban structure to support public transport is seen as an important factor in both city regions.

Hannover city's 'Mobility and Traffic' sector also have indicators of 'Car stock', Car sharing', Public transport offer' and 'Demand for local public transport'. 'Car stock' indicator measures the number of private cars in relation to the population in cars per 1000 residents. This indicator is parallel to the HSY's indicator 'Number of cars per 1000 inhabitants' in the list of 56 climate indicators. The indicator measures the passenger density and describes the number of cars per thousand inhabitants presenting the development of passenger transport and, indirectly, emissions from transport development. Hannover city's key indicator 'Demand for Local Public Transport' measuring the number of passengers on local public transport within the Greater Hannover area per year finds a parallel in the HSY's climate indicator 'People using Public Transport'. This indicator measures the public transport passenger volume changes on an annual basis. Passenger volume in the metropolitan area indicates the annual get-ons in the number of different public transport modes in four municipalities, as well as get-ons in the number of inhabitants. The other Hannover city's 'Mobility and Traffic' sectors indicators do not find parallels in HSY's key climate indicators or in the other 56 climate indicators.

HSY's key climate indicator 'Amount of household waste and recycling rate' is similar to the Hannover city's waste indicators. Hannover city's indicator 'Waste volume' measures the total quantities of waste delivered from the City of Hannover and Hannover Region in kilograms per head per annum. The 'Quantity of recyclables' indicator measures the recyclables collected given as total and broken down by type in kilograms per head per annum. The 'Waste disposal volume' monitors the quantity of disposed waste from the City of Hannover and Hannover Region in relation to the number of inhabitants in kilograms per head per annum. HSY calculates the annual amount of municipal waste and its distribution by sector (private services, public services, households) in the HMA. In addition, the total amount waste produced annually, and the recycling rates are calculated for the different sectors. The annual waste disposal is not a climate indicator in the HSY, although the information is available naturally, because the specialists in the HSY see that the annual waste disposal does not really tell anything about the consumption behavior of the region's residents.

HSY's key climate indicators 'Population and employment density' and 'Acquisitions with environmental conditions' do not have parallel indicators in Hannover city's key indicators. Even though these key indicators do not have parallels, there is no question that these key indicators are significant. Population and employment density describe the urban structure of the HMA, whereas measuring the acquisitions with environmental conditions gives an overall picture of the sustainability factor of the HMA's cities procurements.

The 'Green and open spaces' indicator in Hannover city's key indicator listing measuring the extent of green and open spaces in hectares, percentage of city area and in relation to the population in m2 per resident, would be a potential addition to HSY's key climate indicators. With this indicator the carbon capture and its development could be measured in the HMA.

5.2 Vancouver

Vancouver City has over 600 000 inhabitants, and the total area is 115 square kilometers. Vancouver is situated in the British Columbia in Western Canada. The greater Vancouver region has over two million inhabitants.

Figure 3. Vancouver on the map of British Columbia, Canada.

The Vancouver city was one of the first in the world to recognize the importance of climate change, already in the 1990s. In 2011 the City Council approved the Greenest City Action Plan (GCAP) which has 10 greenest city goals to mitigate climate change, improve the quality of life the of city residents and to reduce the resident's carbon footprint. (City of Vancouver. 2012, 5.)

The GCAP has been divided into 10 smaller sectors each with a long-term (year 2050) goal and a short-term (year 2020) targets, and the implementation update is reported annually. The 10 sectors include 16 Greenest City indicators measuring the city's performance. The sectors are: Green economy; Climate leadership; Green buildings; Green transportation; Zero waste; Access to nature; Lighter footprint; Clean water; Clean air and Local food. The sectors and indicators (Appendix 5.) are all chosen because they target holistically a broad range of sustainability-related priorities that impact the city and its residents (Lee. 2015).

According to the city of Vancouver's monitoring and reporting planner Lloyd Lee "The indicators are definitely integrated into the decision-making process: they directly influence the prioritization of all short-term priority strategies" (Lee. 2015). Sustainability has been made a part of everyone's work plan inside the city organization, which distributes responsibility and sustainability across the city's residents as well.

Category (goal)	Indicator
Green Economy	Total number of green jobs
	Percentage of businesses engaged in greening their operations
Climate Leadership	Total tonnes of community CO_2e emissions from Vancouver
Green buildings	Total tonnes of CO_2e from residential and commercial buildings
Green transportation	Per cent of trips by foot, bicycle, and transit
	Total vehicle km driven per person
Zero waste	Annual solid waste disposed to landfill or incinerator from Vancouver
Access to nature	Per cent of city's land base within a five-minute walk to a green space
	Total number of additional trees planted
Lighter footprint	Number of people empowered[2] by City-led or -supported projects to:
	Take personal action in support of a Greenest City goal
	Reduce levels of consumption (cumulative)
Clean water	Total number of instances of not meeting drinking water quality standards
	Total water consumption per capita
Clean air	Number of instances where air quality standards[3] were not met
Local food	Number of neighbourhood food assets in Vancouver

Table 2. Creenest City Action Plan - City of Vancouver 2014.

Both, the Helsinki Region Environmental Services Authority HSY's key climate indicators and Vancouver's Greenest City indicators include the 'Total tonnes of greenhouse gas (GHG) emissions' indicator. Another similar indicator is the waste indicator. Vancouver's goal is to create zero waste and reduce the amount of solid waste going to the landfill of incinerator by 50 per cent from 2008 levels. This is monitored with the indicator that measures the annual solid waste disposed to landfill or incinerator from Vancouver. The HSY also monitors the amount and repository of solid waste annually. The indicator describes the annual amount of municipal waste and its distribution by sector (private services, public services, households) in the Helsinki Metropolitan Area (HMA). As a

key indicator HSY has chosen to measure the annual amount and recycling rate of household waste in the region, because this indicator better describes the consumption behavior of the society than the total amount of municipal waste.

The transportation indicators are also similar. In Helsinki region as well in Vancouver the goal is to make walking, cycling and public transit preferred transportation options. In Vancouver, the target is that the majority (over 50 per cent) of trips made in the city are made by foot, bicycle and public transit, and also to reduce the average distance driven per resident by 20 per cent from 2007 levels. (City of Vancouver. 2014, 20.) This is monitored with the indicators that measure the per cent mode share by foot, bike and transit and the total vehicle kilometers driven per person in a year. Similarly, the HSY's key climate indicator 'Choise of transport' measures the percentage of public transport, walking and cycling, as well as passenger traffic percentages of trips made in daily traffic. One of HSY's transportation indicators of all of the monitored climate indicators is the 'Traffic by type of vehicle and city' indicator. The traffic explains driven distance traveled inside the metropolitan area boundaries by different types of vehicle in a year. The calculation is based mainly on Transport Agency traffic counting. The traffic is determined so that the number of vehicles observed on the road in a given unit of time is multiplied by the length of the road section in which these cars are moving.

Whereas HSY has chosen to study the development of total energy consumption per person and electricity consumption per person in the HMA, in Vancouver they have decided to track the energy usage and GHG emissions of buildings. Vancouver's 'Green buildings' sector covers HSY's 'District heating' sector and the 'Renewable energy sources' indicator that measures the reduction of energy usage and GHG emissions in existing buildings by 20% over 2007 levels.

Vancouver city's Greenest City indicators and HSY's key climate indicators differ in many ways mainly because the HSY's key climate indicators mean to measure the development in climate change mitigation, and

Vancouver’s Greenest City indicators measure the sustainability level of the city. Vancouver does not track the density of the population in relation to transit, but they measure the density of the population in relation to green space in a similar way. They do not have an indicator parallel to the environmental acquisitions indicator of HSY. Though, Lee Lloyd notes that “sustainable procurement is a priority in the city and that they are currently refining sustainability evaluation process to be more robust” (Lee, 2015).

The other Greenest City indicators that do not have similarities with HSY’s key climate indicators are in the sectors of ‘Green economy’, ‘Access to nature’, ‘Lighter footprint’, ‘Clean water’, ‘Clean air’ and ‘Local food’. (Appendix 4.)

6 CONCLUSIONS

It must be noticed that there is much debate of the usefulness of ranking cities with the help of different indicators. It is quite impossible to compare the sustainability and livability of a specific place, because the methods used to measure sustainability in different areas, countries and continents vary a lot. Rather than ranking the cities or city regions and comparing then to one another, it is more useful to benchmark and learn from each other. It is useful to measure similar matters and select similar indicators, but the results are necessary not comparable because of the variation in the calculation and measurement methods.

The List of indicators for the European Green Capital Award study of factors influencing urban sustainability in 2014-2015 aims to unify the sustainability indicators among the EU cities. The unified indicators make it easier to understand how the different cities perform among the EU, but again the comparison of specific cities is difficult. By unifying the sustainability indicators, the right development direction towards sustainability and climate work are made easier for the cities to recognize. To the decision-makers and to implementation of new policy actions in city regions can be influenced with the right indicators, hence mitigate climate change and create more sustainable cities.

When comparing to ’The List of indicators for European Green Capital Award study of factors influencing urban sustainability 2014-2015’, all the 56 climate indicators can be somehow found from the list, or placed under some category. Also the comparison of HSY’s key climate indicators and the case cities’ key indicators indicate that the chosen key indicators are quite similar. In short, the indicators measuring the sustainability of the city regions are quite similar in all the cities studied in this thesis. The indicators are not necessarily exactly the same, but the purpose of the indicator is the same.

After the comparison, there is not a need to major changes in the HSY’s climate indicators. Although, HSY’s ‘Access to services’ indicator needs

considering whether it is current and worth the work. There have been difficulties in getting the needed information for this indicator, and therefore it has been pushed back a little bit. It seems that the indicators selected as HSY's climate indicators are comprehensive and comparable to international sustainability indicators. Few of the case cities' sustainability indicators have significance in mitigating climate change, and therefore could be seen as new additions to HSY's key climate indicators.

Water theme is highly featured in the international sustainability indicators. Adding water as a new theme into HSY's key climate indicators could be worth considering. Water consumption and its quality are significant sustainability indicators and also a major factor in HSY's operation. From the climate indicator point of view, an indicator measuring the consumption of warm water rather than water consumption in general would be more useful. An indicator describing the average daily warm water consumption in households in liters per person, or the consumption in the buildings owned by the city could be a useful addition. Heating water requires lots of energy, and therefore has significant climate impacts. Measuring the usage of warm water in the buildings owned by the cities gives base data to point out actions to reduce the usage of warm water and hence energy. The usage of warm water could be calculated as estimation based on Motiva's study (Motiva, 2015).

Another possible new indicator is a 'Carbon capture' indicator that describes the amount of green space in Helsinki Metropolitan Area (HMA). Green spaces inside the city sink carbon from the air and therefore are very important in mitigating climate change. The 'Carbon capture' indicator would cover three indicators from the European Green Capital List of Sustainability Indicators: 28. Percentage of area urban green space in municipality, 30. Percentage of area forest in the municipality, and 32. Percentage on Natura 2000 area in municipality.

The benchmarked cities of Vancouver and Hannover also have key indicators measuring green areas. Vancouver's sector 'Access to nature' includes two indicators: 'All Vancouver residents live within a five-minute

walk of a park, greenway or other green space by 2020’ and ‘The city plants 150,000 new trees by 2020’. Hannover's indicator 'Green and open spaces' in the sector of ‘Nature conservation, agriculture and recreation’ measures the area of green spaces in the city. The purpose of these indicators is to ensure the green area in the city and its availability to its citizens.

In HSY, the ‘Carbon capture’ indicator could be used as a climate mitigation indicator measuring the amount and the development of possible carbon capture areas in the HMA. Adding green spaces in the city region is a significant factor in the fight against climate change.

As part of the ILKKA-project, Climate-Proof City – The Planner’s Workbook, the HMA’s land-use emissions of greenhouse gases, carbon sinks and carbon stocks were calculated. The purpose of the ILKKA-project was to promote the climate-friendly sustainable urban planning. New tools and guidelines for city planners and landscaping and construction sector companies were designed to take climate change into account in the planning. The results of the ILKKA-project show that forests store carbon better than other green areas. For example, in Helsinki the results of the project were positive indicating that the city’s forests grow well and store carbon. Land-use planning is the key preserve and increase the carbon sinks in the HMA. (www.ilmastotyokalut.fi , 2014.)

In addition to the ILKKA-project, the green areas that are possible carbon sink areas in the HMA have also been mapped and calculated by HSY in 2014. This gives a good base for the ‘Carbon capture’ indicator to be monitored in the future as one of the HSY’s key climate indicators. The climate strategy for the Helsinki Metropolitan Area to 2030 includes the measures reducing emissions and energy consumption that are under the cities’ own jurisdiction or steering operations. Calculating and mapping the possible carbon sink areas in the HMA would support cities in the climate-friendly land-use planning.

The use of local and organic food in the cities’ public offices could be

another interesting addition to HSY's climate indicators as a completely new perspective compared to the existing climate indicators. The climate impacts of food consumption per person are roughly equal to the transport or housing, so the preference of climate-friendly food is essential for mitigating climate change (www.climateguide.fi , 2014). Key steps in reducing the climate impact of food are to favor local and organic foods. This could be measured, for example, in the pilot schools or daycare centers in the HMA with an indicator describing the amount of schools that use a certain percentage of local or organic food in food preparation. This indicator would measure cities' reduction of indirect but influential greenhouse gas emissions. Cities' own jurisdiction and steering operations would be in great role in measuring this indicator.

In addition to the indicator update suggestions, HSY's indicator reporting could be improved. There are lots of similarities in the reporting systems of HSY and Vancouver city. Both cities monitor and measure the actions towards sustainability in order to mitigate climate change. HSY monitors annually the climate actions implemented in the HMA, and reports periodically about the development of the climate indicators.

The city of Vancouver has combined reporting of the indicators and climate actions quite effectively and clearly. In the Greenest City 2020 Action Plan Implementation Update reports, each Greenest City indicator measured has an example of an implemented action related to the measured indicator that has come to action in the city in previous year. HSY could change their reporting system similar to Vancouver. Combining the climate actions and key climate indicators in the same report would be more compact and give the reader a concrete picture of the ongoing climate work in the HMA.

It would also be more efficient and less resource consuming to only update and calculate the indicators without a deeper analysis from each of the 56 climate indicators. This could be done annually, and figures would be published in HSY's webpage. A deeper analysis by a climate specialist could be done only when asked and needed. Altogether, the main focus

should be on internet reporting for both the key climate indicators and reset of the climate indicators. After all, the internet is the tool for searching and sharing information today. The city of Vancouver also has very up to date webpages where much can be learned and inspiration taken.

Finally, in the future it would be nice to see that the HSY's climate indicators would be in a position where they would directly influence the decision-making processes and would be integrated into the long- and short-term priority strategies in the Helsinki Metropolitan Area. In the studied case cities the indicators are used in decision-making and in the planning of strategies at a completely different level than in the Helsinki Metropolitan Area.

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APPENDICES

Appendix 1. Helsinki Metropolitan Area's climate indicators - Helsinki Region Environmental Services Authority HSY

Category	Indicator	Description	Type
The operating environment changes in the Helsinki Metropolitan Area 2000-2010	Employment density (actual & expected by 2035)	Number of jobs in the Helsinki metropolitan area. Number of jobs affect directly and indirectly to the greenhouse gas emissions, for example through increased mobility and power-consumption.	
	Development of average population density	The number of the inhabitants of the metropolitan area. It can be used to determine the per capita emissions.	population / km2
	The development of number of dwelling units	The number of dwelling units in the Helsinki Metropolitan Area. The number of dwelling units effects on heating, community structure and through building also to the natural resources.	
	Growth of the average size of housing and living space development	Growth of the average size of housing (m2/unit) and living space development (m2/person). More living space, more heated squares and heating emissions, which has economic impacts as well as impacts on community structure and use of natural resources.	m2/person
	GDP in the region / per municipality	Gross domestic product (GDP) growth and economic growth in the metropolitan area. GDP tells indirect consumption and its resulting effects on the climate; the higher the GDP, the higher the consumption.	
Greenhouse gas (GHG) emissions in the different regional levels	Global carbon emissions development	Carbon dioxide emissions gigatonnes of carbon caused by global use of fossil fuels and cement production, relative to the IPCC's new emission scenarios.	GtC
	GHG emissions in Europe	The sum of the amount of greenhouse gas emissions by sector of the 27 European Union Member States. Finland is committed to the EU's emission reduction targets. The current target is a 20% emission reduction by 2020.	Mt CO2-ekv.
	Comparing city regions in Europe	European urban greenhouse gas emissions in tonnes per capita.	

	GHG emissions by sector in Finland	Finland's greenhouse gas emissions by sector for the years 1990-2011 as well as preliminary data for the year 2012. The entry level for reducing emissions is generally regarded as the year 1990. By 2020, the national goal is to reduce 20% of greenhouse gas emissions.	Mt CO2-ekv.
Greenhouse gas emissions and reduction in the Helsinki Metropolitan Area	Total GHG emissions development in relation to reduction target	The calculation takes into account all the direct emissions from buildings, electricity consumption, transport, waste, and industrial machinery and industrial machinery concerned. The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by sector. The indicator also describes the trend in relation to the reduction targets of the Helsinki Metropolitan area's climate strategy. (1000t CO2-ekv.)	1000t CO2-ekv.
	Total GHG emissions per person		t CO2-ekv./as.
	Total GHG emissions by sector and by municipality	The Metropolitan area greenhouse gas emission by sector for the years 1990 and 2000-2012. Line graph describes the actual emissions without trend smoothing. The development of the Metropolitan area's GHG-emissions by city in 1990 and 2000-2012.	1000t CO2-ekv.
GHG emissions from transport	Total GHG emissions from transport by vehicle and per capita	GHG emissions from transport describe the energy consumption of transportation emissions generated in the metropolitan area. Climate strategy's aim is the 20% emission reduction per capita by 2030 (1,2 t CO2-ekv./as.).	1000t CO2-ekv.
	Total GHG emissions from transport by municipality	Transport energy emissions generated in metropolitan municipalities.	1000t CO2-ekv.
	The traffic by type of vehicle and city	The traffic explains driven distance traveled inside the metropolitan area boundaries by different types of vehicle in a year. The calculation is based mainly on Transport Agency traffic counting. The traffic is determined so that the number of vehicles observed on the road in a given unit of time is multiplied by the length of the road section in which these cars are moving.	million km/year
	Kilometers driven by passenger cars by person		km

	Residents modal distribution	Mode of transportation measures the distribution of transport and modes of percentages of the journeys made by metropolitan area residents. In terms of climate change mitigation maximizing the share of walking, cycling and energy efficient public transport is beneficial. With modal split can also be viewed the sustainability of the community. Sustainable mobility requires an effective and comprehensive public transport, functional and safe pedestrian and bicycle paths, as well as an integrated urban structure.	% of journeys made
	People using public transport	Public transport passenger volume changes on an annual basis. Passenger volume in the metropolitan area indicates the annual get-ons in the number of different public transport modes in four municipalities, as well as get-ons in the number of inhabitants. This amount includes the metropolitan area get-ons to the tram, metro, buses (Helsinki, Espoo and Vantaa internal lines and regional transport) as well as the nearby trains. Figures do not include the ferry Finland Castle get-ons. Regional population has increased considerably in the 2000s.	million get ons/year
	Length of designated cycle lanes in relation to total number of inhabitants	This indicator presents the number of cycle paths in relation to the population of municipality. Into the cycle path network are calculated separate cycling and walking paths, park paths as well as the adjacent carriageway combined pedestrian and cycle paths and greenways, if they are part of significant cycling network. It does not include the inner city and suburban streets, pavements. The increases in cycle path network illustrate efforts to promote environmentally friendly mobility.	meters of lane per capita
	Number of public transport tickets provided by municipality to its employers	Employer-subsidized ticket is a public transport ticket provided by employers to their employees. This indicator measures the number of job tickets by city since 2008. This indicator presents the use of public transport to the number of commuter traffic	
	Number of cars provided by municipality to its employers	Car benefit number in the city since 2008. Car benefit includes a car allowance, as well as the free use of the car that interest. Car benefit illustrates the number of private car usage in commuter traffic.	
	Public transport ticket prices	Public transport ticket price describes the cost of using public transport and of its development since 1990. Prices have been corrected by the cost of living index.	€

	The utilization and number of 'park and ride' parking lots for cars	Measures the development and utilization of 'park and ride' parking lots for cars as a percentage. Park and Ride to reduce car traffic within the city and enables the formation of a chain of low-carbon travel.	
	The utilization and number of 'park and ride' parking lots for bicycles	Measures the development and utilization of 'park and ride' parking lots for bicycles as a percentage. Park and Ride promote the use of bicycles and allows the formation of a chain of low-carbon travel.	
	Number of cars by municipality	The total number of passenger cars in a city in the metropolitan area. Increase in the number of cars increase the direct carbon dioxide emissions and other environmental impacts, such as, noise, space requirements and the impact on air quality. Indirectly the motorization consumes natural resources and energy when manufacturing vehicles.	
	Number of cars per 1000 inhabitants	Passenger density describes the number of cars per thousand inhabitants. This indicator presents the development of passenger transport and, indirectly, emissions from transport development.	
	Price of cars and gasoline	Car and petrol price development indexed in 1990. This indicator presents the motoring affordability and competitiveness of the different transport modes.	€
	Fuel distribution of busses	Bus fuel distribution (%) of the total quantities of fuels used. This indicator presents the share of biofuels and its growth	
	Motorization by municipality	Motorization describes the car free, one-and two or more cars housing unit's share of all households.	passenger cars/municipality /1000 residents
	Carbon dioxide emissions of newly registered passenger cars	Carbon dioxide emissions of newly registered passenger cars (g/km, combined driving).	1000t CO2-ekv.
Land use	Area efficiency (growth/change)	Area efficiency measures the gross floor area of buildings in relation to other land uses, this describes the land use efficiency in the metropolitan area. In the analysis the area is divided into 250 x 250 m boxes. Area efficiency is different from a plot efficiency such that there is a total land area, including green areas and roads. The change of area efficiency is obtained by looking at the difference between the area of the effectiveness of the figures in years 2000 and 2010.	

	The population and employment density development	The indicator measures the compaction of the community structure and the possibilities to organize public transport. From the YKR material is summed together from the 250 x 250 m squares the residents and jobs, and then can be seen the actual use of the urban structure. This development can be identified by examining the time series. The resulting spatial data frames are classified into three categories: less than 35 residents+jobs/ha, 35–50 residents+jobs/ha and more than 50 residents+jobs/ha, that are central limit values for the organization of public transport profitability. The indicator takes into account the positive population growth according to the region's prognosis.	
	Rail transport user potential	Rail transport user describes the density of population and the number of jobs, in other words the potential number of users of train or subway near the station in relation to the surface area. It is obtained by adding together the residents and jobs from each station area and dividing by the amount of surface area. Delimitation is set to 600 m, which is considered a reasonable walking distance to the train station. The population and employment densities are divided into five different categories, from which can be seen how effective the use of each station area is.	
	Commuting into the Helsinki Metropolitan Area	Commuting describes the cross-border commuting. Measured as a percentage of commuters employed in the municipality. The data is based on Statistics Finland's employment statistics. Commuting also illustrates the urban structure i.e. population and the job placement in the region.	
	Accessibility of services		% / residents of the municipality
Electricity consumption	Total electricity consumption		GWh
	Total electricity consumption by sector		MWh
	Total electricity consumption per capita		MWh
	Electricity consumption by municipality		GWh

	Final energy consumption in residential sector per m2 of residential floor space by municipality		kWh/m2
	GHG emissions from electricity consumption		1000t CO2-ekv.
Buildings: heating, cooling and energy efficiency	Age of the housing stock		
	GHG emissions from heating buildings		1000t CO2-ekv.
	Type of heating: oil, district heating and electrically heated buildings		million k-m2
	District heating and cooling by municipality and region		GWh
	District heating consumption by sector by municipality and region		GWh
	District heating consumption by form of production: power plants (CHP), heating plants		GWh
	Renewable sources of energy in district heating		GWh
	Heat consumption in municipality's buildings		kWh/m3
Energy production	Fuels used for district heating in the region		GWh
	Fuels used for district heating by municipality		GWh
Procurement, consumption and waste	Amount of household waste in the region		kg/person
	Recycling rate of the household waste in the region		%

	Municipal waste by sector (private services, public services, households) in the region 2004-2012		tonnes
	Composition of household waste	Percentage of types of waste of the total amount of household waste (mixed waste, paper, organic waste, cardboard, glass, metal, hazardous waste, wood, garden waste, electrical appliances)	%
	Paper consumption in offices and institutions		A4 sheet of paper/employer
	Environmental acquisitions	Indicator measures the number of environmental aspects of procurements in euros of the cities purchases.	
General means	Trained eco-supporters in Helsinki Metropolitan Area		
	Environmentally certified day care centers and schools		
	Total Energy consumption per person	The total energy consumption includes transportation, heating of the buildings, electricity consumption, and industries and working machines' fuel usage in the cities in the Helsinki metropolitan area. The heat consumption includes the heating repair.	MWh

Appendix 2.

The List of indicators for European Green Capital Award study of factors influencing urban sustainability 2014-2015 compared to the HSY's 56 climate indicators. (x = measured in HSY, S = new indicator suggestion for HSY)

No	Theme	Indicator	Definition	HSY	Indicator	Description
1	Soil and groundwater	Contaminated sites	Estimated total area of contaminated sites (incl. brownfield sites, according to national criteria) within municipality in % of total surface area			
2	Soil and groundwater	Chemical status groundwater	Average chemical status of groundwater bodies within municipality (Water Framework Directive criteria)	x		
3	Soil and groundwater	Nitrogen input on soil	Total annual nitrogen input in kg nitrogen/km2 city surface (including applied and grazing manure and mineral fertilization)	x		
4	Drinking water and sanitation	Public water supply consumption	Total public water supply consumption in cubic meters per year (households plus industrial and other uses)	x		
5	Drinking water and sanitation		Average daily water consumption in households in liters/capita	S	Warm water consumption	Average daily water consumption in the buildings owned by city. Heating water requires lots of energy and therefore has significant climate impacts. Measuring the usage of warm water in the buildings owned by cities gives base data to point out actions to reduce the usage of warm water and hence energy. The usage of warm water could be calculated as estimation based on Motiva's study. http://www.motiva.fi/julkinen_sektori/energiankayton_tehostaminen/kiinteistojen_energianhallinta/kulutuksen_normitus/laskukaavat_lammin_kayttovesi
6	Drinking water and sanitation	Water metering	Percentage of urban water supply subject to water metering			

7	Drinking water and sanitation	Drinking water quality	Number of days of non-compliance with EU Drinking Water Directive (50 milligram per liter) and annual average concentration			
8	Drinking water and sanitation		Number of days of non-compliance with EU Drinking Water Directive (2500 micro Siemens/cm at 20 degrees Celsius) and annual average value			
9	Drinking water and sanitation		Number of days of non-compliance with EU Drinking Water Directive (0 E. coliform counts in Colony Forming Units per 100 ml)			
10	Drinking water and sanitation	Waste water collection	Percentage of total annually generated waste water load that is directed towards a waste water collection system	x		
11	Drinking water and sanitation	Waste water treatment	Percentage of collected waste water that is treated by urban secondary treatment plant (BOD reduction) or better	x		
12	Air	Concentration nitrogen dioxide	Annual mean concentration NO2 in microgram per m3	x		
13	Air	Concentration ozone	Annual mean concentration O3 in microgram per m3	x		
14	Air	Concentration particulate matter	Annual mean concentration PM10 and PM 2.5 in microgram per m3	x		
15	Air	Emission nitrogen dioxide	Annual emission NO2 in kg per capita	x		
16	Air	Emission Volatile Organic Carbon	Annual emission VOC in kg per capita	x		
17	Air	Emission particulate matter	Annual emission PM10 and PM 2.5 in kg per capita	x		

18	Air	Perception of seriousness air pollution	Perception urban air is a problem Index method of Eurostat			
19	Surface water	Chemical status surface water	Average chemical status of surface water bodies within municipality (WFD criteria)			
20	Surface water	Ecological status surface water	Average ecological status of surface water bodies within municipality (WFD criteria)			
21	Surface water	Soil Sealing	Total area of paved surface within municipality as percentage of total surface area			
22	Surface water	Flooding	Average number of days per year with a significant flooded area due to excess water in rivers and lakes after rainfall			
23	Surface water		Average number of days per year with a significant flooded area due to excess water in sewers after rainfall			
24	Nature and landscape	Area of urban green areas	Percentage of area urban green space in municipality	S	Carbon capture/Green areas/Hiilinielut	Could be gathered from the Regional Land Cover Data. The Carbon Capture potentials have been calculated in the HMA in 2014. The Carbon Capture indicator covers three indicators (24. Area of urban green areas = Percentage of area urban green space in municipality, 26. Area of forests = Percentage of area forest in the municipality, 28. Biodiversity = Percentage on Natura 2000 area in municipality) from the European Green Capital List of Sustainability Indicators.
25	Nature and landscape	Area of urban blue areas	Percentage of area water bodies in municipality			
26	Nature and landscape	Area of forests	Percentage of area forests in municipality	S	Carbon capture/Green areas/Hiilinielut	Regional land cover data

27	Nature and landscape	Urban sprawl	Population density (inhabitants per hectare) in built-up areas (city area minus green and blue areas)	x	Area efficiency (growth/change)	Area efficiency measures the gross floor area of buildings in relation to other land uses, this describes the land use efficiency in the metropolitan area. In the analysis the area is divided into 250 x 250 m boxes. Area efficiency is different from plot efficiency such that there is a total land area, including green areas and roads. The change of area efficiency is obtained by looking at the difference between the area of the effectiveness of the figures in years 2000 and 2010.
28	Nature and landscape	Biodiversity	Percentage of Natura 2000 area in municipality	S	Carbon capture/Green areas/Hiilinielut	Regional land cover data
29	Energy and climate	Emission greenhouse gasses	Emission greenhouse gasses in CO2 equivalents (tonnes per capita) in 2012	x	Total GHG emissions per person (t CO2-ekv./as.)	The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by person.
				x	Total GHG emissions by sector and by municipality (1000t CO2-ekv.)	The Metropolitan area greenhouse gas emission by sector for the years 1990 and 2000-2012. Line graph describes the actual emissions without trend smoothing. The development of the Metropolitan area's GHG-emissions by city in 1990 and 2000-2012.
				x	Total GHG emissions development in relation to reduction target (1000t CO2-ekv.)	The calculation takes into account all the direct emissions from buildings, electricity consumption, transport, waste, and industrial machinery and industrial machinery concerned. The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by sector. The indicator also describes the trend in relation to the reduction targets of the Helsinki Metropolitan area's climate strategy.
30	Energy and climate	Emission GHG from traffic	Emission CO2 equivalents (tonnes per capita) resulting from fuel use in transport in 2012	x	Total GHG emissions from transport (1000t CO2-ekv.)	GHG emissions from transport describe the energy consumption of transportation emissions generated in the metropolitan area. Climate strategy's aim is the 20% emission reduction per capita by 2030 (1,2 t CO2-ekv./as.).
					Total GHG emissions from transport by vehicle (1000t CO2-ekv.)	GHG emissions from transport describe the energy consumption of transportation emissions generated in the metropolitan area. Climate strategy's aim is the 20% emission reduction per capita by 2030 (1,2 t CO2-ekv./as.).

					Total GHG emissions from transport per capita (1000t CO2-ekv.)	GHG emissions from transport describe the energy consumption of transportation emissions generated in the metropolitan area. Climate strategy's aim is the 20% emission reduction per capita by 2030 (1,2 t CO2-ekv./as.).
					Total GHG emissions from transport by municipality (1000t CO2-ekv.)	Transport energy emissions generated in metropolitan municipalities.
31	Energy and climate	Emission GHG from electricity consumed	Emission CO2 equivalents per MWh electricity consumed in 2012	x	GHG emissions from electricity consumption (1000t CO2-ekv.)	The Metropolitan area greenhouse gas emission by sector for the years 1990 and 2000-2012.
				x	Total electricity consumption	Total electricity consumption describes the consumption of electricity in the region and total amount of electricity used (GWh) for heating during the year, broken down by sector, and per capita. The calculation uses the national emission factor, which annual fluctuations are balanced by using a five-year moving average.
				x	Total electricity consumption per capita	The indicator describes the amount of electricity used in one year per capita in the Helsinki metropolitan area. From the electricity supplied by the power grid companies into the municipalities area is reduced the calculated heating consumption of electricity. (MWh)
				x	Total electricity consumption by sector	Total electricity consumption describes the consumption of electricity in the region and total amount of electricity used (GWh) for heating during the year, broken down by sector, and per capita. The calculation uses the national emission factor, which annual fluctuations are balanced by using a five-year moving average.
				x	Electricity consumption by municipality	Electricity consumption by a city describes the amount of electricity consumed and electricity used for heating during the year, by sector in the Helsinki Metropolitan Area cities. The indicator also shows the change in electricity consumption per capita. The calculation of electricity consumption uses the national emission factor, which annual fluctuations are balanced by using a five-year moving

						average.
32	Energy and climate	Renewable energy	*	x	Renewable sources of energy in district heating (GWh)	The fuels used for the production of district heating describe the amounts and proportions of fossil and renewable fuels. Cogeneration fuel is divided into electricity and heat with benefit-sharing method. The goal is to increase the share of renewables significantly.
33	Energy and climate	Energy consumption of residential buildings	Final energy consumption in residential sector per m2 of residential floor space in kWh/m2 in 2012	x	Specific electricity consumption	Specific electricity consumption (kWh / m3) describes the development of amount of electricity consumed in the cities owned public buildings in 2004-2011.
					Age of the housing stock	The age of the housing stock describes each district housing stock's main building decade regionally, in other words, from what decade most of the buildings in the area are (the median). The age of the buildings is measures the need for modernization and energy efficiency of the buildings.
					GHG emissions from heating buildings (1000t CO2-ekv.)	The Metropolitan area greenhouse gas emission by sector for the years 1990 and 2000-2012.
					Type of heating: oil, district heating and electrically heated buildings (million k-m2)	The indicator describes the way of heating of buildings in a city. Most GHG emissions result from the electricity and oil heating. Emissions from district heating depend on the fuel used.
					District cooling by municipality and region (GWh)	The indicator describes the total consumption of district cooling. District cooling is being used to cool buildings since 2003. Its production is mainly based on energy, which would otherwise remain unused.

					District heating consumption by sector by municipality and region (GWh)	The indicator describes the consumption of district heat in the Helsinki Metropolitan Area (GWh) by sector/municipality/region. District heating is produced in the region mainly in combined heat and power production. Separate heating plants are used as needed.
					District heating consumption by form of production: power plants (CHP), heating plants (GWh)	
					Heat consumption in municipality's buildings (kWh/m3)	Specific consumption of heat = heating-energy consumption in kWh per heated cubic meters describes the energy efficiency of public sector buildings. Information is available from 2004 onwards.
					Fuels used for district heating in the region (GWh)	The fuels used for the production of district heating describe the amounts and proportions of fossil and renewable fuels. Cogeneration fuel is divided into electricity and heat with benefit-sharing method. The goal is to increase the share of renewables significantly.
					Fuels used for district heating by municipality (GWh)	The fuels used for the production of district heating describe the amounts and proportions of fossil and renewable fuels. Cogeneration fuel is divided into electricity and heat with benefit-sharing method. The goal is to increase the share of renewables significantly.
34	Energy and climate	CO2 emission reduction target	% CO2 emission reduction over 2010-2020	x	Total GHG emissions development in relation to reduction target (1000t CO2-ekv.)	The calculation takes into account all the direct emissions from buildings, electricity consumption, transport, waste, and industrial machinery and industrial machinery concerned. The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by sector. The indicator also describes the trend in relation to the reduction targets of the Helsinki Metropolitan area's climate strategy. (1000t CO2-ekv.)

					Total Energy consumption per person (MWh)	The total energy consumption includes transportation, heating of the buildings, electricity consumption, and industries and working machines' fuel usage in the cities in the Helsinki metropolitan area. The heat consumption includes the heating repair.
35	Resources and waste	Municipal waste	Total municipal solid waste production in kg/year per capita	x	Municipal waste by sector (*private services, public services, households) in the region 2004-2012 (tonnes)	The indicator describes the amount of municipal waste and its distribution by sector in the Helsinki Metropolitan Area.
					Amount of household waste in the region in kg/year per capita	The amount of household waste per person describes the damage caused by waste to the environment and society, and the consumption behavior of the society.
36	Resources and waste	Landfilling	Percentage of total municipal waste landfilled	x	Recycling rate of the household waste in the region (%)	The recycling rate reflects the effectiveness of the material efficiency in the Helsinki Metropolitan Area.
37	Resources and waste	Incineration	Percentage of total municipal waste incinerated	x	Recycling rate of the household waste in the region (%)	The recycling rate reflects the effectiveness of the material efficiency in the Helsinki Metropolitan Area.
38	Resources and waste	Glass	Collection of glass in kg/year per capita	x	Composition of household waste (%)	Percentage of types of waste of the total amount of household waste (mixed waste, paper, organic waste, cardboard, glass, metal, hazardous waste, wood, garden waste, electrical appliances)
39	Resources and waste	Paper and cardboard	Collection of paper and cardboard in kg/year per capita	x	Paper consumption in offices and institutions	The indicator measures the amount of office paper consumed annually per employee (A4 sheets / employee). Paper consumption describes the environmental responsibility of cities employees and the proliferation of electronic working methods.
40	Resources and waste	Biodegradable waste	Collection of biodegradable waste in kg/year per capita	x	Composition of household waste (%)	Percentage of types of waste of the total amount of household waste (mixed waste, paper, organic waste, cardboard, glass, metal, hazardous waste, wood, garden waste, electrical appliances)

41	Resources and waste	Plastic	Collection of plastics in kg/year per capita			
42	Resource and waste	Eco-innovation budget	Percentage of city's budget dedicated to eco-innovation that address material reuse & improve resource efficiency (including green public procurement	x	Acquisitions with environmental conditions	Indicator measures the number of environmental aspects of procurements in euros of the cities purchases.
				x	Trained eco-supporters in Helsinki Metropolitan Area	The indicator describes the trends in the number of trained eco-supporters by city. It is used to assess the extent of the eco-support actions in the cities organizations. The aim is to draw attention to environmental issues in the workplace: climate change mitigation, reduction of the environmental load and conservation of natural resources.
43	Nuisance (annoyance) and emergencies (calamities)	Noise exposure	Percentage of inhabitants exposed to noise values of Lden above 55 dB(A) and above 65 dB(A) due to major roads (Environmental Noise Directive)			
44	Nuisance (annoyance) and emergencies (calamities)	Noise exposure	Percentage of inhabitants exposed to noise values of Lden above 55 dB(A) and above 65 dB(A) due to railways (Environmental Noise Directive)			
45	Nuisance (annoyance) and emergencies (calamities)	Noise exposure	Percentage of inhabitants exposed to noise values of Lden above 55 dB(A) and above 65 dB(A) due to airports (Environmental Noise Directive)			
46	Nuisance and emergencies	Perception of noise annoyance	Perception noise is a problem Index method of Eurostat			
47	Nuisance and emergencies	Perception odor annoyance	Percentage of inhabitants that experience annoyance due to odors			
48	Nuisance and emergencies	Chance of disaster	Percentage of area with an annual chance of a disaster or major accident of over 1/1,000,000			
49	Social	Membership	Percentage of people that is a			

	participation	societies	member of one or more societies			
50	Social participation	Racism	Annual complaints on discrimination per capita			
51	Social participation	Loneliness	Percentage of people that experience loneliness			
52	Social participation	Volunteering	Percentage of people (18+) active in volunteering work			
53	Economic participation	Long-term unemployment	Percentage long-term unemployed (12+ months unemployed) in labor force			
54	Economic participation	Poverty	Percentage of people below the poverty line			
55	Economic participation	Disability	Percentage of people that are disables in labor force			
56	Political participation	Trust in politics	Percentage of people that have trust in the political system			
57	Political participation	Turnout municipal elections	Turnout percentage of the latest municipal council elections (in case multiple rounds: take 1st round)			
58	Political participation	Turnout national elections	Turnout percentage of the latest elections for national parliament (in case multiple rounds: take 1st round)			
59	Political participation	Turnout European elections	Turnout percentage of the latest elections for the European parliament			
60	Arts and culture	Museums	Museums per capita			
61	Arts and culture	Theaters	Number of theaters per capita			
62	Arts and culture	Galleries	Number of galleries per capita			
63	Arts and culture	Monuments	Number of monuments per capita			
64	Arts and culture	Cultural visits	Number of cultural visits per capita			

65	Residential environment	Rental price	Average rental price per m2	x	Growth of the average size of housing (m2/house)	Growth of the average size of housing (m2/unit) and living space development (m2/person). More living space, more heated squares and heating emissions, which has economic impacts as well as impacts on community structure and use of natural resources.
				x	Living space development (m2/person)	Growth of the average size of housing (m2/unit) and living space development (m2/person). More living space, more heated squares and heating emissions, which has economic impacts as well as impacts on community structure and use of natural resources.
66	Residential environment	Population density	Average population density (population / km2)	x	Development of average population density (population / km2)	The number of the inhabitants of the metropolitan area. It can be used to determine the per capita emissions.
67	Residential environment	Satisfaction with house	Percentage of people that is satisfied with their own house			
68	Residential environment	Satisfaction residential environment	Percentage of people that is satisfied with their residential environment			
69	Residential environment	Satisfaction facilities	Percentage of people that is satisfied with the facilities in the neighborhood			
70	Residential environment	New dwellings	Percentage of new dwellings (> 5 years old) in total number of dwellings	x	The development of number of dwelling units	The number of dwelling units in the Helsinki Metropolitan Area. The number of dwelling units effects on heating, community structure and through building also to the natural resources.
71	Residential environment	Net migration	Net migration rate (immigrants - emigrants / size of population)			
72	Safety	Homocide	Homocide rate per capita			
73	Safety	Burglary	Burglary rate per capita			
74	Safety	Traffic safety	Traffic accidents per capita			
75	Safety	Traffic fatalities	Traffic accident fatalities per capita			
76	Safety	Perception of safety in city	Percentage of people that feel safe in the city			
77	Health	Hospital beds	Number of hospital beds per capita			
78	Health	General practitioners	Number of general practitioners per capita			

79	Health	Life expectancy	Average life expectancy at birth in years			
80	Health	Suicides	Suicide rate per capita			
81	Health	Distance to hospital	Average distance to nearest hospital in km			
82	Health	Risky behavior	Total percentage of heavy smokers + percentage of heavy drinkers + percentage of obesity			
83	Health	Sports	Percentage of people that frequently (once a week or more) sports			
84	Health	Subjective health	Percentage of people that describe themselves as being 'healthy'			
85	Education	Schools	Number of primary and secondary schools per capita	x	Environmentally certified day care centers and schools	The indicator describes the development of the number of eco-certified day-care centers and schools in the Helsinki Metropolitan Area. Eco-Certification has been prepared as a tool and incentive for the development of teaching quality from environmental point of view. In the Green Flag program are combined the reduction of environmental load, sustainable development education and empowerment of children and youth in the activities.
86	Education	Youth unemployment	Percentage of 15-25 year old that are unemployed in labor force (15-25 yr)			
87	Education	Early leavers from education	Percentage of participants which leave education without a formal diploma			
88	Education	Education level	Percentage of population with at least secondary education			
89	Labor	Employment rate	Employment / potential labor force (total 15-65 y/o)			
90	Labor	Employment function	Number of jobs / total labor force			
91	Labor	Unemployment	Percentage of unemployed in the labor force			
92	Labor	Aging labor force	Percentage of more than 45 year old in labor force			

93	Labor	Green jobs	Number of jobs created annually in green sectors as share of total jobs in city			
94	Capital goods	Labor productivity	GDP expressed in PPS / total employment			
95	Capital goods	Investments by companies	Total investments by companies in euro per capita			
96	Capital goods	Availability capital	Percentage of businesses that experiences access to capital as easy			
97	Knowledge	High education	Percentage of labor force with at least tertiary education			
98	Knowledge	R&D intensity	R&D expenditures as percentage of GDP			
99	Knowledge	Employment creative class	Percentage of active people employed in the creative class			
100	Knowledge	Employment science and technology	Percentage of active people employed in science and technology			
101	Economic structure	GDP per capita	GDP per capita expressed in PPS (in 1,000 €/capita)	x	GDP per municipality / region	Gross domestic product (GDP) growth and economic growth in the metropolitan area. GDP tells indirect consumption and its resulting effects on the climate; the higher the GDP, the higher the consumption.
102	Economic structure	Disposable income	Average disposable annual income in euros per household			
103	Economic structure	Employment growth	Percentage annual growth of employment	x	Employment density (actual & expected by 2035)	Number of jobs in the Helsinki metropolitan area. Number of jobs affect directly and indirectly to the greenhouse gas emissions, for example through increased mobility and power-consumption.
104	Economic structure	Births of businesses	Births of businesses as percentage of total number of businesses			
105	Economic structure	Deaths of businesses	Deaths of businesses as percentage of total number of businesses			
106	Economic structure	Tourism	Number of total nights spent within municipality by tourists per capita			

107	Economic structure	Fast growing businesses	Fast growing businesses (growth > 10%) of businesses as percentage of total number of businesses			
108	Infrastructure and accessibility	ICT infrastructure	Percentage of population with an internet connection			
109	Infrastructure and accessibility		Percentage of households with broadband connection			
110	Infrastructure and accessibility	Use of non-car transport	The total percentage of the working population travelling to work by public transport, bicycle or foot	x	Modal split (choice of transport)	Mode of transportation measures the distribution of transport and modes of percentages of the journeys made by metropolitan area residents. In terms of climate change mitigation maximizing the share of walking, cycling and energy efficient public transport is beneficial. With modal split can also be viewed the sustainability of the community. Sustainable mobility requires an effective and comprehensive public transport, functional and safe pedestrian and bicycle paths, as well as an integrated urban structure.
				x	Number of public transport tickets provided by municipality to its employers	Employer-subsidized ticket is a public transport ticket provided by employers to their employees. This indicator measures the number of job tickets by city since 2008. This indicator presents the use of public transport to the number of commuter traffic
				x	Public transport ticket prices	Public transport ticket price describes the cost of using public transport and of its development since 1990. Prices have been corrected by the cost of living index.
				x	The traffic by type of vehicle and city	The traffic explains driven distance traveled inside the metropolitan area boundaries by different types of vehicle in a year. The calculation is based mainly on Transport Agency traffic counting. The traffic is determined so that the number of vehicles observed on the road in a given unit of time is multiplied by the length of the road section in which these cars are moving.
				x	Kilometers driven by passenger cars by person	

				x	The utilization and number of 'park and ride' parking lots for cars	Measures the development and utilization of 'park and ride' parking lots for cars as a percentage. Park and Ride to reduce car traffic within the city and enables the formation of a chain of low-carbon travel.
				x	The utilization and number of 'park and ride' parking lots for bicycles	Measures the development and utilization of 'park and ride' parking lots for bicycles as a percentage. Park and Ride promote the use of bicycles and allow the formation of a chain of low-carbon travel.
				x	Number of cars by municipality	The total number of passenger cars in a city in the metropolitan area. Increase in the number of cars increase the direct carbon dioxide emissions and other environmental impacts, such as, noise, space requirements and the impact on air quality. Indirectly the motorization consumes natural resources and energy when manufacturing vehicles.
				x	Number of cars per 1000 inhabitants	Passenger density describes the number of cars per thousand inhabitants. This indicator presents the development of passenger transport and, indirectly, emissions from transport development.
				x	Commuting into the Helsinki Metropolitan Area	Commuting describes the cross-border commuting. Measured as a percentage of commuters employed in the municipality. The data is based on Statistics Finland's employment statistics. Commuting also illustrates the urban structure i.e. population and the job placement in the region.
				x	People using public transport	Public transport passenger volume changes on an annual basis. Passenger volume in the metropolitan area indicates the annual get-ons in the number of different public transport modes in four municipalities, as well as get-ons in the number of inhabitants. This amount includes the metropolitan area get-ons to the tram, metro, buses (Helsinki, Espoo and Vantaa internal lines and regional transport) as well as the nearby trains. Figures do not include the ferry Finland Castle get-ons. Regional population has increased considerably in the 2000s.

111	Infrastructure and accessibility		Length of designated cycle lanes along roads in relation to total number of inhabitants (meters of lane per capita)	x	Length of designated cycle lanes in relation to total number of inhabitants (meters of lane per capita)	This indicator presents the number of cycle paths in relation to the population of municipality. Into the cycle path network is calculated separate cycling and walking paths, park paths as well as the adjacent carriageway combined pedestrian and cycle paths and greenways, if they are part of significant cycling network. It does not include the inner city and suburban streets, pavements. The increases in cycle path network illustrate efforts to promote environmentally friendly mobility.
112	Infrastructure and accessibility	Hybrid or fully electric cars in total stock of vehicles owned by city	Percentage of hybrid or fully electric cars in total stock of vehicles owned by city	x	Number of cars provided by municipality to its employers	Car benefit number in the city since 2008. Car benefit includes a car allowance, as well as the free use of the car that interest. Car benefit illustrates the number of private car usage in commuter traffic.
113	Infrastructure and accessibility	Public transport vehicles classified as low emission vehicles	Percentage of public transport vehicles classified as low emission vehicles (lower emission standards than EURO V)	x	Fuel distribution of busses (%)	Bus fuel distribution (%) of the total quantities of fuels used. This indicator presents the share of biofuels and its growth
114	Infrastructure and accessibility	Congestion	Average daily km of traffic jams per 1000 inhabitants in city			
115	Infrastructure and accessibility	Vehicle transport network	Total km of highway within municipality per 1000 inhabitants			
116	Infrastructure and accessibility	Distance to airport	Average distance to most nearby airport in km			
117	Infrastructure and accessibility	Capacity airport	Capacity of nearby airport in annual number of passengers			

118	Infrastructure and accessibility	Train/subway usage	Average daily number of passengers on train/subway system expressed as percentage of total inhabitants of city	x	People using public transport (million get ons/year)	Public transport passenger volume changes on an annual basis. Passenger volume in the metropolitan area indicates the annual get-ons in the number of different public transport modes in four municipalities, as well as get-ons in the number of inhabitants. This amount includes the metropolitan area get-ons to the tram, metro, buses (Helsinki, Espoo and Vantaa internal lines and regional transport) as well as the nearby trains. Figures do not include the ferry Finland Castle get-ons. Regional population has increased considerably in the 2000s.
119	Infrastructure and accessibility	Accessibility of public transport system	Percentage of population living within 300 meters of a public transport service	x	Rail transport user potential	Rail transport user describes the density of population and the number of jobs, in other words the potential number of users of train or subway near the station in relation to the surface area. It is obtained by adding together the residents and jobs from each station area and dividing by the amount of surface area. Delimitation is set to 600 m, which is considered a reasonable walking distance to the train station. The population and employment densities are divided into five different categories, from which can be seen how effective the use of each station area is.

Appendix 3. The Key Climate Indicators in the Helsinki Metropolitan Area - Helsinki Region Environmental Services Authority HSY 2014

Category	Indicator	Description
GHG emissions	Greenhouse gas emissions in Helsinki Metropolitan Area	The calculation takes into account all the direct emissions from buildings, electricity consumption, transport, waste, and industrial machinery and industrial machinery concerned. The indicator measures the total greenhouse gas emissions of the Helsinki Metropolitan area sector by sector. The indicator also describes the trend in relation to the reduction targets of the Helsinki Metropolitan area's climate strategy. (1000t CO2-ekv.)
Energy	Total Energy Consumption per person	The total energy consumption includes transportation, heating of the buildings, electricity consumption, and industries and working machines' fuel usage in the cities in the Helsinki metropolitan area. The heat consumption includes the heating repair. (MWh)
Electricity	Electricity Consumption per person	The indicator describes the amount of electricity used in one year per capita in the Helsinki metropolitan area. From the electricity supplied by the power grid companies into the municipalities area is reduced the calculated heating consumption of electricity. (MWh)
District Heating	Renewable Energy Sources	The indicator measures the fuels used in district heat production and describes the amounts and relationship between fossil and renewable fuels.
Urban structure	Population and Employment density	The indicator measures the condensation of the community structure and the potential to organize the public transport. The indicator takes into consideration the positive population growth expected in the region.
Transportation	Development of Station Areas	The indicator measures the rail station areas population and employment change in the region in relation to the average population and job growth in each time period.
	Choice of transport	This indicator measures the percentage of public transport, walking and cycling, as well as passenger traffic percentages of trips made in daily traffic.
Material efficiency	Amount of Household Waste and Recycling Rate	The amount of household waste per person describes the damage caused by waste to the environment and society, and the consumption behavior of the society. Together with the recycling rate the indicator reflects the effectiveness of the material efficiency in the Helsinki Metropolitan Area.
Procurement	Acquisitions with environmental conditions	Indicator measures the number of environmental aspects of procurements in euros of the cities purchases.

Appendix 4. Environment-related sustainability indicators - Hannover 2012

Category	Indicator	Description
Energy and Climate protection	Use of renewable energy sources	Percentage of renewable energy sources in the overall electricity consumption and percentage of photovoltaic installations
	Use of Combined Heat and Power	Number and output of CHP plants in town area (CHP) and their percentage contribution to electricity supply
	Domestic electricity	Domestic consumption of private households in kWh/inhabitant per year
	CO2-emissions due to thermal energy consumption by the city administration	CO2-emissions weather adjusted in tons CO2 per budget year
	CO2-emissions due to thermal energy production by the city administration	CO2-emissions weather adjusted in tons CO2 per budget year
Mobility and traffic	Car stock	Number of private cars in relation to the population in cars/1000 residents
	Modal split (choice of transport)	Share of means of transport (on foot, by bicycle, by car, by local public transport) over all journeys covered within the city of Hannover, in percent (%)
	Car Sharing	Number of persons entitled to drive, car share contracts and vehicles operated by stadtmobil Hannover GmbH
	Public transport offer	Total transportation capacities (vehicle output x average number of seats per vehicle) on all routes in the Greater Hannover public transport area (GVH) in seat-km per year
	Demand for local public transport	Number of passengers on local public transport within the Greater Hannover area (GVH) per year
	Public transport development	Share of residents (in percent) within the city of Hannover living within 300m of the next bus stop and/or maximum 500m of the next S-Bahn/Stadtbahn-stop
Air	General air pollution	Annual average air pollution sulphur dioxide, particulates (PM10), nitrogen dioxide, carbon monoxide and ozone
	Traffic-related air pollution	Annual mean values of pollution particulates (PM10), nitrogen dioxide, benzene, soot and carbon monoxide in roadside area

Noise	Noise exposure	Total area of noise-exposed districts, number of noise-exposed flats, schools and hospitals as well as number of people exposed to noise taking the road network as example
Soil and land-take	Land utilization	Areas by type of use as proportion of the total city area, in percentage and hectares
Recreational space, nature conservation, agriculture and forestry	Green and open spaces	Extent of green and open spaces in hectares, percentage of city area and in relation to the population in m2/resident
	Agricultural land	Size of agriculturally used areas in hectares and percentage
	Protected areas	Extent of protected landscape areas, nature conservation areas and protected landscape components in hectares
	Roadside trees	Number of roadside trees, new planting and tree felling
	Tree adoptions	Number of tree adopters and trees cared for
Water, groundwater, surface waters and wastewater	Drinking-water consumption	Consumption by tariff and special contract customers (e.g. individual industrial customers) in the water supply network of the Stadtwerke Hannover AG, total in million m3, and in liters/head
	Drinking-water consumption by the city administration	Total drinking-water consumption in municipal buildings in m3 in the budget year
	Biological quality of watercourses	Proportion of stretches of watercourses in quality class II in relation to the total length of all watercourses in percent
	Water quality of the River Leine	Water quality class as defined by the Saprobic index as well as ammonium content, BSB, and total phosphate
	Wastewater purification	Combined purification capacity of the sewage alliance operated by the Hannover wastewater urban sewerage plant
	Pollutant content of sewage sludge	Heavy metal content of sewage sludge in mg/kg dry weight and in percentage comparison to threshold values
Waste	Waste volume	Total quantities of waste delivered from the City of Hannover and Hannover Region in kg per head/annum
	Quantity of recyclables	Recyclables collected given as total and broken down by type in kg per head/annum
	Waste disposal volume	Quantity of disposed waste from the City of Hannover and Hannover Region in relation to the number of inhabitants in kg per head/annum

Appendix 5. Creenest City Action Plan Indicators - City of Vancouver 2014

Category (goal)	Indicator	Description
Green Economy	Total number of green jobs	Double the number of green jobs over 2010 levels by 2020
	Percentage of businesses engaged in greening their operations	Double the number of companies that are actively engaged in greening their operations over 2011 levels, by 2020
Climate Leadership	Total tones of community CO_2e emissions from Vancouver	Reduce community-based greenhouse gas emissions by 33% from 2007 levels
Green buildings	Total tones of CO_2e from residential and commercial buildings	Require all buildings constructed from 2020 onward to be carbon neutral in operations
		Reduce energy use and GHG emissions in existing buildings by 20% over 2007 levels
Green transportation	Per cent of trips by foot, bicycle, and transit	Make the majority of trips (over 50%) by foot, bicycle, and public transit
	Total vehicle km driven per person	Reduce the average distance driven per resident by 20% from 2007 levels
Zero waste	Annual solid waste disposed to landfill or incinerator from Vancouver	Reduce total solid waste going to the landfill or incinerator by 50% from 2008 levels
Access to nature	Per cent of city's land base within a five-minute walk to a green space	Ensure that every person lives within a five-minute walk of a park, greenway, or other green space by 2020
	Total number of additional trees planted	Plant 150,000 additional trees in the city between 2010 and 2020
Lighter footprint	Number of people empowered[2] by City-led or -supported projects to:	Reduce Vancouver's ecological footprint by 33% over 2006 levels
	Take personal action in support of a Greenest City goal	
	Reduce levels of consumption (cumulative)	
Clean water	Total number of instances of not meeting drinking water quality standards	Meet or beat the most stringent of BC, Canadian, and appropriate international drinking water quality standards and guidelines
	Total water consumption per capita	Reduce per capita water consumption by 33% from 2006 levels
Clean air	Number of instances where air quality standards[3] were not met	Meet or beat the most stringent air quality guidelines from Metro Vancouver, BC, Canada, and the World Health Organization
Local food	Number of neighborhood food assets in Vancouver	Increase city-wide and neighborhood food assets[4] by a minimum of 50% over 2010 levels